Physics in Aperiomics

Introduction

The Pythagorean Equation

This model is based on the Pythagorean Equation, and various properties of Pythagorean Triangles. From these the concepts of electromagnetism and space-time are derived. It begins with classical physics from first principles, where most first year university textbooks start. It uses some new concepts in math, but shows these are compatible with first classical physics then more advanced fields. Quantum mechanics, General and Special Relativity, quantum field theory are derived in this model after it is shown to be consistent with classical physics. Because of this beginning from the foundations, it takes some time to go through to the frontiers of modern physics.

Beginning with classical physics

The model then begins with simple classical physics as do most physics courses. It includes these other math concepts when they are needed, excerpts from math textbooks are included with them. In following actual textbooks, the aim is make sure all aspects of modern physics are compatible with this model. No topic is skipped, in principle all the problems and exercises in these textbooks should be solvable by this model as they are now. Basic ideas such as kinematics are covered in some depth, the model is shown to work with concepts such as velocity, momentum, conservation of energy, kinetic and potential energy, work and impulse, etc.

Electromagnetism

The model then goes into electromagnetism, it shows how electric charge and magnetic fields are also derived from it. Light is derived as photons, the model has these behave as particles and waves. It also includes the nature of protons and electrons, how they may be formed from the math of this model. Many physical constants are also derived mathematically in this framework.

Quantum mechanics and relativity

Once these foundations are shown to be compatible with this theory, then quantum mechanics, quantum electrodynamics, quantum field theory, and relativity are also derived. All of these flow from the model's basic compatibility with the basics of classical physics. For example general and special relativity are also based on Pythagorean Triangles.

Basic and advanced concepts

Because the text needs to be very long, it follows two main paths. Each part of many textbooks is analyzed to show how the model is consistent with it. Also, some more advanced concepts are added in between when some new idea is introduced in a textbook. This allows a reader to sample some ideas that will be covered in exhaustive detail later. For example, discussing Cartesian coordinate systems leads to some discussions on curved coordinate systems in General Relativity. Sometimes concepts are repeated because of their relevance to other aspects of conventional math and physics. This can make some easier to remember.

Before the textbooks

The introduction discusses some basic concepts before the textbooks begin. In some cases these will be hard to remember, they will be revisited many times later with actual examples going through the textbooks.. It is more important to get an intuitive overview and then revise as needed later. At this stage it is not known how difficult this will be to understand and remember, it then tries to err on the side of explaining many times in different ways.

Proving consistency step by step

When time is discussed as part of kinematics for example, this leads to some discussions on General and Special Relativity. Where these seem obscure or hard to follow, the best way may be to read them and absorb some of the ideas. Then later when they covered in more detail the basic ideas may be easier to revise. The whole basis of this model is that it should be mathematically consistent throughout. This necessitates a lot of analysis to prove that step by step.

Pythagorean Triangles

The model derives most of its concepts from Pythagorean Triangles and the Pythagorean Equation, this leads to discussions on the nature of trigonometry and calculus. Some different math is used in parts, but this gives the same answers as conventional math does.

A model

In most cases the hypotheses here are referred to as a model. When this deviates from mainstream math, physics, chemistry, cosmology, etc those are referred to as conventional. For example, it might discuss conventional physics or conventional calculus.

12 color codes

This model uses color coding as friendly names, to make it easier to remember. Each color represents a Pythagorean Triangle side with a different property. These colors have no significance except they make it easier to keep some concepts from being confused. This should not need to be studied at first, with some repetition the friendly names should become easier to remember. The idea of friendly names like this is common in conventional physics.

Roy and Biv

There are also groups of colors, Roy or Red-Orange-Yellow refers to electromagnetism including protons, electrons, neutrons, as well as quarks and neutrinos. Biv or Blue-Indigo-Violet represents space-time, that includes General and Special Relativity. Yellow and Green refer to photons, Green and Blue refer to gravity waves. Separating Roy and Biv like this prevents confusion between electromagnetism and such concepts as inertia and gravity.

Nomenclature

This model tries to use conventional math and physics terms where possible. To avoid confusion some new terms are also used. In some cases using these conventional terms can also cause confusion, the potential for example is used here. Energy is used because this is a common term, but energy itself is regarded as an approximation of other principles.

Adjectives from the Pythagorean Triangles

Each Pythagorean Triangle has common connections to conventional physics, because of this that attribute is prefaced by the Pythagorean Triangle’s name. The kinetic energy comes from the -𝟘d and e𝕪 Pythagorean Triangle as the electron, this leads to the terms -𝕆D kinetic torque or -𝕆D probability. When the -𝕚d and e𝕧 Pythagorean Triangle is used as inertia this uses the term -𝕚d as inertial time, -𝕠d from the -𝕠d and e𝕪 Pythagorean Triangle would be kinetic time. This is to avoid confusion, using the term time for example would not show where this time was being observed in this model. Seeing the adjective kinetic would immediately associate it with the -𝕠d and e𝕪 Pythagorean Triangle as the electron.

Positive and negative

Generally, the use of positive and negative terms is avoided outside of this model, this is because some Pythagorean Triangle sides such as +𝕠d and -𝕠d have signs that mean different things. They are similar but not the same as a positive and negative charge, +𝕠d is associated with the proton and -𝕠d with the electron. Often positive and negative are used in other concepts with conventional physics, such as positive acceleration and negative acceleration. In this model they are not used to avoid confusion with the applications of positive and negative here. A negative acceleration would be referred to as deceleration for this reason. When these differences are clear enough, many positive and negative terms can be reused later. The text tries to avoid confusion where possible.

Classical physics

Usually in classical physics more advanced ideas such as quantum mechanics and relativity are avoided. In this model to avoid confusion and approximations these are discussed very early on. Kinematics for example is tied to General Relativity when a ball rolls down a hill, this could be near an event horizon so there can be a slowing of time and a height contraction. When a ball is thrown Special Relativity is discussed from the beginning, a high enough velocity of the ball might approach c. The uncertainty principle is also discussed early, in classical physics the concept of a simultaneous measure of a position and momentum is assumed to be possible. Also, probability is associated with wave concepts at an early stage. This avoids the use of classical terms that do not fit with this model, while showing the model is consistent with them as an approximation.

Square roots and squares

Each Pythagorean Triangle begins with sides that are square roots, many are the same in conventional math. Some work like imaginary numbers, these are explained as the text requires it.

Doublescript with lower and uppercase

When a Pythagorean Triangle side is a square root it is a lowercase letter, this model uses doublescript letters to distinguish them from other variables. When a Pythagorean Triangle side is squared this gives an uppercase letter. For example e𝕒 refers to a lowercase square root of one Pythagorean Triangle side in the +𝕠d and e𝕒 Pythagorean Triangle. If this side is squared then it becomes E𝔸.

Using d and e

In this model a square root has a d or an e value associated with it, -𝕠d from the electron is the square root of -1. e𝕪 would be a square root but it has no sign, as a vector it can be added and subtracted but not as plus or minus. Here -𝕠d works in a similar way to ni in conventional math where i is the square root of -1, -𝕠 is like an instant or fluxion in calculus, it is multiplied by a squared root d. The positive square root of -1 is +𝕠d, this has different properties and is associated with the proton. The term e𝕒 refers to an infinitesimal 𝕒 times e. When this is squared e becomes a square also as E to avoid confusion, so (e𝕒)^2=E𝔸.

Deviations from conventional math

The following gives some of the Pythagorean Triangle side interactions, it is not necessary to remember these here. They will be used and explained as needed in the text. All of them will be shown to be consistent with concepts in conventional math. Where there are some deviations to this, they will be shown to give the same overall answers. One of the proposals in this model is these variations make some outstanding problems easier to solve.

Color codes

These are the 12 colors which are abbreviated in brackets: Red (e𝕒), Red-Orange (+𝕠d), Orange (𝕠d), Orange-Yellow (-𝕠d), Yellow (e𝕪), Green (-𝕘d), Yellow-Green (e𝕪×-𝕘d) Green-Blue (+𝕘d× e𝕓), Blue (e𝕙), Blue-Indigo (+𝕚d), Indigo (𝕚d), Indigo-Violet (-𝕚d), and Violet (e𝕧).

Straight and spin Pythagorean Triangle sides

The Pythagorean Triangle sides +𝕠d, -𝕠d, -𝕘d, +𝕘d, +𝕚d and -𝕚d represents spin as Pythagorean Triangle sides. The straight sides of a Pythagorean Triangle are e𝕪, e𝕒, e𝕧, and e𝕙. For example a straight Pythagorean Triangle side as e𝕧 is length, this might be turned with -𝕚d as spin. The two together can represent a vector which can be rotated, it is similar to the exponents in the Euler Equation.

Roy and Biv

In this model Roy refers to electromagnetism, r stands for the e𝕒 positive charge and e𝕪 for the negative charge. Biv stands for space-time where e𝕙 is the height above a gravitational source and e𝕧 is the length moved with inertia.

Spin and straight Pythagorean Triangle sides

Each Pythagorean Triangle has a spin side and a straight side. The spin side can represent a rotation or torque, the straight side represents moving straight without spin. The Pythagorean Triangle sides have specific properties and cannot be swapped to use elsewhere, for example e𝕧 acts as the length of something and e𝕙 is the height above matter. It cannot be said that a satellite is a e𝕧 length above a planet for example, e𝕙 height is a special property of gravity. There is no width in this model, all of Biv space-time can be defined in terms of a e𝕙 height above a gravitational source and a e𝕧 motion with inertia. Volumes are a classical approximation only here, that is because all the forces are squares not cubes.

Constant areas

Each Pythagorean Triangle has a constant area, as one side contracts for example the other side dilates inversely to this. The Pythagorean Triangle areas are conserved in this model and cannot change, the Pythagorean Triangle acting as a particle can be annihilated or created.

Iotas

Because of the particle/wave duality particles here are referred to as iotas, meaning a single Pythagorean Triangle. This reduces some confusion when a particle can be measured as a wave function, here the word particle would not be used. An iota then can be a particle or a wave.

Measurement and observation

In this model a measurement refers to waves only, because the wave cannot be observed as an object it can be measured. A particle is an object and so it can only be observed not measured. Sometimes an iota might be a wave function that is measurable, then a particle that is observable.

Angle θ

Although the Pythagorean Triangle areas are fixed their angles can change, the angle θ is defined by convention to be opposite the spin Pythagorean Triangle side. Sinθ would then be the spin Pythagorean Triangle side such as -𝕚d divided by the hypotenuse. Cosθ would be the straight Pythagorean Triangle side such as the e𝕧 length divided by the hypotenuse.

Constant area trigonometry

Because the Pythagorean Triangle area cannot change, constant area trigonometry does not have a hypotenuse with a constant size here. The answers are the same, for any Pythagorean Triangle in conventional trigonometry it can be grown or shrunk so the area is the same throughout. The ratios of the sides remain the same as well, for example sin 30° would be the same in conventional and constant area trigonometry. The point is the constant Pythagorean Triangle area is conserved, that leads to some different insights with conservation laws.

The hypotenuse as zeta

In this model the hypotenuse is rarely used, usually tanθ gives a ratio between a straight and spin Pythagorean Triangle side. For example, e𝕧/-𝕚d would be the ratio of the length to inertial time. That gives an angle θ, tanθ would have the same value in conventional and constant area trigonometry. Here zeta or ζ is used as a name for the hypotenuse.

The nature of the Pythagorean Triangles

This model is described by eight different Pythagorean Triangles, each acts in a different way with various physical laws. These are not the same as a many dimensioned model such as string theory, e𝕒 for example is associated with a positive or potential charge while e𝕪 is associated with a kinetic or negative charge. +𝕠d refers to a potential magnetic field, that is associated with the concept of a potential. It also refers to the magnetic field of a proton. -𝕠d refers to a kinetic magnetic field, this is from an electron. e𝕙 refers to height above a mass exerting gravity, the inverse of this is sometimes used as e𝕓 depth in a gravitational well. e𝕧 refers to a length.

Space-time positions

In this model a straight Pythagorean Triangle side can be regarded as a ruler or scale, it is never curved. A position or point on it would be e𝕧 for example, that is a position on the ruler in terms of length. A vertical ruler from a gravitational source would have a e𝕙 height, with points or positions on it. A point or position is an infinitesimal like in calculus, it has a position but no size.

Space-time displacements

Here a displacement is moving from an initial position to a final position. That requires a force in this model, it is not possible to move without one. In between an initial position e𝕧$_I$ and a final position e𝕧$_f$ there would have to be a force displacing this motion. It would accelerate and then decelerate. It is called E𝕍 here as the inertial displacement. With the e𝕙 height a motion from an initial e𝕙$_I$ to a final e𝕙$_f$ is called an Eℍ gravitational displacement. That also would represent an acceleration and deceleration requiring a force.

Electromagnetic positions

In this model e𝕒 is also like a ruler, it is the altitude above a proton. It is also the positive electric charge, referred to here as the potential electric charge. That is because positive and negative should not be used with straight Pythagorean Triangle sides. They only have vector addition and subtraction which does not need signs. e𝕒 then would be a potential position where the potential electric charge had a value above a proton. The e𝕪 kinetic position would be a position above an electron on a straight ruler. Here charges work the same as the dimensions of height and length. These are also vectors.

Electromagnetic displacements

In this model an electromagnetic displacement is a motion from an initial to a final position like with height and length. The potential displacement would be E𝔸 going from $e\mathbb{a}_I$ to $e\mathbb{a}_f$. The kinetic displacement would go from $e\mathbb{y}_I$ to $e\mathbb{y}_f$. These would be used in Coulomb's law as an attraction between charges, they accelerate with an E𝔸 potential and E𝕐 kinetic displacement. That means unlike charges are displaced closer to each other with an acceleration, then a deceleration.

Space-time positions and displacements with impulse

Electromagnetic points and positions can define all motions of the charges, space-time points and positions can define all motions in regard to height and length. Here these are used with impulse as a force with respect to time. For example, an E𝕍/-𝕚d inertial impulse is a change of inertial position, as an inertial displacement, observed at an instant of -𝕚d inertial time. An object moves with inertia from an initial inertial position and then is observed at a final inertial position at a particular instant of time. A Eℍ/+𝕚d gravitational impulse would be from an initial to a final gravitational height observed at a +𝕚d gravitational time. The -𝕚d inertial time need not be the same as the +𝕚d gravitational time, for example near an event horizon gravitational time would be slower.

Electromagnetic positions and displacements with impulse

Just as with height and length, a proton can move with a E𝔸/+𝕠d potential impulse from an initial to a final potential position. Then it is observed as a particle at a +𝕠d potential time as an instant. An electron can move with a E𝕐/-𝕠d kinetic impulse from an initial to a final kinetic position. Then it is observed at a -𝕠d kinetic time as an instant. With impulse all displacements can be observed with impulse at particular times. This describes much of the Newtonian universe.

Space-time instants

In this model there are four different spin Pythagorean Triangle sides, in Biv space-time there is the +𝕚d gravitational field and the -𝕚d inertial field. With the Eℍ/+𝕚d gravitational impulse mentioned earlier this is observed with +𝕚d gravitational time. It is consistent with general relativity, so time can be slower near an event horizon for example. The -𝕚d inertial time is used to observe the E𝕍/-𝕚d inertial impulse. That is consistent with special relativity, it would be slower as a rocket approached c.

Space-time duration

In this model an instant is a point in time on a clock gauge, this is a circular device that used with spin. The ruler is used with straight Pythagorean Triangle sides for straight-line positions and displacements. In between a starting and final instant of time there is a duration, that is a force like displacement. A clock hand would accelerate with a torque from an initial instant of time, then decelerate to a final instant. These durations are used to measure work done at various positions on a ruler.

Electromagnetic instants

There is also +𝕠d potential time from the proton, this is used to observe the E𝔸/+𝕠d potential impulse. The E𝕐/-𝕠d kinetic impulse uses -𝕠d kinetic time to observe the E𝕐 kinetic displacement. This will become clearer in the main text, the point here is that the model uses four different kinds of time to observe the four kinds of impulse.

Electromagnetic duration

There are two kinds of time as a duration, with a potential and a kinetic clock gauge. These also change with a torque from an initial to a final instant of time. They allow for two kinds of work to be measured, as +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. They measure wave functions with positions on the ruler.

Work and impulse

Together there are four kinds of impulse which can be observed, two are Roy electromagnetic with protons and electrons. Two use Biv space-time with gravity and inertia. There are four kinds of work which can be measured, two are Roy electromagnetic with protons and electrons. Two in Biv space-time use gravity and inertia.

Newtonian physics

Together these can describe all of Newtonian physics, collisions between particles occur with impulse. The fields such as gravity are described with work. Light also uses Pythagorean Triangles here as work and impulse. This model can duplicate all the equations of Newtonian physics, later it will be shown how it also covers relativity and quantum mechanics.

Gravity and inertia

This model allows for simple physical ideas to be represented with Pythagorean Triangles, the +𝕚d and e𝕙 Pythagorean Triangle acts as gravity. e𝕙 is the height above a planet's surface for example, +𝕚d acts as the gravitational field. Dropping a ball then can be described as a change in e𝕙 height in a +𝕚d gravitational field. Throwing a ball uses the -𝕚d and e𝕧 Pythagorean Triangle as inertia, the ball is thrown a length e𝕧, it has a -𝕚d inertial mass.

Mass and time

Also in this model +𝕚d acts as gravitational time, -𝕚d is inertial time. In some cases these Pythagorean Triangle sides act as mass, in other situations they act as time. This will be explained in the text, the two Pythagorean Triangles then can describe simple situations like a ball being thrown and falling with gravity.

Electromagnetism

Electromagnetism is described by the +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the -𝕠d and e𝕪 Pythagorean Triangle as the electron. An electric attraction can be represented as the e𝕒 altitude above a proton giving the potential electric charge. The electron has a e𝕪 kinetic electric charge and these two attract each other, together a simple model as a hydrogen atom can be described by the two Pythagorean Triangles.

Light

In this model light comes from the e𝕪 and -𝕘d Pythagorean Triangle, photons as these Pythagorean Triangles can be emitted and absorbed by the electrons as -𝕠d and e𝕪 Pythagorean Triangles. This causes their angles θ, opposite their spin Pythagorean Triangle sides -𝕠d, to contract or dilate. When these photons move through Biv space-time they can affect the inertia of matter with its -𝕚d and e𝕧 Pythagorean Triangles. Their paths are also bent by becoming closer to the +𝕚d and e𝕙 Pythagorean Triangles as gravity.

Modeling Roy electromagnetism and Biv spacetime

With these Pythagorean Triangles then many physical phenomena can be modeled, electricity and magnetism can be associated with photons. They interact with inertia and gravity.

Relativity

As will be shown, these Pythagorean Triangles work with General and Special Relativity from their nature. They give the correct answers for such as e𝕧 length contraction and -𝕚d time dilation. This is because the equation for Special Relativity uses a Pythagorean Triangle, γ or gamma $=\sqrt{(1-v^2/c^2)}$ which multiplied by c^2 in the brackets gives $\sqrt{(c^2-v^2)}$.

Constant area trigonometry

In this model there is a change to trigonometry, because the areas of Pythagorean Triangle are constant then a changing angle requires the Pythagorean Triangle sides and hypotenuse to change differently to conventional trigonometry. The answers are the same in most cases, with an angle θ change as sinθ, opposite the spin Pythagorean Triangle side, this side would change in size.

Converting to conventional trigonometry

Instead of the adjacent Pythagorean Triangle side staying the same this must change inversely to the changes in the spin Pythagorean Triangle side. For example, if the spin Pythagorean Triangle side doubles, then the straight Pythagorean Triangle side must halve to maintain the same Pythagorean Triangle area. Because of this the hypotenuse ζ cannot also remain a constant size with the angle change. This can be converted to standard trigonometry by resizing the Pythagorean Triangles as needed.

Special Relativity and trigonometry

This becomes important in Special Relativity where the equation $\sqrt{(1-v^2/c^2)}$ is used, the 1 acts as a hypotenuse in conventional physics. This model converts that equation to give the same answers using a constant Pythagorean Triangle area.

Square root Pythagorean Triangles and squaring sides

In this model a Pythagorean Triangle has square root sides, for example the -𝕚d and e𝕧 Pythagorean Triangle as inertia might have one side of e𝕧 with $e=\sqrt{3}$ and another of -𝕚d with $d=\sqrt{5}$, the hypotenuse ζ or zeta is rarely used. This leads to the concept of quantization as shown later, with a squared force $\sqrt{3}$ as E𝕍 would become 3 as an integer. The quantum numbers come from the spin Pythagorean Triangle sides squared, these give the discrete spectrum from quantized orbitals. The straight Pythagorean Triangle sides give a continuous spectrum so the two need to defined as separate.

Quantum numbers

Taking the spin Pythagorean Triangle sides squared these would quantum numbers +𝕀D from the +𝕠d and e𝕒 Pythagorean Triangle as the proton. This is the same as n in quantum mechanics where d= 1, √2, √3, √4,… as √n. When squared as a force this gives 1,2,3,4,… as n. The difference comes from +𝕀D being a squared spin which in this model is a potential torque. Because waves are associated with torque as an oscillation then only the spin Pythagorean Triangle sides can act as waves. The straight Pythagorean Triangle sides do not spin, because of this they act as particles.

Velocity and conversions

A velocity e𝕧/-𝕚d might have e=√3 and d=√5, as an acceleration it might be E𝕍/-𝕚d where E=3 and d=√5 in meters^2/second. This is related to the E𝕍/-𝕚d inertial impulse and is different in this model to e𝕧/-𝕀D in meters/second^2 which relates to the -𝕀D×e𝕧 inertial work. The two are not convertible from one to another in this model except as a classical approximation.

Wave particle duality

This is because the E𝕍/-𝕚d inertial impulse refers to forces with particles, -𝕀D×e𝕧 inertial work refers to forces with waves. These have different properties, in quantum mechanics they are separate. In classical physics however they are often combined, in this model they are kept separate from the beginning to avoid confusion later.

Defining the Pythagorean Triangle sides

A Pythagorean Triangle in this model has two sides excluding the hypotenuse, the straight side has a position that is read on a scale. This is like a straight ruler, √3 centimeters on it for example is a position. When this Pythagorean Triangle side is squared it becomes a force as a displacement. To move from the start of the ruler to the end or final position such as √3 requires a force of displacement. This takes time, then the spin Pythagorean Triangle side acts as a gauge of time like a clock. This is like a position in time, this model calls it a moment, an instant, or the calculus term fluxion. When this is squared it is called a duration, from a starting time to a final time.

Impulse

Using the -𝕚d and e𝕧 Pythagorean Triangle as an example a position would be e𝕧 on a ruler. The scale is of length. The displacement from the start of the ruler to the end requires a force E𝕍, this would be centimeters^2 on the ruler. A clock would be used as a gauge to observe this displacement, a position on this clock is called a moment. This is called observing the impulse in this model.

Work

If instead the clock was being measured then it would be a torque or rotational force where a clock hand was spun faster from an initial to a final moment. That would be a square called a duration of time. This would be measured in relation to a position on the ruler as e𝕧. That is called measuring work in this model because the force of the torque is compared to a scale or ruler of positions. The terms scale and ruler are used interchangeably here.

Observing versus measuring

In this model the two terms are separated, it is proposed that a particle can be observed but a wave cannot. This is because a wave is a field with no observable boundary. Instead, a wave is measured here. Impulse always refers to observing particles and work always refers to measuring waves. This is not defined exactly like this in classical physics, but it will become important later in how the model deals with relativity and quantum mechanics. In the meantime this will give the same answers to equations as a conventional use of these terms.

The -𝕠d and e𝕪 Pythagorean Triangle

This acts as an electron in this model, more explanations will be given later as to how this accounts for its mass, size, charge, etc. The e𝕪 straight Pythagorean Triangle side acts as the kinetic electric charge, when it is attracted electrically to a proton this is called the Coulomb force. The -𝕠d spin Pythagorean Triangle side is called the kinetic magnetic field, the two together are called the kinetic electromagnetism, the work kinetic is used to connect this to the -𝕠d and e𝕪 Pythagorean Triangle. E𝕐 is the kinetic electric force, it represents a displacement from a starting e𝕪 position to a final position. There is a E𝕐/-𝕠d kinetic impulse where the e𝕪 kinetic electric charge is squared as the kinetic electric force. There is also -𝕆D×e𝕪 kinetic work where the -𝕠d kinetic magnetic field is squared as the kinetic magnetic force, also called the -𝕆D kinetic difference in voltage, the kinetic mass force, the kinetic torque, and the kinetic probability.

The +𝕠d and e𝕒 Pythagorean Triangle

This is the proton, the e𝕒 straight Pythagorean Triangle side is referred to as the potential electric charge, it is also referred to as the altitude above a proton on a straight scale like the ruler. That gives the attraction between it and the e𝕪 kinetic electric charge in the Coulomb force. The +𝕠d spin Pythagorean Triangle side is called the potential magnetic field, the two together are called potential electromagnetism. With E𝔸 this is a squared displacement from a starting position to a final position. This gives a E𝔸/+𝕠d potential impulse where +𝕠d is called potential time on a clock gauge. It also gives the +𝕆D×e𝕒 potential work where +𝕆D is the potential magnetic force, it is also called a potential torque, a potential mass force, a potential difference in voltage, or a potential probability. The terms are the same with each Pythagorean Triangle, a position is used as a term here with an electric charge to keep the terminology the same throughout.

The e𝕪 and -𝕘d Pythagorean Triangle

This represents a light photon, it gives the differences between the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron. In a Hydrogen atom for example the changing of the electron's orbital would cause a e𝕪×-𝕘d photon to be absorbed or emitted. This has a straight Pythagorean Triangle side e𝕪 as the kinetic electric charge, that is the same as the electron but it represents the change in the electron from the photon being emitted or absorbed. Here -𝕘d is the spin Pythagorean Triangle side, it is like -𝕠d from the electron but it again represents the change in the electron. E𝕐 represents a displacement from a starting to a final position as with the electron. -𝔾D represents the square of -𝕘d, this is the duration from a starting to a final moment. It can also be called the light torque or the light probability here. The light Pythagorean Triangle like all the others has a constant area. The photon can be observed as a particle with a e𝕐/-𝕘d light impulse, it can also be measured as a wave with -𝔾D×e𝕪 light work.

Roy electromagnetism

These three Pythagorean Triangles are proposed to give all the observations and measurements of electromagnetism, with the emission and absorption of photons. Roy is a friendly name of Red-Orange-Yellow. Here e𝕒 is often used as altitude instead of e𝕣 as the radius of the proton's potential electric charge. This is more useful, an altitude e𝕒 refers from the proton up to a position. An e𝕣 radius refers to from the position above down to the proton, so they are inverses of each other.

There is a fourth Pythagorean Triangle also used called the e𝕒 and +𝕘d Pythagorean Triangle, this is not needed until later.

Biv space-time

Just as three Pythagorean Triangles define Roy electromagnetism, there are another three that define Biv space-time. Here Blue-Indigo-Violet refers to three colors like Roy. Blue refers to a depth of a gravitational well, also used is the term e𝕙 height which represents from the surface of a gravitational mass to a position above it. In some cases e𝕓 as depth is more useful, generally e𝕙 as height is used here. The e𝕓 depth is the inverse of the e𝕙 height.

The -𝕚d and e𝕧 Pythagorean Triangle

This will be more commonly used for examples because its Pythagorean Triangle sides are more familiar. As before, e𝕧 represents an inertial position like on a ruler, this is different from a kinetic position and a potential position referred to with different Pythagorean Triangles earlier. -𝕚d would represent an inertial time on a clock gauge, also an inertial field or mass. E𝕍 represents a displacement from a starting to a final position. -𝕀D represents a temporal duration from a starting to a final inertial moment. This is referred to, similar to the previous Pythagorean Triangles as a -𝕀D inertial torque, inertial mass force, inertial difference, or an inertial probability. There is the E𝕍/-𝕚d inertial impulse where the Pythagorean Triangle reacts like a particle, the -𝕀D×e𝕧 inertial work where it reacts like a wave.

The +𝕚d and e𝕙 Pythagorean Triangle

This Pythagorean Triangle represents gravity, the e𝕙 height as the straight Pythagorean Triangle side is a position above matter. The inverse to this is e𝕓 as the depth in the gravitational well down to this matter. The spin Pythagorean Triangle side is +𝕚d, this represents the gravitational field as well as time. Eℍ is e𝕙 squared, it represents a gravitational displacement from a starting e𝕙 position to a final e𝕙 position. When +𝕚d is squared this gives +𝕀D as the gravitational torque, probability, difference depending on the context.

The +𝕘d and e𝕓 Pythagorean Triangle

In this model the +𝕘d×e𝕓 Pythagorean Triangle is called a Gravi, it is similar to a photon but acts with gravity also like a graviton as a particle. It has a particle/wave duality as well, it models gravitational waves. Here e𝕓 is used as depth, also e𝕙 could be used as height depending on which is most useful. When Eℍ is the square it is a Gravi displacement, with neutron stars approaching each other then this would be an initial e𝕓 position to a final e𝕓 position. This gives the e𝔹/+𝕘d Gravi impulse where +𝕘d represents a Gravi time on a clock gauge. While gravitational waves are being measured this is +𝔾D×e𝕙 Gravi work where +𝔾D is the spin Pythagorean Triangle side +𝕘d squared. It can also be the Gravi torque, the Gravi mass force, the Gravi difference, and the Gravi probability.

Six Pythagorean Triangles

There are two more Pythagorean Triangles, but these will suffice to show how the model works. The e𝕒 and +𝕘d Pythagorean Triangle acts like a virtual photon, the e𝕧 and -𝕘d Pythagorean Triangle is called an Iner (shortened from inertia like a Gravi is shortened from gravity), it acts like a virtual Gravi but with inertia. The Iners are not observed or measured directly. In Roy electromagnetism the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle give the proton and electron in a Hydrogen atom, the e𝕪×-𝕘d Pythagorean Triangle gives the photon emissions and absorptions. This model uses work and impulse to describe their forces. In Biv space-time there is the +𝕚d and e𝕙 Pythagorean Triangle with gravity and the -𝕚d and e𝕧 Pythagorean Triangle with inertia. Gravity would be proportional to the proton and inertia to the electron, this describes how they move with both an electromagnetic charge and with gravity and inertia. The Gravi is similar in concept to the graviton, its acts like the photon to transmit changes between gravity and inertia. Gravitational waves as +𝔾D×e𝕓 Gravi work are being measured with neutron stars combining currently, black holes are discussed later.

Classical physics

The six Pythagorean Triangles could be used to describe classical physics accurately. Biv space-time gives gravity and inertia with work and impulse. Roy electromagnetism covers the properties of magnetism and electricity. Light is modeled by the e𝕪 and -𝕘d Pythagorean Triangle. While the Gravi as the +𝕘d and e𝕓 Pythagorean Triangle was not known, it was expected in the 19th century that gravitational changes would be propagated somehow. These Pythagorean Triangles will be shown to be consistent with classical physics, then shown to be compatible with quantum mechanics, quantum field theory, quantum electrodynamics, Special and General Relativity. They will also be shown to explain some unknown aspects of these as direct implications of the Pythagorean Triangles.

Matter and mass

In this model mass refers to the spin Pythagorean Triangle sides, it also acts as time with impulse. Instead of using the word mass, which here is associated with waves and work, the words matter and iotas are preferred to encompass a particle/wave duality. The term mass is sometimes used with the +𝕚d gravitational mass and the -𝕚d inertial mass. There is also -𝕠d as the kinetic mass and +𝕠d as the potential mass, the reasons for these terms will be explained later.

Circular, parabolic, and hyperbolic geometry

The +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravitation are in circular geometry with this model. This is similar to spherical geometry in conventional math and physics. The difference is this model does not use volumes except as a classical approximation, instead areas are used such as a circle. The -𝕠d and e𝕪 Pythagorean Triangle as the electron and the -𝕚d and e𝕧 Pythagorean Triangle as inertia are in hyperbolic geometry, in between these they form parabolic geometry which explain most classical forces.

Conic sections

The circle and hyperbola are associated with the Pythagorean Triangles here because they are conic sections, the circular geometry comes from circles and ellipses through the cone. The hyperbolic geometry comes from a vertical section through the cone, the parabolic geometry is in between the two.

Active and reactive forces

In this model two of the Pythagorean Triangles are active forces and two are reactive. The -𝕠d and e𝕪 Pythagorean Triangle as the electron has active forces, this means it can act on a reactive Pythagorean Triangle. For example, the -𝕠d and e𝕪 Pythagorean Triangle as the electron has a kinetic impulse or does kinetic work, when pushing on an object there is an equal and opposite reactive force from the -𝕚d and e𝕧 Pythagorean Triangle as inertia. That makes an action/reaction pair.

Action reaction pairs

The +𝕚d and e𝕙 Pythagorean Triangle as gravity is also active, it can pull objects toward it, inertia from the -𝕚d and e𝕧 Pythagorean Triangle is reactive so this acts with an equal and opposite force against it. The +𝕠d and e𝕒 Pythagorean Triangle as the proton is also reactive only, it reacts against the electron with its active forces. It also reacts against the active forces of gravity, for example a number of protons in a nucleus would attract each other with gravity. They also have a reaction against this which appears as a repulsion in between the protons.

The nature of mass and time

In this model time is rotation in relation to impulse not with work, we tell time for example by how a clock's hands turn as a gauge. It comes from the spin Pythagorean Triangle sides, there is then kinetic time, potential time, light time, inertial time, Gravi time, and gravitational time. In Special Relativity we measure time dilation by a slowing of the rotation of a clock's hands. Other physical phenomena are also reduced to rotation in this model. When the spin Pythagorean Triangle sides are multiplied in an integral they act as mass, so there is kinetic mass, potential mass, light mass, Gravi mass, inertial mass and gravitational mass. Each is prefaced from the type of Pythagorean Triangle it comes from, the reasons for calling all these mass will be explained later.

Magnetic fields and time

In this model an electric force can only be observed in relation to time as a clock gauge, for example a generator or motor will be associated with a particular electric charge according to the time it takes to rotate. The fraction e𝕪/-𝕠d is referred to as a kinetic velocity but it is also a ratio of electricity to magnetism. A compass needle or a meter using magnets turns at a rate giving the strength of a electric field from a generator.

Speed and velocity

In this model speed has no particular direction, as in conventional physics. A straight-line motion is called a velocity. The +𝕠d and e𝕒 Pythagorean Triangle as the proton has a e𝕒/+𝕠d potential speed, that is proportional to the e𝕙/+𝕚d gravitational speed. The -𝕠d and e𝕪 Pythagorean Triangle electron has a e𝕪/-𝕠d kinetic velocity, this is proportional to the e𝕧/-𝕚d inertial velocity.

Four Pythagorean Triangles with speed and velocity

In this model there are four Pythagorean Triangles having a speed or velocity, with the -𝕠d and e𝕪 Pythagorean Triangle as the electron there is the e𝕪/-𝕠d kinetic velocity. This is proportional to the -𝕚d and e𝕧 Pythagorean Triangle and its inertial velocity e𝕧/-𝕚d. Why this kinetic velocity is a useful concept will be shown later, it extends the convention of naming each physical phenomenon where possible with each Pythagorean Triangle's properties. There is a potential speed as e𝕒/+𝕠d, that is proportional to a e𝕙/+𝕚d gravitational speed also called brevity here. A ball falling in gravity would then have a e𝕙/+𝕚d gravitational speed at a e𝕙 gravitational position and a +𝕚d gravitational moment. This is a gravitational angular speed where the ball might be in an orbit at a e𝕙 height with an orbital period of +𝕚d in seconds. The e𝕒/+𝕠d potential speed would also be represented by an orbital.

Time and probability

In this model a straight Pythagorean Triangle side acts like a scale, such as a position on a ruler. A spin Pythagorean Triangle side acts like time as moments or instants on a clock, this can also be called a gauge here. Probability is also referred to as a proportion using the phrase "of the time" rather than being time as an instant. It means that there would be a starting to a final measurement as a temporal duration, in between there is a probability of what times are measured. A temporal duration is associated with the uncertainty principle, a point in time as an instant or moment is not uncertain. So when a time becomes uncertain it is a probability in this model. When a position becomes uncertain it is a displacement between two points.

Distance and possibility

A position on a ruler is called a point, a displacement is called a line in relation to a straight Pythagorean Triangle side. A position on the ruler is certain, a displacement from a starting to a final position on a ruler is not certain, it can refer to many possible positions. In that sense the displacement might refer to different possible points similar to with probability. Uncertainty in this model can refer to probability in relation to time, and possibility in relation to position. This keeps the two concepts separate.

Calculus and infinitesimals

In this model calculus works in a similar way to conventional math, the answers are the same. This is because the straight Pythagorean Triangle sides are composed of square roots, because they are not observable they can be regarded as infinitesimals. A Pythagorean Triangle here cannot have a zero area so this infinitesimal is always different from zero or ∞. This is because if the Pythagorean Triangle collapsed into a line the area would disappear.

Calculus and fluxions

Here a moment or instant represents a point on a spin Pythagorean Triangle side, this can be on a clock gauge which is circular as spin. A straight Pythagorean Triangle side is like a straight ruler. A point on this clock gauge would be a fluxion as Newton described it, this cannot be zero because the Pythagorean Triangles have a constant area.

A slope as a derivative

In calculus a slope is the hypotenuse of a very small Pythagorean Triangle, this shrinks to an infinitesimally small size but not zero. These Pythagorean Triangles in this model can also be very small, because of this they act like calculus Pythagorean Triangles. It is not necessary to use calculus on these Pythagorean Triangles, instead they themselves act like calculus Pythagorean Triangles. A position on a straight Pythagorean Triangle side acts as an infinitesimal, a point on a spin Pythagorean Triangle side acts as a fluxion. One difference between this model and conventional calculus is each Pythagorean Triangle has a straight and a spin Pythagorean Triangle side, not two of either. For example there are no Pythagorean Triangles where both sides are distances in meters, except as approximations.

A slope and a particle

A slope as a derivative can define the position of a particle as well as its velocity at an instant of time, with the -ⅈd and e𝕧 Pythagorean Triangle for example there would be a position e𝕧 on a ruler and a -ⅈd instant on a clock gauge. As this Pythagorean Triangle shrinks in calculus it approaches the concept of being stationary and still having a velocity. In calculus this paradox that was proposed by Zeno is avoided by the concept of a limit.

Limits

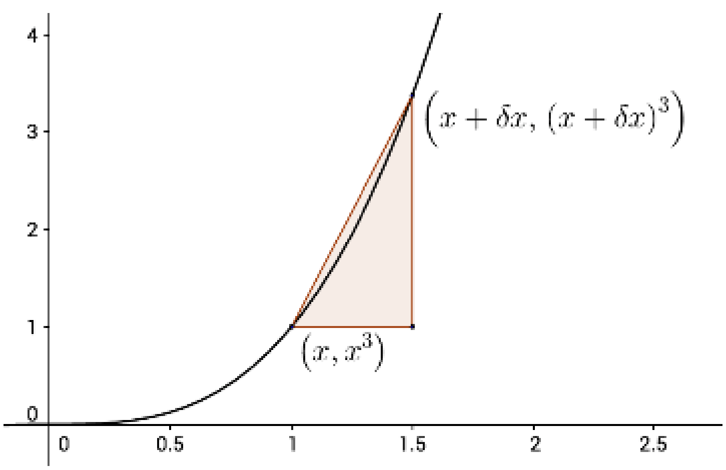
In this model each Pythagorean Triangle also has limits, its angle θ opposite the spin Pythagorean Triangle has a maximum and minimum value. Why this happens is explained later, it enables the Pythagorean Triangles to act as calculus Pythagorean Triangles with derivatives and with limits. The -𝕚d and e𝕧 Pythagorean Triangle then could be substituted for the calculus Pythagorean Triangle to calculate velocity and acceleration.

Definite and indefinite integrals

In this model all integrals that can be measured are definite, they have a temporal duration from a starting to a final moment. When a Pythagorean Triangle is not being measured it has an integral area, such as -𝕚d×e𝕧. This is indefinite because it is not being measured, but it still has the constant Pythagorean Triangle area.

A calculus Pythagorean Triangle

This shows a calculus Pythagorean Triangle, with the -𝕚d and e𝕧 Pythagorean Triangle, the y axis would be -𝕚d as the inertial time and the x axis would be e𝕧 as a length. As the Pythagorean Triangle shrinks e𝕧 approaches a point of position, -𝕚d approaches a point as a moment or fluxion. The limit is the minimum area of the Pythagorean Triangle, also the maximum and minimum of the angle θ. It is proposed these changes to calculus are consistent with its conventional use, it also allows it to be directly part of how the Pythagorean Triangles operate. With these limits the Pythagorean Triangles have a fundamental uncertainty, that is consistent with the Heisenberg uncertainty principle.



Positive and negative terms

Generally, in this model positive and negative terms are not used except for the spin Pythagorean Triangle sides +𝕠d, -𝕠d, +𝕚d, -𝕚d, -𝕘d and +𝕘d. Because of this possible confusion, acceleration and deceleration for example are used as terms instead of positive and negative acceleration. Clockwise and counterclockwise can be subtracted from each other, vectors are summed together with the dot product and conventional rules of vector addition. These do not use positive and negative terms. A number line in conventional math can be regarded as being made up of straight Pythagorean Triangle sides where vectors pointing left and right are vector added or subtracted. It is not known where ambiguities may cause problems, because of this positive and negative are restricted in this text.

Uncertainty

In quantum mechanics the Heisenberg Uncertainty principle gives a limit to how precisely a position, such as e𝕧 from the -𝕚d and e𝕧 Pythagorean Triangle, and momentum can be known. In this model the uncertainty principle is derived from the constant Pythagorean Triangle area, work and impulse. For example, when the position e𝕧 is being observed too precisely, this causes the -𝕚d spin Pythagorean Triangle side to dilate to maintain the constant Pythagorean Triangle area.

Limits of observation and measurement

Observing the E𝕍/-𝕚d inertial impulse of a point particle has a displacement force from a starting to a final position, that is observed on a clock gauge of moments. This causes the -𝕀D×e𝕧 inertial work to become stronger as the dilated -𝕚d inertial mass becomes squared as a -𝕀D inertial probability with e𝕧 contracting. That makes the position uncertain because the inertial probability is measured on a scale of e𝕧 points. The E𝕍/-𝕚d inertial impulse is observed as a particle, when this is too precise the wave nature dilates from the -𝕀D×e𝕧 inertial work. The particle appears more as a wave with an uncertain position, this appears as an increased inertial momentum.

Impulse and work are fundamentally different

More will be explained on this later, it shows the model is compatible with the uncertainty principle. It also illustrates that here impulse and work are fundamentally different, they can appear to be convertible to each other in classical physics with the examples from textbooks in the main part of the book.

The nature of time and distance are mysterious

The nature of time is mysterious, as shown by time dilation in Special Relativity. When work is measured a scale, like a ruler, is used with positions over a e𝕧 length. The nature of distance itself is equally mysterious in Special Relativity, a rocket can appear to have its e𝕧 length contracted as it moves closer to c.

An overview

The preceding sections are meant to be an overview of some basic and advanced concepts. They may not be easily remembered or understood. Having read through these, some will be recalled as more concrete examples are given for each later. The introduction so far describes a consistent model to explain classical physics. It has Roy electromagnetism, that has a e𝕪 kinetic electric charge from an electron and an e𝕒 potential electric charge from a proton. There is also a +𝕠d kinetic magnetic field from the electron and a +𝕠d potential magnetic field from the proton. There are photons and light from a Pythagorean Triangle. Biv space-time contains a e𝕧 length and a e𝕙 height that can describe dimensions, +𝕚d describes a gravitational field or mass as well as time. -𝕚d describes inertial mass as well as time.

Advanced concepts

As the model is explained more difficult concepts are included, the Pythagorean Triangles are shown to be compatible with Special and General Relativity. The -𝕠d and e𝕪 Pythagorean Triangle is shown to be compatible with quantum electrodynamics and Schrodinger's equation. Matter and antimatter are explained in relation to quantum field theory. Some constants are explained as arising from the math of these Pythagorean Triangles. The structure of the proton and neutron are also explained in relation to this model, with three generations of quarks.

Classical physics

Motion diagrams

In this model a motion diagram can be of two types, one is where the variables are not changing their ratios. An example of this would be a constant velocity, a constant ratio of electric charge to magnetism, a constant frequency and wavelength of light. The second type is where there is a change due to a force, as Newton's first law says that all bodies have a constant motion unless acted on by an external force.

Motion with and without forces

A motion diagram can then be where a Pythagorean Triangle does not change its angle θ, this is where there is no change, no force, no measurement or observation. This is obscured in nature because there are many small forces. The classical world then gives many measurements of work as waves and observations of particle with an impulse, but many things are not changing such as the strength of a gravitational field. This model then contains both parts of Newton's first law, where there are no changes, and changes from an external force.

Two active and two reactive Pythagorean Triangles

A rocket launch in (a) would have active forces pulling the rocket downwards from gravity as the +𝕚d and e𝕙 Pythagorean Triangle. It also has active forces from the chemical reactions in the rocket fuel making it go upwards, this is from the -𝕠d and e𝕪 Pythagorean Triangle. It moves through the air which has inertia, that has an equal and opposite reaction slowing the rocket from the -𝕚d and e𝕧 Pythagorean Triangle. The fuel reacts against burning, the electrons are held in their original orbitals by the +𝕠d and e𝕒 Pythagorean Triangles of the nuclei.

Inertia and friction

In (b) a car stopping has inertia as a reactive force from the -𝕚d and e𝕧 Pythagorean Triangle. It also has friction from the air also as inertia, there are some active motions of electrons in this friction from the -𝕠d and e𝕪 Pythagorean Triangle. The tires tend to stick to the surface of the road and form chemical bonds, these are reactive forces from the +𝕠d and e𝕒 Pythagorean Triangle as the nuclei.

Work and impulse together

In classical physics the rocket and the car also move with work as well as impulse. The rocket can be regarded as changing its position of time with four forces, these would be the E𝕐/-𝕠d kinetic impulse, the E𝕍/-𝕚d inertial impulse, the Eℍ/+𝕚d gravitational impulse, and the E𝔸/+𝕠d potential impulse. It can also be regarded as doing work as these forces occur over a distance, in this model a distance means a straight Pythagorean Triangle side. This covers most cases outside of quantum mechanics because at positions the iotas are acting as particles, at other times as waves.

The Uncertainty Principle and work

Between these two the Uncertainty Principle from the constant areas of the Pythagorean Triangles is obscured. It appears as if events can happen in the same position and moment, in this model they cannot because a measurement requires a squared spin Pythagorean Triangle side. That leads to an uncertain outcome because the Pythagorean Triangle is no longer predictable with its constant area. The distance can be certain as a scale, for example with -𝕀D×e𝕧 inertial work the -𝕀D can be inertial torque against a nut being turned by a wrench. But this certain distance as a e𝕧 length leads to an uncertainty of the forces of the -𝕀D inertial torque.

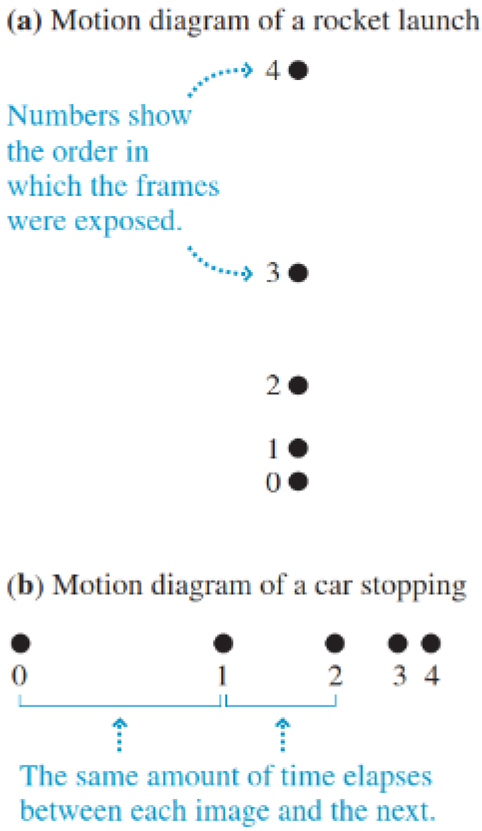
The Uncertainty principle and impulse

With the E𝕍/-𝕚d inertial impulse there is also uncertainty, the time can be observed precisely but then the straight Pythagorean Triangle side is squared as a force with some uncertainty. For example a tennis ball might be observed to hit a tennis court surface with a precise time, but the deformation of the ball would be in terms of the square E𝕍. This is where the ball compresses and its length e𝕧 decreases as part of the force so it is squared as E𝕍. In (b) the car is slowing with the same time between frames, this is a constant time scale as -𝕚d in the E𝕍/-𝕚d inertial impulse.

Acceleration and deceleration as the squares of square roots

In this model the deceleration would be observed as E𝕍/-𝕚d in meters^2/second, for each constant second a constant deceleration would have E as integers in descending order. This is because the Pythagorean Triangles have their sides in square root, the meters^2/second then has the meters as square roots then squared, then divided by a constant scale in square roots of time. This works the same way with a constant velocity e𝕧/-𝕚d as if d and e were integers, because the ratio and the angle θ in the -𝕚d and e𝕧 Pythagorean Triangle is not changing then the velocity is constant with square roots. So if the numerator here is a square of the scale in the denominator it is the same as if both were integers and one was squared.

FIGURE 1.4 Motion diagrams in which the object is modeled as a particle.



Straight Pythagorean Triangle sides as vectors

In this model the straight Pythagorean Triangle sides have no sign, they are not positive and negative. The positive charge in the +𝕠d and e𝕒 Pythagorean Triangle comes from the +𝕠d potential magnetic field, the e𝕒 potential electric charge is not positive. Also the e𝕪 kinetic electric charge is not negative as the sign comes from the -𝕠d kinetic magnetic field. The e𝕙 height from the +𝕚d and e𝕙 Pythagorean Triangle as well as the e𝕧 length from the -𝕚d and e𝕧 Pythagorean Triangle also do not have signs.

Adding and subtracting vectors

This is because they add and subtract as vectors, they are rotated in various directions by the spin Pythagorean Triangle sides. This gives vectors positive negative attributes from being associated with the spin Pythagorean Triangle sides. In this model that is like the potential electric charge e𝕒 and the kinetic electric charge e𝕪 getting signs from their +𝕠d potential magnetic field and -𝕚d kinetic electric field respectively.

Spinning a vector as positive or negative

A vector can then be spin to a direction where it is subtracted from another vector with the dot product. With electromagnetism then the positive +𝕠d potential magnetic field can spin an e𝕒 potential electric charge vector to be added or subtracted with different values.

Electromagnetism

In this model a e𝕪 kinetic electric charge might be observed with its E𝕐/-𝕠d kinetic impulse, then at 90° there is a magnetic field which is measured as -𝕆D×e𝕪 kinetic work. This work can then be observed in how it acts on particles, that can appear as if the electric charge also acts as a field like the magnetic field. Here the electric charge is not a field, it is a derivative not an integral and so can only be observed as a particle.

Reference frames and electromagnetism

It also appears as if the difference between an electric and magnetic field is the reference frame, that happens here because e𝕪 as the kinetic electric charge and -𝕠d as the kinetic magnetic field are inverses.

Vectors have magnitude not spin

In conventional physics they also do not have signs but they have a magnitude, for example e𝕪 has a magnitude of e. If the vector is a kinetic electric force E𝕐 then it has a magnitude of E. In these examples they are in one dimension so far, but the Pythagorean Triangles can also be represented with vectors in 3 or more dimensions. They do not form a volume or area however, the vectors would remain as straight lines.

Fractals

This is related to fractal dimensions where lines can fill an area without becoming an area, they are not an actual integral of this area. In chaos these straight Pythagorean Triangle side can have an impulse that has no randomness because there is no work done as an integral. The lines can create shapes that are deterministic, because without an integral in this model there is no probability.

Basis vectors as a classical approximation

In this model a coordinate system can use vectors, for example Cartesian coordinates where x and y are horizontal and vertical vectors. Then a vector e𝕪 in the -𝕠d and e𝕪 Pythagorean Triangle might be described as a vector with a magnitude e and a direction determined by a rotation with a value of d in -𝕠d. The basis vectors would require a force to move to them, and then more forces would be needed to observe or measure the original vector. It is the same with coordinates in this model, there would be a distance and time away from the original iota such as a vector. There is an assumption here that it is possible to instantly move to where these basis vectors or coordinates are, but that requires a force in this model.

Inertial reference frames

To observe or measure where and when these basis vectors are, that requires forces from work and impulse. This increases uncertainty when they are assumed to be observable or measurable too precisely, as with the uncertainty principle. Knowing where these coordinates or basis vectors are also requires forces.

Different times and distances

Special relativity recognizes this by showing that two reference frames do not have the same time between them, nor do they have the same distances when approaching c. A rocket near c for example would appear to have its e𝕧 length contracted and its -𝕚d inertial time dilated compared to a stationary observer. Even when velocities are low these are still not translatable to different coordinate systems except as classical approximations.

Dimensions and uncertainty

A motion diagram implies a set of coordinates in classical physics; a rocket for example travels upwards from a planet's surface with a change in e𝕙 height like a y axis. If it moves in a parabola then there is also a change in the x axis. But the Pythagorean Triangles do not get e𝕙 height and e𝕧 length from basis vectors or coordinates, they are themselves coordinates.

No coordinate systems

A rocket then moves according to the +𝕚d and e𝕙 Pythagorean Triangle which has a straight Pythagorean Triangle side as e𝕙 height, and a +𝕚d spin Pythagorean Triangle side as the gravitational field. This does not need coordinates, it has distance and time in the Pythagorean Triangle itself. This model then does not have a coordinate system from which iotas are observed and measured, the Pythagorean Triangles themselves are both the coordinate system and what is measured and observed. Other coordinates can only be other Pythagorean Triangles with their own properties.

Volumes and Pythagorean Triangles

A volume of a Hydrogen atmosphere around a planet might have gravity from the -𝕚d and e𝕧 Pythagorean Triangle with each atom, this has a e𝕙 height above the nucleus for each atom but the height of the gas volume is an approximation. There is no cube that is associated with a Pythagorean Triangle, each +𝕠d and e𝕒 Pythagorean Triangle as the Hydrogen proton has a e𝕙 height associated with it in its own circular geometry.

Heights and lengths

The electrons have a length e𝕧 associated with them, they can then move with a velocity as e𝕧/-𝕚d while also falling towards a Hydrogen proton under gravity with an instantaneous gravitational speed of e𝕙/+𝕚d. When both have no forces the electron would have a gravitational angular speed or brevity of e𝕙/+𝕚d, the e𝕙 height of the orbital is divided by the +𝕚d orbital period.

Approximate basis vectors

So while the gas has e𝕙 heights and e𝕧 lengths in its Pythagorean Triangles there is uncertainty from the work and impulse each Pythagorean Triangle does. Each might have an approximate angle to the other as vectors, from these basis vectors can give approximate heights and lengths in a volume. But there is no actual Biv space-time like that in this model.

No length, breadth, and depth

Biv space-time then in this model does not have a length, breadth and depth in three dimensions, and an additional dimension of time. Instead each Pythagorean Triangle has its own time dimension, the +𝕚d and e𝕙 Pythagorean Triangle with gravity has its +𝕚d gravitational mass. This keeps time because it can hold an electron in an orbit so it revolves in a given time. The electron has its own -𝕚d inertial mass so its velocity is also revolving in a given time.

No x,y,z dimensions with time as a fourth

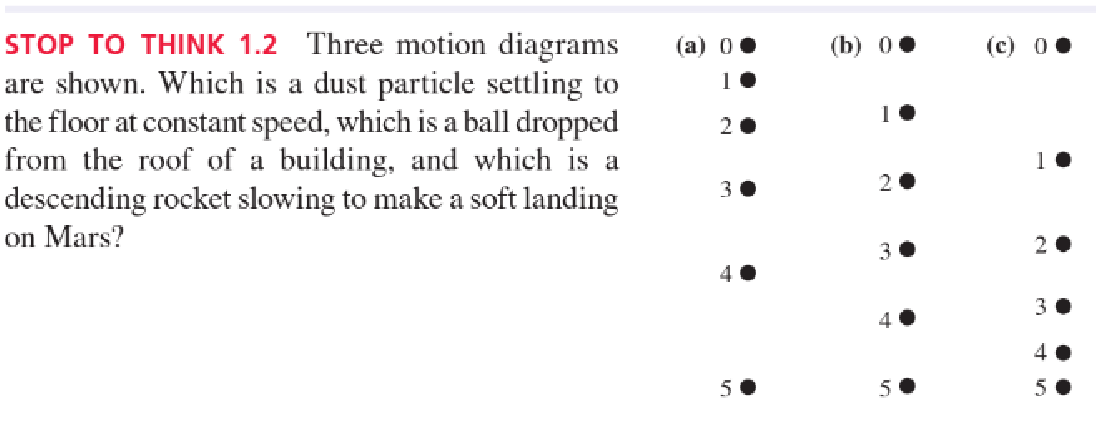
Also in this model the concept of x,y,z coordinates are a classical approximation, there cannot be three Pythagorean Triangles joined to each other so each is orthogonal to the other. If there were then each can only be measured with its work and observed with its impulse by itself, the other two Pythagorean Triangles have an uncertainty in relation to it.

Basis vectors introduce uncertainty

When concepts like basis vectors and volumes are used then they require the use of h as a minimum of this uncertainty. However this model does not require an Uncertainty Principle added with h as this arises naturally from the mathematics as will be seen.

Three motion diagrams

In (a) there is an acceleration, this can be regarded as impulse with time as a scale or work with increments of distance as a scale. (b) has a constant speed, this can be from the +𝕠d and e𝕒 Pythagorean Triangle and the proton, the -𝕠d and e𝕪 Pythagorean Triangle and the electron, the -𝕚d and e𝕧 Pythagorean Triangle with inertia or the +𝕚d and e𝕙 Pythagorean Triangle with gravitation. (c) shows a deceleration, in this model it is not referred to as a negative acceleration because plus and minus signs can confuse +𝕚d and -𝕚d for example.



F=ma

The motion diagram below can use the formula force equal mass times acceleration or F=ma. In this model the force would be +𝕚d as the gravitational mass times e𝕙/+𝕀D, this reduces to an instantaneous gravitational speed of e𝕙/+𝕚d, that increases because the mass +𝕚d has a constant d and the denominator 1/+𝕀D has D as a square where d is a square root that is increasing. The +𝕚d gravitational mass then multiplies the force, if this is doubled then so is the gravitational force. If the seconds change in a different gravitational field, then so does the force. If this e𝕙/+𝕚d gravitational speed is a circular orbit, then the +𝕀D gravitational probability would move it upwards or downwards in an exponential spiral.

Gravitational derivatives and integrals

This would be +𝕀D×e𝕙 gravitational work in this model, the derivative is taken from the +𝕚d and e𝕙 Pythagorean Triangle where it has a constant slope and a constant angle θ. That would give a gravitational speed e𝕙/+𝕚d, but this is changing as the e𝕙 height of the sled changes and also as the time increases. This can be written as a second derivative of the +𝕚d and e𝕙 Pythagorean Triangle with respect to +𝕚d to give e𝕙/+𝕀D, but in this model the +𝕀D×e𝕙 gravitational work is an integral area. This is because it represents a wave not a particle, the gravity here is not definable as a graviton but as a force field.

Squaring a Pythagorean Triangle side

Because of this it would be written as the +𝕀D×eh gravitational work, that represents the area of the +𝕀D and eh Pythagorean Triangle where one Pythagorean Triangle side is a square +𝕀D. It can also be comparing the square area on one side of the +𝕚d and eh Pythagorean Triangle with the constant side eh. Then the angle θ remains a constant, the second integral with respect to +𝕚d gives an area as the +𝕀D×eh gravitational work.

Inertial work opposing the gravitational work

Opposing this with an equal and opposite reactive force is the -𝕀D×e𝕧 inertial work from the -𝕚d and e𝕧 Pythagorean Triangle. This also acts like a field, the inertia cannot be defined here as a particle with an E𝕍/-𝕚d inertial impulse. In this model the -𝕀D×e𝕧 inertial work is subtracted from the +𝕀D×eh gravitational work to give the motion of the sled.

Kinetic and potential energy

In conventional physics the sled height is regarded as the kinetic energy compared to the potential energy, as the sled drops it loses kinetic energy and the potential energy increases. In this model the sled does -𝕀D×e𝕧 inertial work while there is +𝕀D×eh gravitational work at a lower height eh. This can be written as the +𝕆D×e𝕒 potential work minus the -𝕆D×e𝕪 kinetic work in terms of Roy electromagnetism. This is because the two are proportional to each other, kinetic and potential energy can be used as a classical approximation in Biv space-time.

Kinetic work and gravitational work are active forces

The kinetic work would be the active force here, for example a motorized sled climbing the slope against the reactive force of the +𝕆D×e𝕒 potential work. Then it might roll back down when the +𝕀D×eh gravitational work is the active force and the -𝕀D×e𝕧 inertial work is reactive.

Pythagorean Triangles connect to each other

As an example an electron, as the -𝕠d and e𝕪 Pythagorean Triangle emits a e𝕪×-𝕘d photon. Then it drops down to a lower orbital where its e𝕪 kinetic electric charge is dilated and its -𝕠d kinetic magnetic field is contracted. The emission of the e𝕪×-𝕘d photon has the difference between these two orbitals, the e𝕪 kinetic electric charge difference and -𝕘d as the difference in the -𝕠d kinetic magnetic field is now the photon's rotational frequency.

Each Pythagorean Triangle affects the next

This causes the -𝕚d and e𝕧 Pythagorean Triangle associated with the electron to also change its angle θ, e𝕧 dilates proportionally to e𝕪 and -𝕚d as the electron's inertial mass contracts proportionally to -𝕠d. This dilates the +𝕚d gravitational mass of the proton as the eh height above the proton is contracted. Because gravity is an active force this is reacted against by the +𝕠d and e𝕒 Pythagorean Triangle as the proton, it also contracts its e𝕒 altitude or potential electric charge as a +𝕘d×e𝕓 gravitational iota or wave is emitted by this. That causes the electron with its -𝕠d and e𝕪 Pythagorean Triangle to possibly absorb another e𝕪×-𝕘d photon and the Pythagorean Triangles retain their conserved values.

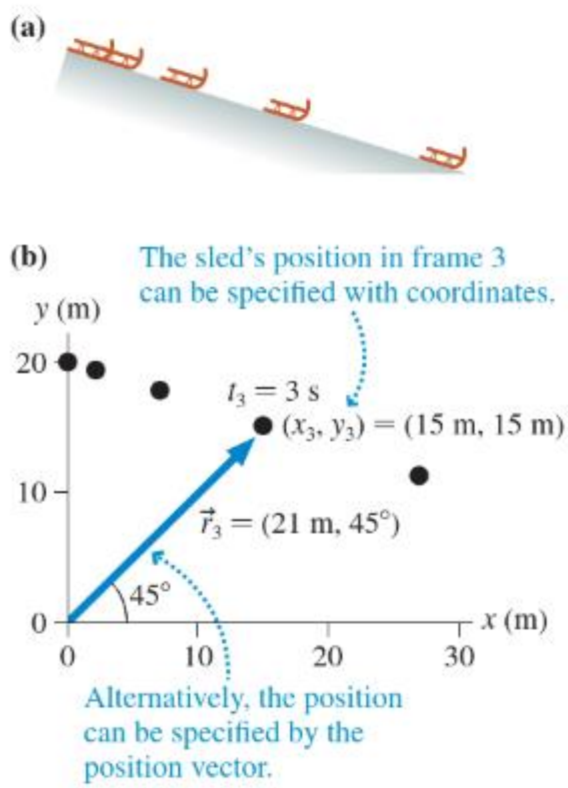
A changing angle θ represents a force

In (b) the angle θ can be how the vector changes orientation, with the +𝕚d and eh Pythagorean Triangle it can be regarded as the eh height decreasing while the time +𝕚d increases. This is using a constant area of the Pythagorean Triangle. It can also be shown as the +𝕀D and e𝕙 Pythagorean Triangle with a constant angle θ, in (b) the x axis would be a square and y would remain constant.

The hypotenuse is rarely used

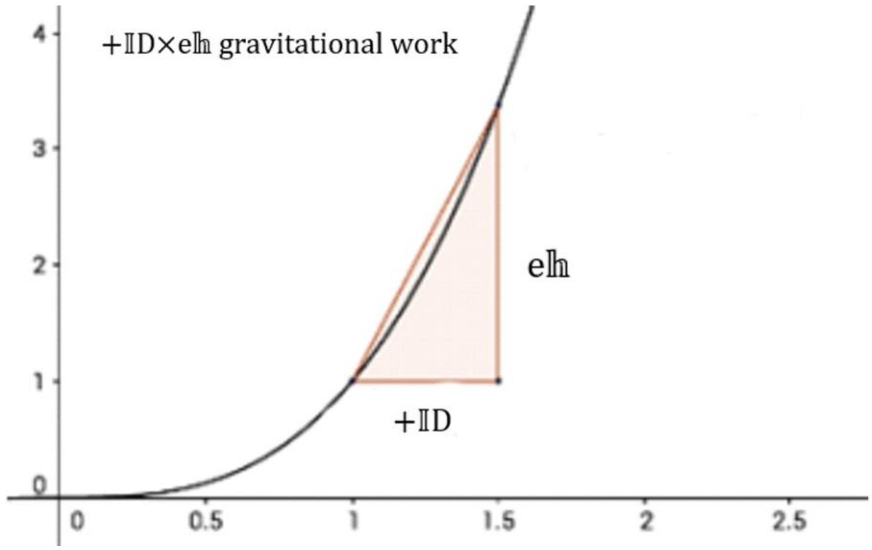
The vector in (b) would be the hypotenuse ζ of the +𝕚d and e𝕙 Pythagorean Triangle, this is rarely used in this model. Instead the vector used would be on the y axis as e𝕙 itself, then this contracts as +𝕚d dilates. In this model a force does not come from the hypotenuse, so a vector does not use this except as a classical approximation. It is not important here, but it does become relevant in quantum mechanics and relativity later.

FIGURE 1.5 Motion diagram of a sled with frames made every 1 s.



Work diagrams

In the diagram the sled does +𝕀D×e𝕙 gravitational work as the e𝕙 decreases, if the +𝕀D gravitational force or gravitational torque is constant then the +𝕀D and e𝕙 Pythagorean Triangle would have a constant angle θ. If the +𝕚d and e𝕙 Pythagorean Triangle is used the angle θ opposite +𝕚d changes. The same Pythagorean Triangle could represent the -𝕀D×e𝕧 inertial work with an equal and opposite force where the x axis becomes e𝕧 and the y axis becomes -𝕀D. It could also represent the -𝕆D×e𝕪 kinetic work and the +𝕆D×e𝕒 potential work where the x axis would become e𝕪 and e𝕒, the y axis would become -𝕆D and +𝕆D respectively.



Scalars and vectors

In this model the spin Pythagorean Triangle sides act as scalars with impulse, this is because they are on a scale rather than acting or reacting as forces. With the E𝕐/-𝕠d kinetic impulse for example the scale is -𝕠d as the kinetic magnetic field which acts as time. With the E𝕍/-𝕚d inertial impulse the scale is also time as -𝕚d. If work is being measured then the scale is a position, for example with the -𝕀D×e𝕧 inertial work then the scale is a e𝕧 length. The value e here would be a scalar.

Scales and gauges

In this model a scale is a straight-line collection of infinitesimal points by convention, such as a ruler. A gauge is round like a clock also as a convention, it has a series of instants or moments on it as time. In calculus these points and instants are infinitesimals and instants, they have no size but are not zero.

Limits in physics

In this model there are minimum and maximum sizes of Pythagorean Triangle sides, they act as infinitesimals and instants but their limits are different from calculus. For example there is a limit as a minimum e𝕧 length called a Planck length, there is also a minimum Planck time.

Derivatives and integrals with vectors and scalars

In this model a straight Pythagorean Triangle side has a direction as a vector, this cannot be observed unless it is squared with a magnitude such as in the E𝕍/-𝕚d inertial impulse. It could be said that straight Pythagorean Triangle sides are vectors and that spin Pythagorean Triangle sides are scalars, this would be because they have a spin not a direction. In conventional physics many straight Pythagorean Triangle side values are referred to as scalars, such as a e𝕪 temperature. This temperature is where the velocity of molecules, such as in a gas, has vectors acting in all directions. Because of this the vectors can be regarded classically as summing to no direction as a scalar.

Mass and time as scalars

Usually in conventional physics the inertial momentum would be written as -𝕚d×e𝕧/-𝕚d where -𝕚d acts as the inertial mass as a coefficient then as time in the denominator. These two are equivalent, for example if the -𝕚d inertial mass of an object doubles then its inertial momentum also doubles. If the -ⅈd in the denominator doubles then it moves the same e𝕧 length in half the time, so its inertial momentum also doubles.

Scalars and Vectors

Some physical quantities, such as time, mass, and temperature, can be described completely by a single number with a unit. For example, the mass of an object is 6 kg and its temperature is 30°C. A single number (with a unit) that describes a physical quantity is called a **scalar.** A scalar can be positive, negative, or zero.

Many other quantities, however, have a directional aspect and cannot be described by a single number. To describe the motion of a car, for example, you must specify not only how fast it is moving, but also the *direction* in which it is moving. A quantity having both a *size* (the "How far?" or "How fast?") and a *direction* (the "Which way?") is called a **vector.** The size or length of a vector is called its *magnitude*. Vectors will be studied thoroughly in Chapter 3, so all we need for now is a little basic information.

The dot product as a slope

Vectors can be added with the dot product. The spin Pythagorean Triangle sides use the cross product, this is often shown as below where a×b would be the spin Pythagorean Triangle side. The area |a×b| acts like the integral area of the -ⅈd and e𝕧 Pythagorean Triangle for example.

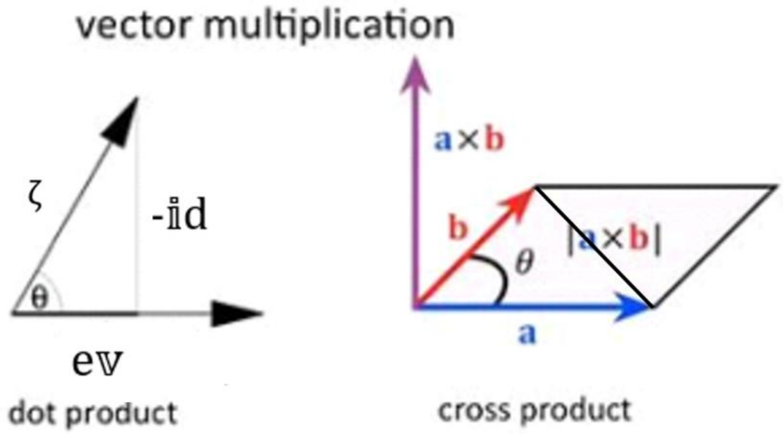
This can be reduced to the Pythagorean Theorem, the dot product below gives an angle θ opposite the vertical Pythagorean Triangle side which would be -ⅈd here as the inertial mass. The dot product would be giving the value of e𝕧 from ζ. Taking the hypotenuse ζ as the original vector with a value of 1, from trigonometry cosθ=e𝕧/1 which gives the horizontal Pythagorean Triangle side e𝕧.

The cross product as an integral

Taking the cross product, the parallelogram area |a× b| below would be two -ⅈd and e𝕧 Pythagorean Triangles where a is the hypotenuse ζ=1 and b is e𝕧. The vertical line a×b here is the same as -ⅈd in the -ⅈd and e𝕧 Pythagorean Triangle. The integral area of the -ⅈd and e𝕧 Pythagorean Triangle is ½×-ⅈd×e𝕧 or ½×a×b so the parallelogram area is a×b.

The angle θ opposite the spin Pythagorean Triangle side

This model uses θ by convention because cosθ gives the cross product as shown above, this is associated with impulse as a force and a derivative in this model. Sinθ uses the cross product as shown above, this is associated with work and an integral area.



Gravitational and inertial torque

The torque can be represented here by a bolt, the e𝕙 height of the bolt decreases as it is turned by the active +𝕀D gravitational torque. Opposing this is the -𝕀D inertial torque. This torque is measured as the force called mass, it is proportional to $seconds^2$ in acceleration both in gravity and inertia as $meters/second^2$ which is e𝕧/-𝕀D and e𝕙/+𝕀D. In this model the spin Pythagorean Triangles represent mass because measuring it cannot be separated from measuring time.

Potential and kinetic torque

The same sled diagram is used to illustrate the potential and kinetic energies later, this would use +𝕆D as the potential magnetic force or potential torque and -𝕆D as the kinetic magnetic force or kinetic torque. Because of the use of kinetic and potential energies in kinematics the relation between magnetism and mass is briefly explained here according to this model.

Magnetism and torque

The strength of the magnetic force comes from torque, this is seen in how generators and motors create a rotational force using magnets. It also occurs in a Hydrogen atom, the proton has a magnetic field which here is called +𝕠d and the electron has -𝕠d. Both of these are associated with spin, the electron rotates around the proton at different orbital levels depending on the ratios of these two magnetic fields.

Magnetism and mass

In this model magnetism comes from the spin Pythagorean Triangle sides +𝕠d and -𝕠d in Roy electromagnetism, mass comes from the spin Pythagorean Triangle sides +𝕚d and -𝕚d in Biv spacetime. These act in similar ways, the +𝕠d positive and -𝕠d negative magnetic fields in a Hydrogen atom are proportional to the +𝕚d gravitational mass of the proton and the -𝕚d inertial mass of the electron. Both magnetism and mass are defined in relation to time, an atomic orbital has a period according to magnetic fields while an orbit in Biv space-time has a period according to fields from masses. The gravitational equation m_1m_2/r^2 is known to be similar to the Coulomb force equation q_1q_2/r^2.

Magnetism, mass, and time

In this model magnetism and mass act as integrals, these are in the +𝕆D×e𝕒 potential work, the -𝕆D×e𝕪 kinetic work, the +𝕀D×e𝕙 gravitational work, and the -𝕀D×e𝕧 inertial work. Time acts in relation to a derivative or slope of a Pythagorean Triangle, in the E𝔸/+𝕠d potential impulse, the E𝕐/-𝕠d kinetic impulse, the Eℍ/+𝕚d gravitational impulse, and the E𝕍/-𝕚d inertial impulse.

Acceleration as meters/second^2 or meters^2/second.

When time is squared as a force in an integral it acts as magnetism or mass, it also appears as a torque or a probability. When it is squared in a second derivative this is a classical approximation. For example a car might accelerate as meters/second^2 but the weight felt by the occupants is from the change in the -𝕀D inertial force. An engine with a larger torque can accelerate faster. If the car is observed it has an E𝕍/-𝕚d inertial impulse instead of doing -𝕀D×e𝕧 inertial work.

The accelerations are the inverse of each other

This would be meters^2/second which is classically equivalent to and convertible to meters/second^2. For example with a constant velocity a car might go 1 meter in 1 second, 2 meters in 2 seconds, and 3 meters in 3 seconds where e𝕧/-𝕚d have e and d each increasing by 1 each time so the ratio of the velocity is the same. With the E𝕍/-𝕚d inertial impulse this would have 1, 4, 9, 16,… in the numerator and 1, 2, 3, 4,… in the denominator to give 1/1, 4/2, 9/3, 16/4,… or 1, 2, 3, 4. With the -𝕀D×e𝕧 inertial work written as a second derivative -𝕀D/e𝕧 this would give 1, 2/4, 3/9, 4/16, or 1, 1/2, 1/3, 1/4,… as the inverse of the impulse.

Position and vectors

In this model the value e in for example e𝕙 or e𝕧 represents a position in Biv spacetime, also in Roy electromagnetism with e𝕒 and e𝕪. Positions means the vectors are added together as shown, the vectors do not have a positive or negative sign in this model. The direction of the vectors represents a rotation in relation to each other, this comes from the spin Pythagorean Triangle sides.

Changing a vector requires a force

Changing a vector from one magnitude and orientation to another is a classical approximation here. For example a vector might have a e𝕧 length of a meter on a large clock as the minute hand. It would then rotate clockwise to complete a revolution in an hour. This is allowed in this model because the vector turns at a constant rate, there is no -𝕀D inertial torque like a wrench turning a nut because there is no acceleration. The minute hand does not move faster and so there is no force.

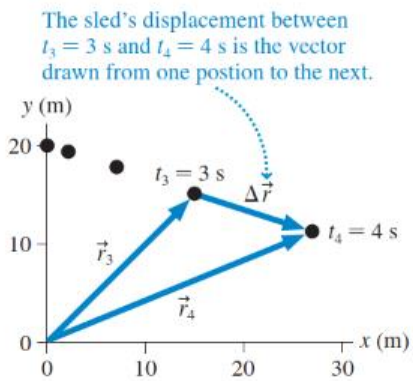
Centrifugal force and inertial mass

The -𝕚d and e𝕧 Pythagorean Triangle then has a constant area, the e𝕧 magnitude does not change nor does its -𝕚d inertial mass. If this clock was horizontal measuring the centrifugal force at the end of the minute hand would show it does not change. This would appear to be a constant -𝕚d inertial mass and so the -𝕚d and e𝕧 Pythagorean Triangle has a constant area. However, if the minute hand was stopped it would require a -𝕀D inertial torque to start it turning.

Turning the sled requires a torque

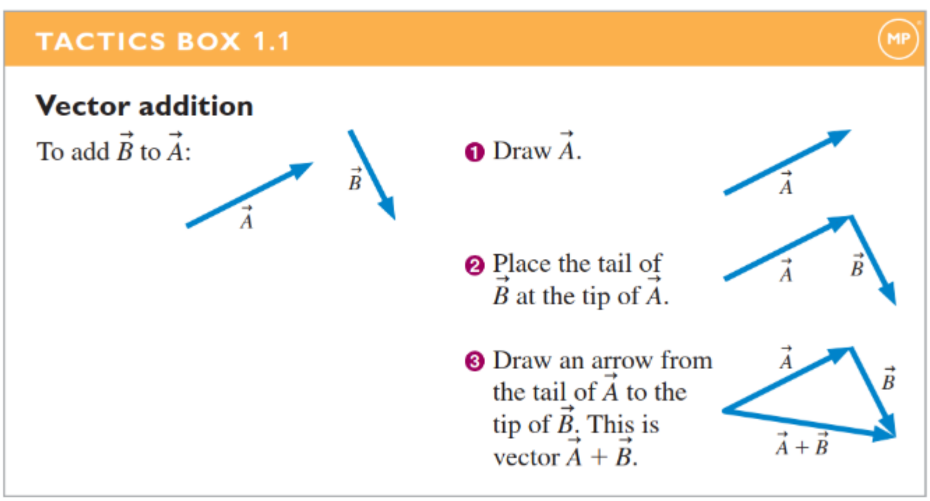
The sled below then requires a -𝕀D inertial torque to change its direction similar to a wrench turning a nut. The e𝕧 length of the vectors after each turn are different -𝕚d and e𝕧 Pythagorean Triangles because their areas are not the same as each other. These are separated by a measurement of -𝕀D×e𝕧 inertial work when the inertial torque was applied to change the direction. In between those measurements the sled might have a difference e𝕧/-𝕚d velocity.

FIGURE 1.6 The sled undergoes a displacement $\Delta\vec{r}$ from position $\vec{r}_3$ to position $\vec{r}_4$.



Adding Pythagorean Triangles together

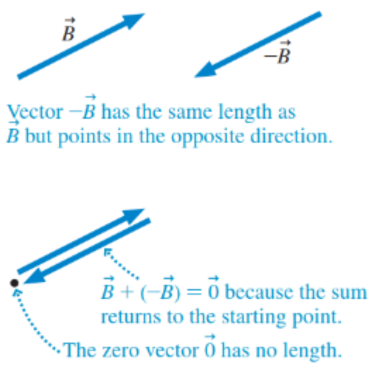
Adding vectors then is like adding multiple Pythagorean Triangles together, but the straight Pythagorean Triangle sides are the vectors. In the tactics box then this would be adding 3 -𝕚d and e𝕧 Pythagorean Triangles together for example, each with a different e𝕧 length or magnitude. Generally, unless the Pythagorean Triangle areas are conserved this is adding 3 separate -𝕚d and e𝕧 Pythagorean Triangles.



Subtracting vectors

In this model there are no positive or negative vectors, as a classical approximation these can be subtracted as shown. The first vector can also be transformed into the second with a rotation, -𝕀D×e𝕧 inertial work is done on it so the -𝕀D inertial torque turns it 180°. The -𝕀D inertial torque has a constructive and destructive interference as with waves, here the -𝕀D×e𝕧 inertial work done has a destructive interference that removes the original -𝕀D inertial torque of the vector. These are then subtracted to give zero, it gives the same answer as the negative of a vector.

FIGURE 1.7 The negative of a vector.

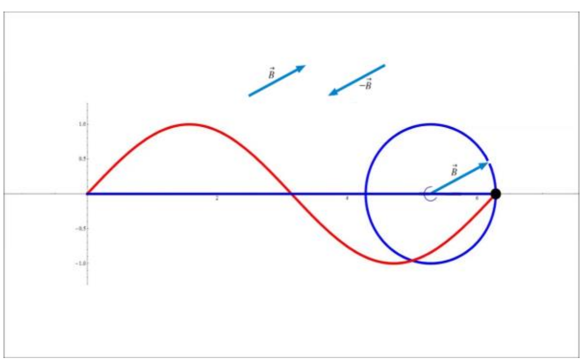


Ocean waves interfering as addition and subtraction

This could be represented by -𝕀D×e𝕧 inertial work done in ocean waves where there is a -𝕀D inertial torque rotating in the wave. When the crest of one wave meets the trough of another this inertial torque is destructively interfered with. That results in the crest and trough disappearing to leave a flat point in the ocean.

Sine waves as rotating vectors

The motion of the wave can be modeled then as a rotating vector, this is also often shown as a sine wave being created by a rotating vector. In this model the square of a spin Pythagorean Triangle side can add and subtract through destructive interference. However they cannot interfere unless squared, otherwise there is no force and so one cannot change the other. A vector with a length e𝕧 and a -𝕚d inertial mass then could not subtract itself from another with an opposing -𝕚d value. This is because unless there is -𝕀D×e𝕧 inertial work done in rotating one vector to oppose the other there is no force.



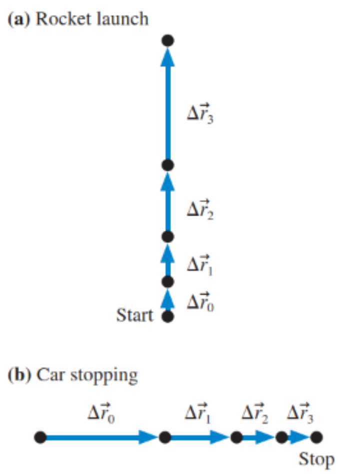
Active and reactive Pythagorean Triangles

Here there are position vectors as different lengths e𝕧, the rocket has an increasing -𝕚d inertial mass as it moves upwards. So, the -𝕚d and e𝕧 Pythagorean Triangles here do not have their area conserved. Instead an external force from -𝕠d and e𝕪 Pythagorean Triangles, as kinetic energy from burning fuel, is the active force here. With the car the external force comes from friction as chemical bonds in the brakes are formed and broken, this is reacted against by the -𝕚d and e𝕧 Pythagorean Triangles and their inertia.

Conserving Pythagorean Triangle area

With opposing Pythagorean Triangles, here the -𝕠d and e𝕪 Pythagorean Triangles and the -𝕚d and e𝕧 Pythagorean Triangles then the Pythagorean Triangle areas are not classically conserved as one changes the other. In quantum mechanics these are conserved as +𝕠d and e𝕒 Pythagorean Triangle proton and -𝕠d and e𝕪 Pythagorean Triangle electrons do not change size because of external forces. Instead here the Pythagorean Triangles are moved, some are expelled in the exhaust with an equal and opposite reaction as -𝕚d and e𝕧 Pythagorean Triangles.

FIGURE 1.9 Motion diagrams with the displacement vectors.



Zeno’s paradox of motion

Zeno discussed how an arrow has a paradox of motion, at a given instant it must be stationary and so it cannot be in a different position in the next instant. In this model nothing can be stationary. The -𝕚d and e𝕧 Pythagorean Triangle cannot have a side that is of zero size in e𝕧/-𝕚d as the velocity. It also cannot appear this way from any reference frame, that would mean the reference frame also had a zero Pythagorean Triangle side.

A constant velocity cannot be measured or observed

In this model a constant Pythagorean Triangle cannot be measured for its work or observed with its impulse. That is because there is no change and so there is not squared Pythagorean Triangle side as a force. The arrow then cannot be measured or observed when moving at a constant velocity, it can only be measured at a position for example with its -𝕀D×e𝕧 inertial work. It can only be observed with its E𝕐/-𝕠d kinetic impulse at a time. It cannot be measured and observed at the same time and position because of the Uncertainty Principle. If the arrow is measured or observed when stationary then this is when it changed, in between those changes it cannot be.

Points on a line

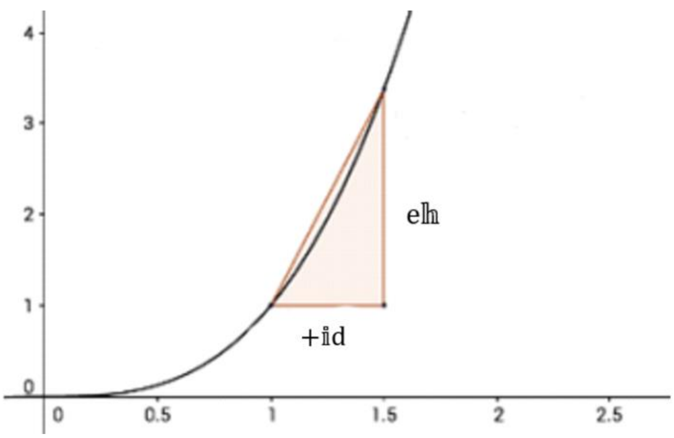
Zeno also said that a point has zero width, so an infinite number of points would still only be a point not a line. So a line is not transformable into a point and vice versa. In this model a point in time is called and instead such as -𝕠d with d=1. This becomes a line when d > 1. This is because the Pythagorean Triangle sides are square roots, they do not have definable points which are separated from other points. As Cantor showed these square roots are not denumerable on a list, there will always be others in between not on the list.

Squared points

In this model a point when measured has work, then it has a squared force as torque over a position, for example in -𝕀D×e𝕧 inertial work. The point then can be regarded as spin. Then the points have a minimum e𝕧 length because the Pythagorean Triangles have a constant area which cannot be infinitely small. They can also be observed as particles with their E𝕍/-𝕚d inertial impulse, then the E𝕍 length force value is like an area of the point. They can then be observed as separated points on a time scale of -𝕚d.

Calculus and Zeno

This becomes relevant to the model's use of calculus. A calculus Pythagorean Triangle on a slope has a finite size, it can change its slope by changing its angle θ with a constant Pythagorean Triangle area. The Pythagorean Triangle sides for example with the +𝕚d and e𝕙 Pythagorean Triangle would have an infinitesimal as a e𝕙 height, this has no definable size because it is a square root. The +𝕚d side acts as an instant of time also with no definable size. It is the same then as Zeno's points on a line, the Pythagorean Triangle on a line is not denumerable as Cantor showed.

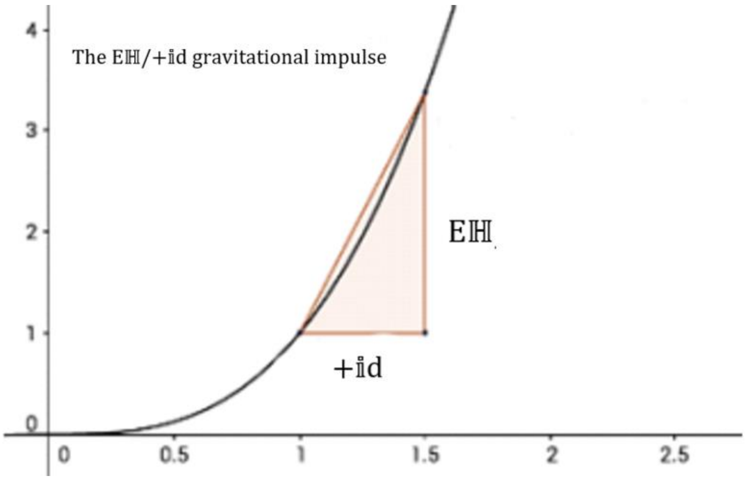


Derivatives and Integrals

Taking the first derivative of the -𝕚d and e𝕧 Pythagorean Triangle with respect to e𝕙 or +𝕚d gives the slope, there is still no force because the Pythagorean Triangle is not changing. It is then an infinitesimal divided by an instant as e𝕙/+𝕚d. If the first integral is taken with respect to e𝕙 or +𝕚d it gives the area of the Pythagorean Triangle doubled as +𝕚d×e𝕙. This area is also not denumerable according to this model as it multiplies together an infinitesimal and an instant.

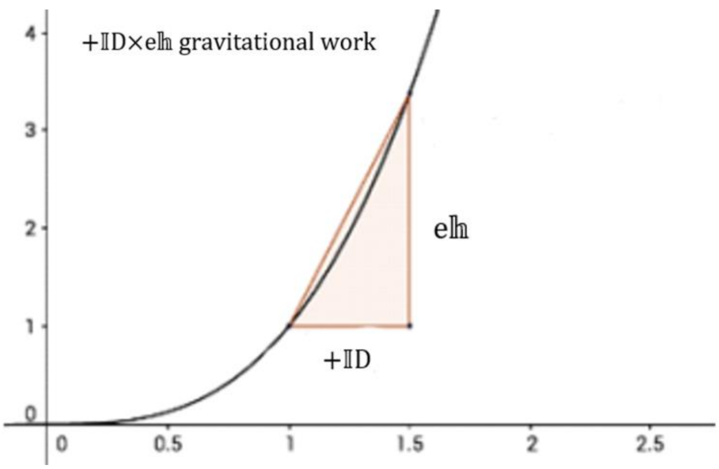
Second derivative

In this model the second derivative can only be taken with respect to the straight Pythagorean Triangle side here as e𝕙, that gives the Eℍ/+𝕚d gravitational impulse. As a classical approximation work can also be used as a slope such as the +𝕀D/e𝕙 gravitational work. However work in this model refers to a field because +𝕀D is not measuring a particle as it does not square an infinitesimal. The Eℍ/+𝕚d gravitational impulse uses the equation F=ma and would be meters^2/second here. Additional derivatives can be done, the model has derivatives as beginning from the Pythagorean Theorem.



Second integral

This would be the +𝕀D×e𝕙 gravitational work where the two terms are multiplied together to represent a field. There is a force +𝕀D which can be measured, this is no longer an instant of time. It can be a probability or a moment where the term is used with a moment of torque.



Instants and moments

In this model then a moment would be a square of an instant. When a spin Pythagorean Triangle side is squared then it is not definable as a size, it only represents a spin or torque. With an uncertainty it no longer is an instant of time, in this model it is a probability. This is because it may happen at a time or it may not, this is the uncertainty.

Infinitesimals and positions

An infinitesimal when squared then can be a position or change from one position to another. A constant velocity might be moving from one position to another but it not itself changing. To make this position then a force is needed, for example to move a particle with a velocity of e𝕧/-𝕚d with an initial E𝕍/-𝕚d inertial impulse.

Point particles

Impulse observes a particle over a time scale, it does not give a dimension over a straight Pythagorean Triangle side scale such as e𝕧 length. In this model then the e𝕧 length of an electron cannot be calculated, when this is tried it becomes the -𝕀D×e𝕧 inertial work done by it. -𝕀D then is an inertial probability and so there is an uncertainty of where it is.

Quantum electrodynamics

That also gives -𝕀D inertial probabilities of other iotas appearing around it, calculating the electron's -𝕚d inertial mass is also uncertain. The measurement process creates forces which act to increase the -𝕚d inertial mass of the electron, this can also have the -𝕠d and e𝕪 Pythagorean Triangle of the electron changing its angle so e𝕪×-𝕘d photons are emitted making the measurement more uncertain. These probabilities can be illustrated with Feynman diagrams as shown later. The model's interpretation of Zeno then leads to some of the electron's and other particle's properties.

Stopwatches and rotation

In this model a stopwatch measures an impulse, for example the E𝕍/-𝕚d inertial impulse, on a constant scale of time here as -𝕚d in seconds. When the stopwatch starts and stops there is -𝕀D×e𝕧 inertial work where the hand accelerates to a constant rotational velocity, then decelerates when it stops. As this happens the time is uncertain, the watch hand is accelerating or decelerating with an inertial torque. This would be measured in -𝕀D inertial moments or with a -𝕀D inertial probability of where the hand is. It is similar to a wrench turning a nut with a -𝕀D inertial torque, after loosening the nut it might turn at a constant rotational velocity until it is decelerated into a final position by the wrench with -𝕀D×e𝕧 inertial work.

A stopwatch is used to measure a time interval.

Two dimensions as two e𝕧 lengths

Here two dimensions are used, in this model they would be two Pythagorean Triangles which have an uncertainty compared to each other unless they are entangled. The boat's motion would be in the -𝕚d and e𝕧 Pythagorean Triangle, this would be referred to in this model as a velocity in two directions. It would also be two e𝕧 lengths the boat travels not length and width.

Other Pythagorean Triangle interactions

There is also gravity pulling it downwards from the -𝕚d and e𝕧 Pythagorean Triangle. The -𝕠d and e𝕪 Pythagorean Triangle gives kinetic energy to drive the ship forward, friction against this comes from the +𝕠d and e𝕒 Pythagorean Triangle as the proton. With these changes there are e𝕪×-𝕘d photons absorbed and emitted, also +𝕘d×e𝕓 gravitation iotas as particles or waves.

Position vectors

As a classical approximation the -𝕀D×e𝕧 inertial work done in accelerating the ship initially, or a -Id inertial torque in turning it is assumed. Then the e𝕧 Pythagorean Triangle sides have lengths e𝕧 which can be added together as vectors having a magnitude e. With two ships these would be vectors e𝕧$_A$ and e𝕧$_B$, the velocities would be e𝕧$_A$/-𝕚d$_A$ and e𝕧$_B$/-𝕚d$_B$. This would not be position vectors in this model because the e𝕧 lengths are infinitesimals times a value d.

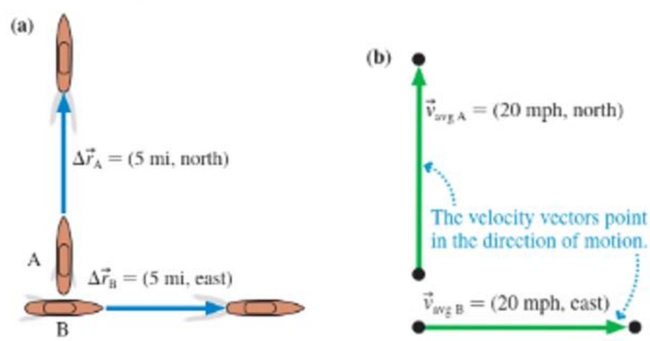
Observing vectors

Because the ships move at a constant velocity this cannot be observed so the position also cannot be observed. When the ships are initially accelerated with -𝕀D×e𝕧 inertial work and then decelerated with -𝕀D×e𝕧 inertial work then these two points can be estimates. In between them on this scale e𝕧 there are the vectors with some -𝕀D inertial probabilities of where the ships began and finished.

Time is not a vector

In terms of velocity the ships could also be observed according to their initial E𝕍/-𝕚d inertial impulse and their final E𝕍/-𝕚d inertial impulse. In this model time cannot be modeled as a vector like e𝕧 here as a position. Instead, this would be a number of rotations along this path such as on a clock. In classical physics this is not important as squares and square roots are not separated, later it is shown how the particle wave duality is modeled using work and impulse.

FIGURE 1.11 The displacement vectors and velocities of ships A and B.



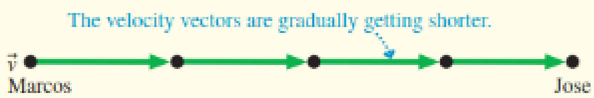
Many Pythagorean Triangles acting together

Here the e𝕧 lengths of each -𝕚d and e𝕧 Pythagorean Triangle is smaller than the one before. In this model each electron in the soccer ball has an -𝕚d and e𝕧 Pythagorean Triangle related to inertia, the electrons also have active forces from the -𝕠d and e𝕪 Pythagorean Triangles. The protons have reactive forces from the +𝕠d and e𝕒 Pythagorean Triangles and there are active forces from the +𝕚d and e𝕙 Pythagorean Triangles with gravity. Each of these is having its angle θ changing with work and impulse, e𝕪×-𝕘d photons are being absorbed and emitted with -𝔾D×e𝕪 light work or bouncing off electrons with the e𝕐/-𝕘d light impulse.

Friction as reactive work

Because the soccer ball is slowing the inertia from the -𝕚d and e𝕧 Pythagorean Triangles is being reduced. The e𝕧/-𝕚d velocity is decreasing so e𝕧 is becoming a shorter length over a longer -𝕚d period of time. Friction from the +𝕠d and e𝕒 Pythagorean Triangles and their bonds to electrons does reactive +𝕆D×e𝕒 potential work, these act as an integral Gaussian to diffuse the ball's motion with heat. The protons in the ball make bonds with electron as -𝕠d and e𝕪 Pythagorean Triangles in the ground, as these are broken by the ball rolling this acts to slow the ball.

FIGURE 1.14 Motion diagram of a soccer ball rolling from Marcos to Jose.



Average acceleration

In this model the velocity over time would be the -𝕀D×e𝕧 inertial work, but as a fraction e𝕧/-𝕀D. This is a classical approximation because in this model work represents a wave not the motion of a particle. It would be described here as the E𝕍/-𝕚d inertial impulse in meters^2/second instead of meters/second^2. The average acceleration during a time interval -𝕚d is the same, it acts on a constant time scale. Here -𝕚d can also be regarded as an instant with this an instantaneous acceleration.

Gaussian average

With uncertainty it is not known exactly how E𝕍 changes as the square of the length e𝕧, because of this it can be regarded as the average acceleration. However in this model average refers to a Gaussian or normal curve, this comes from an integral and the exponent in $e^{-𝕀D}$. A negative square as an exponent gives a Gaussian integral curve, here any of the spin Pythagorean Triangle sides when squared give a Gaussian. The exponent then can be the square of +𝕠d, -𝕠d, +𝕚d, -𝕠d, -𝕘d or +𝕘d.

Square roots of +1 and -1

In this model +𝕠d is the positive square root of -1, -𝕠d is the negative square root of -1. +𝕚d is the positive square root of +1 and -𝕚d is the negative square root of +1. -𝕘d acts as a difference between levels of -𝕠d, when squared it is -𝔾D. Here +𝕘d is the difference between levels of e𝕙 height or its inverse e𝕓 depth, when squared it is +𝔾D. Each of these would give a Gaussian curve when used as an exponent. This is a different mathematical interpretation but it gives consistent mathematics in these models.

Converting square roots of +1 and -1

In this model the true square root of -1 is -𝕠d, the +𝕠d square root of -1 is not directly convertible into it. This is different from conventional mathematics where i as the square root of -1 can be positive or negative. Here this can result in contradictions so the two are separated. With Roy electromagnetism then the overall magnetic field between a proton and electron comes from +𝕠d-𝕠d. When this is positive overall then the +𝕆D×e𝕒 potential work dominates, this acts like the potential in conventional physics as a reactive force only.

The potential and hyperbolic geometry

When an electron leaves an atom then -𝕠d is larger than +𝕠d then the -𝕆D×e𝕪 kinetic work done is an active force, it is not canceled out by the +𝕆D×e𝕒 potential work as in inside the atom. This model then makes the potential a different kind of force to kinetic energy by separating the two definitions of the square root of -1. The reason -𝕠d is the real square root here is because Roy electromagnetism is the left-hand side of the Pythagorean Theorem as the difference of two squares.

A hyperbola in Roy electromagnetism

This is also the equation for a hyperbola, so the natural orbit for an electron is the hyperbola and it moves in a hyperbolic trajectory. When bound by the +𝕠d potential magnetic field this hyperbola becomes a parabola, ellipse, or circle with the various orbitals. It can then move from one circle or ellipse to another by changing orbitals with a parabolic trajectory. These orbital changes can also be represented by conic sections.

Circular geometry in Biv spacetime

Biv space-time is represented by the right-hand side of the Pythagorean Theorem as the sum of two squares. Here gravity is the active force which is also in circular geometry as opposed to the electron in hyperbolic geometry. This also allows for Special Relativity to be in hyperbolic geometry from the -𝕚d and e𝕧 Pythagorean Triangle and gravity with General Relativity from the +𝕚d and e𝕙 Pythagorean Triangle. There is the active +𝕚d gravitational mass and the -𝕚d inertial mass, both in this model are the square roots of +1.

Separating positive and negative square roots

This is similar to in conventional mathematics where a positive number can have a positive or negative square root. In this model the two are separated, that the real square root is also positive. This negative square root then cannot be directly squared to give a positive number, here when squared it gives a negative number such as with -𝕠d when squared is -𝕆D. The answers don't change from conventional mathematics, the +𝕠d and -𝕠d values are summed, when a satellite is in orbit +𝕚d-𝕚d is a positive value and when squared this is +𝕀D as an active force. That is different from in Roy electromagnetism where +𝕠d-𝕠d when positive and squared in +𝕆D, this is not directly measurable.

Not directly measurable or observable

So +𝕆D and -𝕀D in this model are not directly measurable as forces, only in relation to an active force. This is why inertia is not an active force, instead it acts to reduce an active force like gravity in an equal and opposite way. Weightlessness then is where this inertia cancels out gravity as +𝕚d-𝕚d in orbit. This model derives all the correct answers with gravity and inertia using +𝕚d and -𝕚d, also the correct answers with +𝕠d and -𝕠d in Roy electromagnetism.

Active forces from e𝕪×-𝕘d photons

The e𝕪×-𝕘d photon is the difference in the active force of the electron in its orbitals, as d changes in -𝕠d as the kinetic magnetic field then a e𝕪×-𝕘d photon is emitted or absorbed. This has a d value in -𝕘d the same as the difference in the orbitals. Because e𝕪 as the kinetic electric chargeis the same in the photon as with the electron e is also the difference in energy levels.

Active forces from +𝕘d×e𝕓 Gravis

The +𝕘d×e𝕓 Gravi is also active, this represents the change in e𝕓 depth in a +𝕚d gravitational field. When this changes there is a gravitational wave spreading outwards as +𝔾D×e𝕙 Gravi work. This can also act with a -𝕘d/e𝔹 Gravi impulse like a particle or graviton.

Reactive forces from e𝕣×+𝕘d photons

While not directly measurable or observable the e𝕣×+𝕘d virtual photon is added to the negative value of the e𝕪×-𝕘d photon. This balances the energy of the photon according to whether it is absorbed in a higher or lower electron orbital.

Reactive forces from -𝕘d×e𝕧 inertials

As with the virtual photons these balance the emission and absorption or collisions of the Gravi, a larger -𝕚d inertial mass then might have a smaller measurable change from a gravitational wave or Gravi if the body is moving faster.

Gaussian probabilities

This means each of these does work with a Gaussian curve and probability; the +𝕆D×e𝕒 potential work, the -𝕆D×e𝕪 kinetic work, the +𝕀D×e𝕙 gravitational work, the -𝕀D×e𝕧 inertial work, -𝔾D×e𝕪 light work, and +𝔾D×e𝕙 Gravi work or gravitational waves. Here a Gravi is meant to be a gravitational equivalent to a photon with a particle wave duality.

The ratio $\Delta\vec{v}/\Delta t$ is called the **average acceleration,** and its symbol is $\vec{a}_{avg}$. **The average acceleration of an object during the time interval Δt, in which the object's velocity changes by $\Delta\vec{v}$, is the vector**

$$\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} \quad (1.7)$$

Velocity is not a vector

In the tactics box the velocity is represented as a vector, this would be where an iota moves with a constant velocity over this e𝕧 length. This would be written as e𝕧/-𝕚d where the denominator is time with rotation and is not a straight vector like the straight Pythagorean Triangle sides. These would be a first derivative of the -𝕚d and e𝕧 Pythagorean Triangle with respect to e𝕧, because of this e𝕧 is represented as a vector. If this was the first derivative with respect to -𝕚d then it would be a rotation like a rotating vector on a clock not pointing in one direction.

Adding vectors

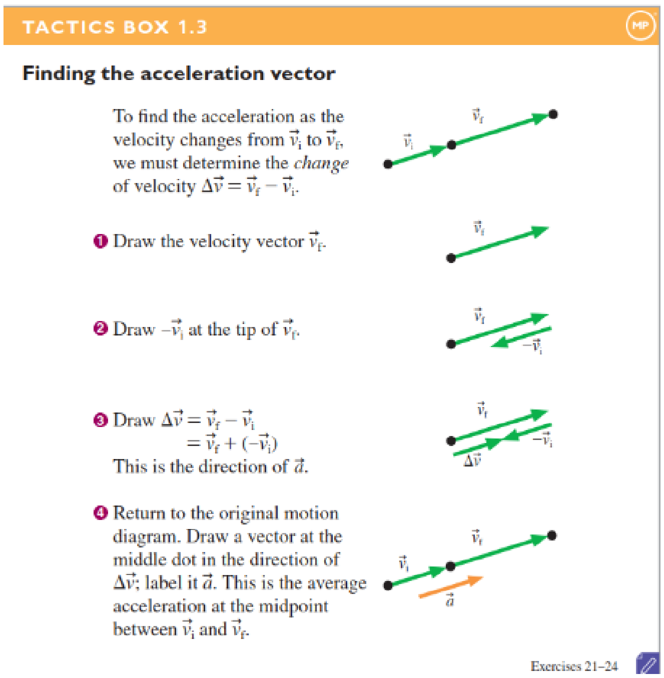
Here the vectors are added as straight Pythagorean Triangle sides, these can also represent changes in a single -𝕚d and e𝕧 Pythagorean Triangle where the velocity changes by a different ratio of e/d. If this was an electron then as a particle it might have its velocity changed with an E𝕍/-𝕚d inertial impulse by colliding with another electron or other particle. This would change its velocity and direction as shown. In classical physics the -𝕚d and e𝕧 Pythagorean Triangle area would rarely be conserved, but with a single electron in quantum mechanics this is relevant.

Acceleration vectors

An acceleration vector here represents the change between one e𝕧/-𝕚d velocity and the next, this would be from the E𝕍/-𝕚d inertial impulse collision between them for example. This change would happen over a time period as -𝕚d, the acceleration would be with the E𝕍/-𝕚d inertial impulse in meters^2/second.

Acceleration vectors as areas

Because E𝕍 is the square of a straight Pythagorean Triangle side it can still be represented by a vector here, it could also be the area of the vector as a rectangle to distinguish it from a one-dimensional e𝕧 length here. It is referred to as the E𝕍 length force because the square of a e𝕧 length creates the force. This also allows for the velocity and acceleration vectors to be on a constant time scale as the spin Pythagorean Triangle side. In this model a negative sign would preferably not be used to subtract vectors, this would be to avoid confusion between positive and negative spin sides.



Classical physics approximations

Here there is a constant velocity e𝕧/-𝕚d, in this model the skier contains many interactions of the 6 Pythagorean Triangles, there is -𝕀D×e𝕧 inertial work being done and the E𝕍/-𝕚d inertial impulse where atoms are accelerating and being decelerated. These are subtracted from gravity even on a horizontal surface, the atoms move up and down doing +𝕀D×e𝕙 gravitational work and with a Eℍ/+𝕚d gravitational impulse. That forms +𝕘d×e𝕓 Gravis which act as gravitational wave and particles. In Roy electromagnetism e𝕪×-𝕘d photons are emitted and absorbed doing -𝔾D×e𝕪 light work and colliding with a e𝕐/-𝕘d light impulse.

Active and reactive forces

In most cases these will not be shown in this model with the classical physics sections. As the skier reaches the slope there is a gravitational speed e𝕙/+𝕚d also called brevity in this model, this is to distinguish it from e𝕧/-𝕚d velocity. There is then a velocity as an equal and opposite reaction upwards against this gravitational speed. This need not be in an orbit to be constant, it is an infinitesimal divided by an instant. In this model the -𝕚d and e𝕧 Pythagorean Triangle has reactive forces only, this cannot be measured or observed directly as inertia but only in relation to active forces. There would then be +𝕀D×e𝕙 gravitational work downwards and there is -𝕀D×e𝕧 inertial work upwards which interferes destructively with it. The result is free fall and a sense of weightlessness as the two cancel each other out.

Inertia subtracted from gravity

With the downhill motion the d and e values of the Pythagorean Triangles change, e𝕙 decreases so e contracts while +𝕚d as the gravitational field dilates with d. This is why in this model a +𝕚d gravitational field is stronger closer to a mass. If a satellite was orbiting a planet closer to the edge of the e𝕙 gravitational well, it has an inertia with its e𝕧/-𝕚d which could take it out of orbit in a hyperbolic trajectory. Then this inertia from the -𝕚d and e𝕧 Pythagorean Triangle is subtracted from a much weaker +𝕚d and e𝕙 Pythagorean Triangle, the +𝕚d gravitational field is contracted at a dilated e𝕙 height.

Higher orbits

Conversely the -𝕚d and e𝕧 Pythagorean Triangle has its -𝕚d inertial mass inversely changed compared to the +𝕚d gravitational mass, this is because both Pythagorean Triangles have a constant area. The e𝕧/-𝕚d is much slower in a higher orbit, so e𝕧 is contracted inversely to the increase in e𝕙 height. Generally, e𝕧 then is proportional to +𝕚d so that e=d here, -𝕚d is proportional to e𝕙 so that d=e.

Kinetic and potential energy

Later the skier will also have their motion represented as a change between kinetic energy and potential energy. In this model it is the same as with the -𝕚d and e𝕧 Pythagorean Triangle as inertia and the +𝕚d and e𝕙 Pythagorean Triangle as gravity. One difference is the kinetic energy is active and the potential energy is reactive in Roy electromagnetism in Biv space-time inertia is reactive and gravity is active.

Changes in velocity and brevity

When the skier moves they have a velocity as e𝕧/-𝕚d which is subtracted from the gravitational speed or brevity as e𝕙/+𝕚d. Because gravity is an active force this gravitational speed changes as the skier moves downwards, e𝕙 has e contracted and +𝕚d has d dilating. The velocity changes inversely, the e𝕧 length is dilating and the -𝕚d inertial mass is contracting. Here the e𝕙/+𝕚d gravitational speed would not be in an orbit, changes would be more from a Eℍ/+𝕚d gravitational impulse than +𝕀D×e𝕙 gravitational work.

Work or impulse from speed

The velocity is also straighter, when in an orbit the e𝕧/-𝕚d velocity moves reactively against the e𝕙/+𝕚d gravitational angular speed so both are rotating. With this rotation the measurement would be +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, the two Pythagorean Triangles are constants because their angles θ are not changing. When a skier moves straight down these are also not changing unless observed, with a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse. This can be at the top of a parabola for example where the e𝕙 height is constant for an instant +𝕚d.

Inertia and gravity in orbit

This can be seen with a satellite orbiting a planet in Biv space-time, the satellite uses propulsion to move downwards into a lower orbit. The gravitational speed here is larger because e𝕙/+𝕚d has e𝕙 contracted at a lower height and the +𝕚d gravitational field is stronger so this is dilated. That happens with the +𝕚d and e𝕙 Pythagorean Triangle having a constant Pythagorean Triangle area compared to the higher orbit.

Higher and lower orbits

The satellite has an inversely faster velocity in the lower orbit, the satellite must move faster with a shorter orbital period to stop it falling. The e𝕧 length is dilated and the -𝕚d inertial mass is contracted, in this model the satellite has a lower -𝕚d inertial mass in a lower orbit. If it moves to a higher orbit the inertial mass increases, if it leaves the planet's +𝕚d gravitational field then +𝕚d-𝕚d becomes negative and it moves with reactive inertia only.

Work and impulse of the skier

Because the skier moves with the same inertia and gravity as the satellite their motion is calculated here also as a subtraction of velocity from brevity. The answer is the same as with conventional physics, with the acceleration vector below this would be represented by the skier doing +𝕀D×e𝕙 gravitational work by moving down to a lower height. Against this there is an equal and opposite reaction from their -𝕀D×e𝕧 inertial work. There is also observed a Eℍ/+𝕚d gravitational impulse as their acceleration means they move down into a stronger or dilated +𝕚d gravitational field.

Separating forces in quantum mechanics, General and Special Relativity

In classical physics these four forces are combined together, in this model relativity and quantum mechanics needs to separate them. For example, in Special Relativity there is -𝕀D×e𝕧 inertial work and the E𝕍/-𝕚d inertial impulse. In General Relativity there is +Id×e𝕙 gravitational work and the Eℍ/+𝕚d gravitational impulse. This model automatically gives the γ contraction and dilation in Relativity.

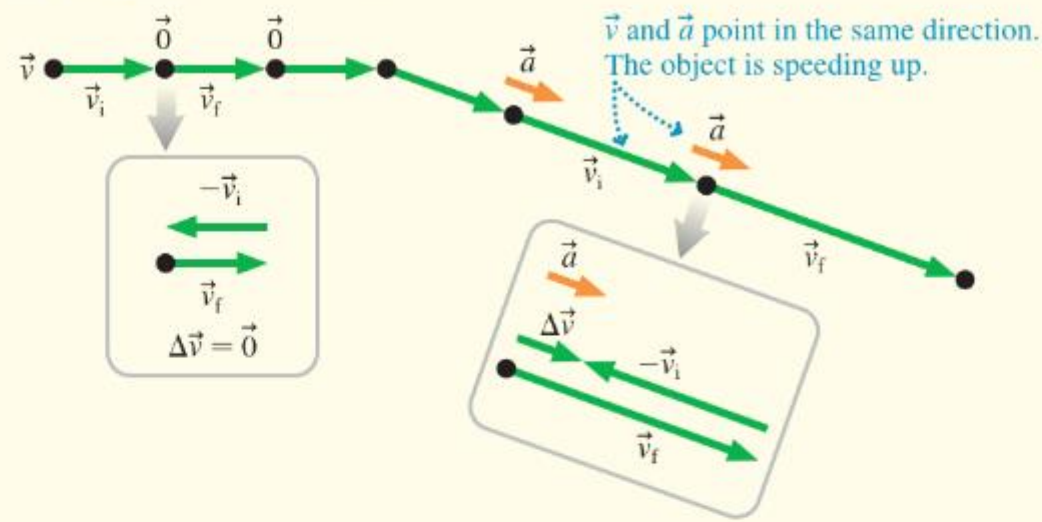
Continuous forces and acceleration

In classical physics the +𝕚d and e𝕙 Pythagorean Triangle as gravity and the -𝕚d and e𝕧 Pythagorean Triangle as inertia would have their angles θ opposite the spin Pythagorean Triangle sides change continuously. This would give a continuous acceleration vector, the velocity vectors below would be reduced to infinitesimals in calculus. Also, the +𝕀D×e𝕙 gravitational work and the Eℍ/+𝕚d gravitational impulse would be regarded as continuously changing. This relates to the concepts of calculus where in this model the e𝕧 and e𝕙 straight Pythagorean Triangle sides are infinitesimals while the +𝕚d and -𝕚d spin Pythagorean Triangle sides are instants.

Quantization

In this model the Pythagorean Triangles cannot be infinitely smaller and so there is no continuous acceleration nor are there continuous forces. This would give a minimum limit to the sizes of the velocity vectors below and the acceleration vectors. This will only become important later in the sections on Relativity and Quantum Mechanics. Here they are explained to show this model is consistent with classical physics.

FIGURE 1.16 Motion diagram of a skier.



Tossing a ball compared to a satellite

In this model tossing a ball up in the air is similar to the examples of a satellite in orbit, the motion upwards is e𝕧/-𝕚d velocity and the motion downwards is e𝕙/+𝕚d brevity. The name brevity then is intended to avoid confusion in examples like this.

Active work and impulse slowing the ball

As the ball moves upwards against gravity there is a +𝔻D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse slowing it down. These forces are the same at a e𝕙 height with its corresponding strength of the +𝕚d gravitational field whether it is going up or down. So the same d and e values in this brevity as well as the +𝔻D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse are also the same whether the ball is going up or down.

Continuously changing θ as a classical approximation

The acceleration vectors with this +𝔻D×e𝕙 gravitational work and the Eℍ/+𝕚d gravitational impulse can be regarded as continuously changing in classical physics. This is where the +𝕚d and e𝕙 Pythagorean Triangle would have its angle θ also continuously changing. As a reactive force the ball has an inertia, this has an equal and opposite reaction to the gravity. That keeps the ball rising upwards, there is an -𝔻D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse that changes with the angle θ in the -𝕚d and e𝕧 Pythagorean Triangle as well.

The two Pythagorean Triangles with inverse values of d and e

So the motion of the ball can be described by its velocity e𝕧/-𝕚d where e and d are the inverses of e and d in the e𝕙/+𝕚d brevity at each point. At the greatest e𝕙 height of the ball then the e𝕧 in velocity reaches its minimum. When the ball hits the ground e𝕧 in the e𝕧/-𝕚d velocity reaches its maximum when the e𝕙 height in the brevity reaches its inverse as the minimum. The -𝕚d inertial mass of the ball also reaches its maximum at its greatest e𝕙 height, this is where the +𝕚d gravitational field is weakest at its minimum. Then when it falls the -𝕚d inertial mass is lowest where it hits the ground as the +𝕚d gravitational mass is its highest.

The ball to the edge of the gravitational field

This would be more obvious if the ball with thrown to the edge of the +𝕚d gravitational field on an airless planet, the +𝕚d d value would be lowest while the d value in the -𝕚d inertial mass would be highest.

Weightlessness on the ball

Because the d and e values are inverted in the +𝕚d and e𝕙 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle the forces cancel out, someone on the ball would experience no gravity and no feeling of inertia.

Gravitational acceleration and deceleration

In this model there would be four kinds of accelerations here, the gravitational acceleration is from two kinds as the +𝕀D×e𝕙 gravitational work and the Eℍ/+𝕚d gravitational impulse. These both point downwards, with a greater e𝕙 height the +𝕀D×e𝕙 gravitational work decreases exponentially. With a longer time elapsed from when the ball was thrown the Eℍ gravitational height force also decreases exponentially.

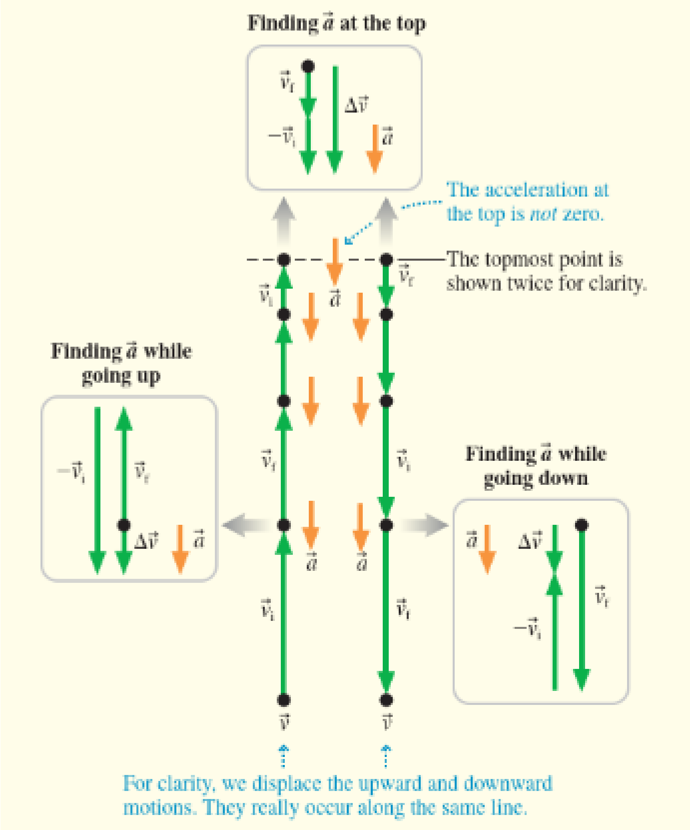
Inertial acceleration and deceleration

The inertial acceleration inversely increases with a greater height with the -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse. The inertial acceleration is upward because inertia is always and equal and opposite reaction. Because inertia is subtracted from gravity when the ball is close to the ground its inertia is low, the gravity is much stronger than it. If the ball was thrown close to the edge of the gravitational well then, the inertia would be much stronger than the weak gravity there.

Exponential curves and constant Pythagorean Triangle areas

This is because with a constant area comparing the square of one Pythagorean Triangle side with a non-squared other side this traces out an exponential curve. This is seen with exponential decay for example where as time increases constantly a radioactive source decreases as a square.

FIGURE 1.17 Motion diagram of a ball tossed straight up in the air.



Positive and negative signs

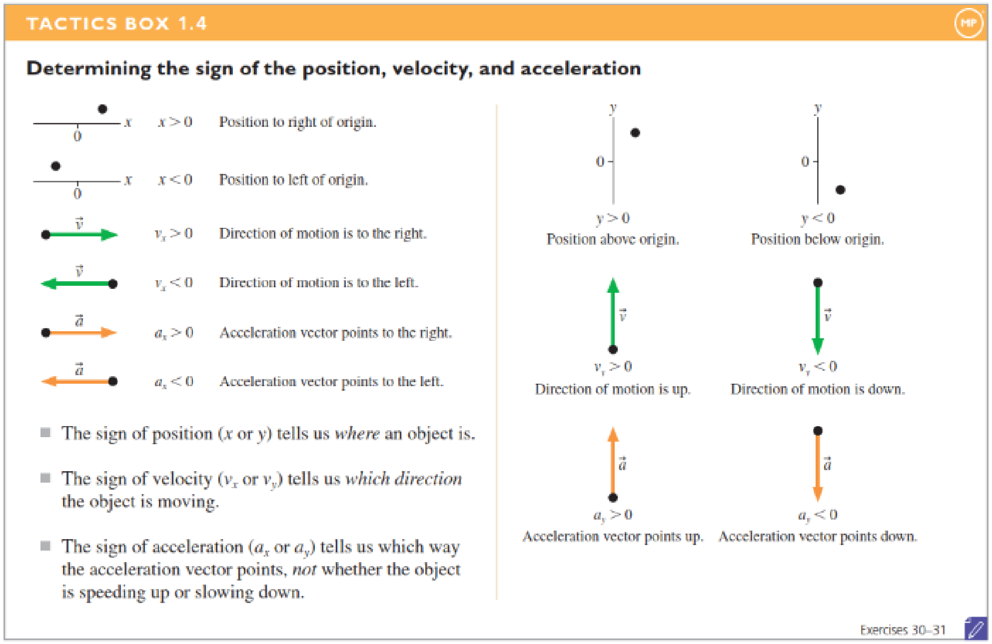
In this model positive and negative signs are preferably not used for changes in the Pythagorean Triangles, this is to avoid confusion with +𝕠d and -𝕠d, +𝕚d and -𝕚d. Instead rotation is preferably clockwise and counterclockwise. The speed, work and impulse can also be defined with d and e contracting or dilating. Positive and negative signs might be used where there is no ambiguity, in this model there are avoided to make it clearer here.

Using brackets with Pythagorean Triangle sides

Another convention might be two place Pythagorean Triangle sides in brackets with an external signs, for example +(e𝕧)-(e𝕧) while +𝕚d-𝕚d would not need brackets. In this model adding and subtracting Pythagorean Triangles can introduce uncertainty because any change in the angle θ happens with a force of work or impulse. The two cannot be added such as with the -𝕆D×e𝕪 kinetic work and the E𝔸/+𝕠d potential impulse. With work there can be addition and subtraction with constructive and destructive interference.

Vector addition and subtraction

With impulse the squared Pythagorean Triangle sides can be added and subtracted with their directions, this is the same as with vector addition and subtraction. This could be done as a classical approximation with basis vectors such as the x and y coordinates, up with y can be increasing and down decreasing. Right can be increasing and left decreasing. It's not known how confusing this might be, so this is pointed out here in the text.



Using d and e

In this model the acceleration can show that e is dilating and d contraction as it increases.

Brevity, gravitational work and impulse

Having the acceleration pointing to the right might occur with the +𝕚d and e𝕙 Pythagorean Triangle as a ball falls to the ground, this would be where the +𝕀D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse are associated with the e𝕙/+𝕚d brevity. As this brevity has e dilating and e contracting the gravitational speed increases, then the +𝕀D×e𝕙 gravitational work would be dilating and the Eℍ/+𝕚d gravitational impulse contracting. This is because the impulse fraction is getting smaller.

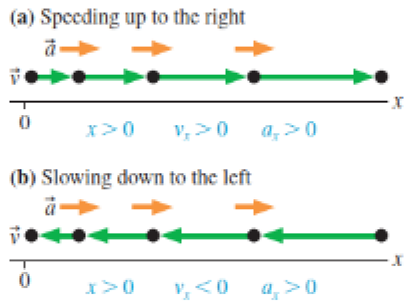
Velocity, inertial work and impulse

When the ball is rising according to the -𝕚d and e𝕧 Pythagorean Triangle and inertia it is decelerating with its e𝕧/-𝕚d velocity. Its -𝕀D×e𝕧 inertial work would be dilating and its E𝕍/-𝕚d inertial impulse would be contracting.

Inverted Pythagorean Triangles

As the ball is rising then its +𝕀D×e𝕙 gravitational work is contracting because +𝕚d is decreasing as a square while e𝕙 is increasing constantly. Also with the ball rising the -𝕀D×e𝕧 inertial work is dilating because the -𝕚d inertial mass is increasing as a square while the e𝕧 length is decreasing constantly. Conversely the Eℍ/+𝕚d gravitational impulse is dilating because Eℍ as the height force is increasing as a square while +𝕚d is decreasing constantly. The E𝕍/-𝕚d inertial impulse is contracting because E𝕍 is decreasing as a square while -𝕚d is increasing constantly.

FIGURE 1.18 One of these objects is speeding up, the other slowing down, but they both have a positive acceleration a_x.



Hyperbolic geometry

The position versus time graph of a car in this model would be represents by the -ⅈd and e𝕧 Pythagorean Triangle, x would be e𝕧 where upwards has e increasing. The t axis would represent -ⅈd with d increasing towards the right. Because the -𝕠d and e𝕪 Pythagorean Triangle and -ⅈd and e𝕧 Pythagorean Triangle are in hyperbolic geometry the hypotenuse does not extend from the origin of the graph, instead it connects the axes as shown.

Pythagorean Triangles and hyperbolas

This is because a Pythagorean Triangle under a hyperbola with a constant area traces out a hyperbola where the hypotenuse forms a tangent to it. As the angle θ changes in the -ⅈd and e𝕧 Pythagorean Triangle then this represents changes in hyperbolic geometry with this model.

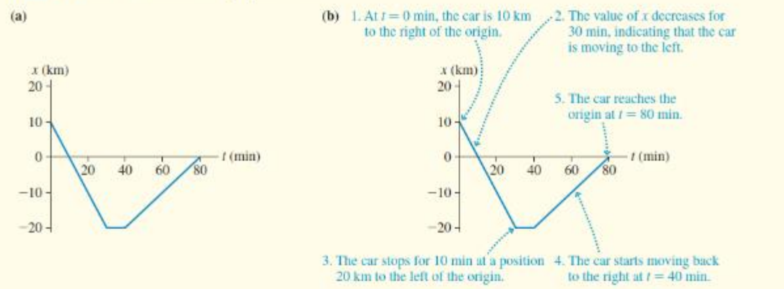
Infinitesimals and instants

When the car moves with a constant e𝕧/-ⅈd velocity the e:d ratio remains constant, e𝕧 is an infinitesimal and -ⅈd is an instant. These can be extended and remain infinitesimals and instants in this model as the long as the ratios remain the same, that is because the time has not changed in relation to the e𝕧 length. Also, the e𝕧 length has not changed in relation to the time.

Forces from a change in velocity

When the car starts, stops, or changes its velocity then there is a force which can be measured as -𝕀D×e𝕧 inertial work or observed with the E𝕍/-ⅈd inertial impulse. The -𝕀D×e𝕧 inertial work would be measured using the vertical scale as x kms, the E𝕍/-ⅈd inertial impulse would be observed using the horizontal scale as t seconds. In this model -𝕀D and E𝕍 represent two different forces when the velocity changes. Here the car can move forwards and backwards on this line as e𝕧 changes its e value.

FIGURE 1.21 Position-versus-time graph of a car.



Past and future with work

In this model increasing entropy comes as time progresses, this comes from the randomizing process of work such as with the -𝕀D inertial probabilities. This is why time cannot go backwards as this randomization comes from the Gaussian integral of the squares of the spin Pythagorean Triangle sides, for example $e^{+\mathbb{I}D}$ would trace out a normal curve where the area gives the randomizing effects of gravity. Over time a mountain would crumble into sand from this +𝕀D×eℍ gravitational work being done.

Reversing position with work

While time cannot be reverse as a +𝕀D gravitational probability it can be reversed with the straight Pythagorean Triangle side as a constant scale. This is why running a video backwards shows iotas returning to their previous positions. With gravity this would restore a mountain to its previous eℍ height as the +𝕀D gravitational probabilities were reversed. In this model that can be illustrated with a movie but it cannot occur in reality.

Past and future with chaos

There is also an increasing uncertainty in the positions of objects which causes erosion, the Eℍ/+𝕚d gravitational impulse means that objects would become scattered in their eℍ height according to an exponential curve. While not random with traditional entropy this can be observed in chaos according to this model. Examples of this would be 3 asteroids moving chaotically with the Eℍ/+𝕚d gravitational impulse changing their orbits. Mixing paint can cause it to blend chaotically rather than randomly depending on the Reynolds number.

Reversing time with impulse

Because time as the spin Pythagorean Triangle side acts as a constant scale it can be reversed. A 3-body motion of asteroids can also be reversed deterministically in time. When this is done the E𝕍 length forces return to their original values, for example in running a video backwards. This is a rotational change in reverse then, just as the paint separates by reversing the rotation the 3 bodies return to their original positions.

The wave function and Schrodinger’s equation

This also evolves deterministically so that the equation can be reversed in time. In this model Schrodinger’s equation converts the E𝕍/-𝕚d inertial impulse to -𝕀D×e𝕍 inertial work where it becomes a probability. Then it is no longer deterministic.

Kinematics

In this model derivatives are associated with particles and impulse, integrals with work and waves. If graphs are read with respect to time or position can then be important, though as a classical approximation it makes little difference. A slope refers to a derivative as a fraction, below x might be e𝕙 as height and t would be +𝕚d as the gravitational field or it can act as time. The slope is changing with respect to time or +𝕚d and so this would be the Eℍ/+𝕚d gravitational impulse.

Partial derivatives

That would be written as ∂e$𝕙^2$/∂+𝕚d as the second derivative with respect to e𝕙, in this model partial derivatives are used because one Pythagorean Triangle side is being squared as a force. In a partial derivative, other variables are held as constants so +𝕚d would not change as a force as well. One difference is ∂+𝕚d can change with d when the ∂e$𝕙^2$ or ∂Eℍ changes as a square. This is maintaining a constant area of the +𝕚d and e𝕙 Pythagorean Triangle.

The first derivative as a slope

The slope then is e𝕙/+𝕚d as the kinetic velocity or brevity, this is the first derivative with respect to +𝕚d or ∂e𝕧/∂+𝕚d. In this model e𝕧 is already an infinitesimal and +𝕚d an instant so there is no reduction to smaller than these. If the ratio between the straight and spin Pythagorean Triangle sides remains constant, then this is like a constant e𝕧/-𝕚d velocity over a fixed distance and time. There are no forces to change the infinitesimal and instant.

Small Pythagorean Triangles in this model from physics

More usually in calculus there are changes over small positions and small instances, the Pythagorean Triangle used would be exceedingly small to reduce the errors between it and the curve. This is also because the Pythagorean Triangles used in this model are exceedingly small according to their physics.

Pythagorean Triangles and forces

In calculus there are Pythagorean Triangles on a curved line representing a changing force. The Pythagorean Triangle is shrunk down to an infinitesimal size to determine the slope. In this model the process is reversed, the Pythagorean Triangle already has sides of an infinitesimal and an instant. When the curve deviates from the hypotenuse ζ this is represented by a force as a square.

This Pythagorean Triangle cannot be measured or observed

The difference between this calculus Pythagorean Triangle and physics measurements or observations is this Pythagorean Triangle is uncertain in its nature. It cannot be directly measured or observed because doing this requires squaring a Pythagorean Triangle side which changes it.

A squared side as an area versus the Pythagorean Triangle area

Then there is a conflict between the constant Pythagorean Triangle area and the squared side, that is resolved by a change in the angle θ which is measured or observed as a e𝕪×-𝕘d photon or a +𝕘d×e𝕓 Gravi.

Additional derivatives like a square

An additional derivative can take this to the third degree as a cube, and so on. The curve then cannot change from a straight-line hypotenuse without a measurement as an integral or an observation as a particle. In this model's quantum mechanics, the hypotenuse technically is not used as the curve does not actually exist as an approximation to the hypotenuse. Instead, the change occurs from work or impulse, this appears as a squared Pythagorean Triangle side.

Additional derivatives like additional observations

If an additional derivative is taken this is like taking that square and subtracting 1 from the exponent. That would not be allowed in this model except for a classical approximation, a Pythagorean Triangle can only have a side become a square because areas are added in the Pythagorean Theorem. An -ⓓd and e𝕪 Pythagorean Triangle as the electron can for example have third or higher derivatives with respect to e𝕪, for example it might collide with other atoms and each time it happens to be accelerated. Its acceleration then is not constant as in gravity but higher such as in jerk.

The form of writing derivatives

It might be preferred to write the E𝕐/-ⓓd kinetic impulse for example as -ⓓd/E𝕐 so that additional derivatives add 1 to the exponent in the denominator. In this model that represents a separate observation so this might be a convention rather than it affecting the Pythagorean Triangle form.

Anti-derivatives

Conversely the electron might reduce its acceleration in these collisions, overall it might then be observed to be decelerating towards a constant e𝕪/-ⓓd kinetic velocity proportional to a e𝕧/-𝕚d velocity. In this model they would be separate observations of a second derivative, each time a derivative acts like a squared force to increase the power of the acceleration or to decrease it. The same rules of derivatives are used each observation.

Partial integrals

Integrals are usually regarded as partial, but in this model it is made explicit. The position would not be the integral of velocity here, this would make position such as e𝕧 a wave. This is a straight Pythagorean Triangle side not an area. Instead, this area might be the inertial momentum with the -𝕚d and e𝕧 Pythagorean Triangle as -𝕚d×e𝕧. When this is measured as a force the area of the Pythagorean Triangle becomes uncertain. The diagram shows the area under a curve which is a classical approximation.

The curve changes with work

The curve would be where the inertial momentum -𝕚d×e𝕧 changed with the -𝕀D×e𝕧 inertial work. Each time this changed the curve would deviate from a straight line as the hypotenuse ζ. Often this area is represented as a series of rectangles making up the integral area with small Pythagorean Triangles giving the slope between them. These rectangles would each represent two Pythagorean Triangles together where their sides are infinitesimals as e𝕧 and instants as -𝕚d for that small section of the curve that is a straight line.

The curve bends from torque as a force

In this model then the rectangles do not shrink down to become the same as parts of the curve. Instead each time the curve bends here this would be from -𝕀D×e𝕧 inertial work where the -𝕀D inertial torque cause it to rotate.

Pythagorean Triangles and rectangles interfering

That results in a measurement and then the next rectangle gives another measurement. These can be added up together as waves that interfere with each other constructively or destructively. The -𝕀D×e𝕧 inertial work done need not then be at regular intervals in real life the measurements might be highly irregular and still give an integral area as a classical approximation. If these overlap such as with several instruments taking measurements together, then these would be constructive and destructive interferences to give the overall area.

Uncertain rectangle areas

The rectangles also have an uncertain area because the tops are Pythagorean Triangles or are curved, they might be regarded as in the Pythagorean Theorem with a Pythagorean Triangle and an area affixed to one side.

Uncertain electron waves

This makes them uncertain because Pythagorean Triangles cannot change their area, the integrals as electrons would then represent e𝕪×-𝕘d photons being emitted and absorbed with electron waves as -𝕠d and e𝕪 Pythagorean Triangles.

Uncertain inertial integrals

If these were -𝕚d and e𝕧 Pythagorean Triangles then there would be -𝕘d×e𝕧 integras which are not directly measurable. They would be a reactive force only in relation to active forces from the -𝕠d and e𝕪 Pythagorean Triangles as electrons or +𝕚d and e𝕙 Pythagorean Triangles as gravity.

Gaussian integrals and probability

A similar process can create a Gaussian integral area from $e^{e𝕧-𝕀D}$ where D is a negative square with changing values. Here e changes inversely to d. Because the -𝕀D×e𝕧 inertial work measured can be anywhere on this curve it need not be a series of regular rectangles. It can be any kinds of rectangles overlapping with constructive and destructive interference.

Two constant area Pythagorean Triangles as a rectangle

Also a rectangle would have to maintain a constant area, so a higher rectangle near the center of the Gaussian would have a taller -𝕚d value indicating an event had a higher -𝕀D inertial probability there compared to on the edges. These Pythagorean Triangles and rectangles might also be highly irregular, for example the normal curve might be derived from Pascal's Triangle with flipping a coin. There might be many coins flipped and the results added so there is against constructive and destructive interference between them. These would still approach a Gaussian integral in shape.

Integrals and anti-integrals

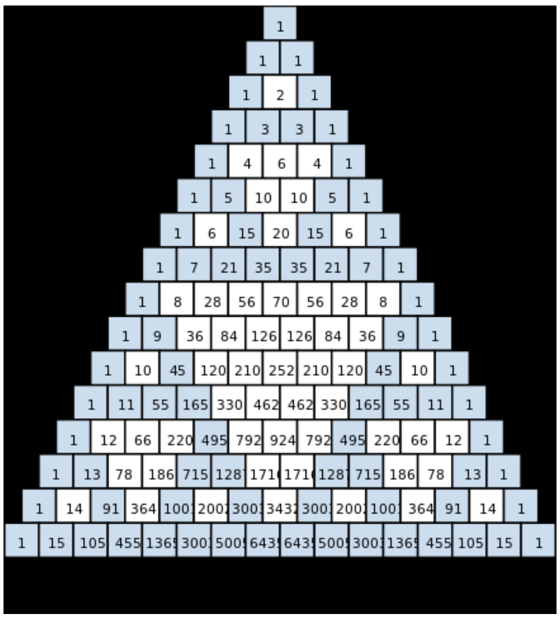
In this model then additional integrals are a classical approximation, each time the integral rule is applied to raise the exponent from -𝕚d, to -𝕀D, to -𝕚d×-𝕀D and so on. Each time the Pythagorean Triangle has changed so these are separate measurements. Conversely anti-integrals with respect to -𝕚d here would reduce the higher power back to the inertial momentum as -𝕚d×e𝕧. The curve then gives uncertain inertial probabilities here because there are a number of separate measurements interfering with each other.

Pascal’s Triangle, derivatives and integrals

In this model derivatives and integrals also come from the binomial theorem. This connects them with the normal curve as the limit of the rows of the Triangle. The cells then represent a derivative times an integral, that allows for the normal curve as a row to be composed of integral areas with a variable slope. It also allows for groups of cells in the Triangle to act like a fractal from the impulse Pythagorean Triangles.

Rows as integrals of work and columns as derivatives of impulse

In this model the rows represent integrals because their distribution approaches a normal curve. The columns represent chaos because they form fractal pattern similar to a Sierpinski Gasket. Separating impulse as derivatives from work and impulse is relevant later to how probability and chaos is calculated with this model.



Derivatives times integral in Pascal’s Triangle

Here each cell is composed of a derivative times an integral, that allows it to be part of a probability or chaotic calculation according to this model. For example, one row would be $x^5+5x^4y+10x^3y^2+10x^2y^3+5xy^4+y^5$. This is also x^5 then $5x^4$ as the derivative of x^5 with respect to x. Then there is $20x^3$ as the second derivative $\times$ $½y^2$ as the first integral with respect to y which gives $10x^3y^2$. The next cell is the third derivative $60x^2$ times the second integral $1/6 \times y^3$ to give $10\ x^2y^3$, then there is the fourth derivative 120x times the third integral $1/24\times y^4$ and the last cell is where the fifth derivative becomes 120 times the fourth integral $1/120\times y^5$.

The Pascal's Triangle calculus

In this model the cells are derivatives times integrals, the whole Triangle is then referred to as the Pascal's Triangle calculus. One advantage of this system is that infinitesimals and instants like fluxions are not needed, they are both derived from adding together integers. It’s not known whether Newton used this system, he discovered the Binomial Theorem and calculus so they may have been used together.

Reactive integrals not directly measurable

Starting with the inertial momentum -𝕚d×e𝕧 then an additional or second integral with respect to -𝕚d would give a measurement as the -𝕀D×e𝕧 inertial work. An anti-integral would take this back to a constant inertial momentum. With the -𝕚d and e𝕧 Pythagorean Triangles as inertia these would not be directly measurable, the changes in inertial momentum here might then be a reaction to a kinetic energy from the -𝕠d and e𝕪 Pythagorean Triangle or from gravity with the +𝕚d and e𝕙 Pythagorean Triangle. There would not be in this model a second integral with respect to e𝕧 except as a classical approximation, that would make impulse a wave instead of a particle.

Position graphs for each Pythagorean Triangle

Here the position graph would be the -𝕚d and e𝕧 Pythagorean Triangle and inertia, but the same graph could also be used for the +𝕠d and e𝕒 Pythagorean Triangle, the -𝕠d and e𝕪 Pythagorean Triangle, the +𝕚d and e𝕙 Pythagorean Triangle, the -𝕠d and e𝕪 Pythagorean Triangle, and the +𝕘d and e𝕓 Pythagorean Triangle. In each case they represent a Pythagorean Triangle with square root sides and a constant angle θ.

Conventions on straight Pythagorean Triangle side directions

The straight Pythagorean Triangle side in each case can be vertical and the spin or time Pythagorean Triangle side would be horizontal. In this model as a convention the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle would have the e𝕪 and e𝕧 Pythagorean Triangle sides respectively horizontal while the e𝕒 and e𝕙 Pythagorean Triangle sides respectively remain vertical. This is because they often oppose each other at right angles, the proton with a e𝕒 altitude is like the e𝕙 height as vertical, an electron moves orthogonally to this with e𝕪 and a length e𝕧.

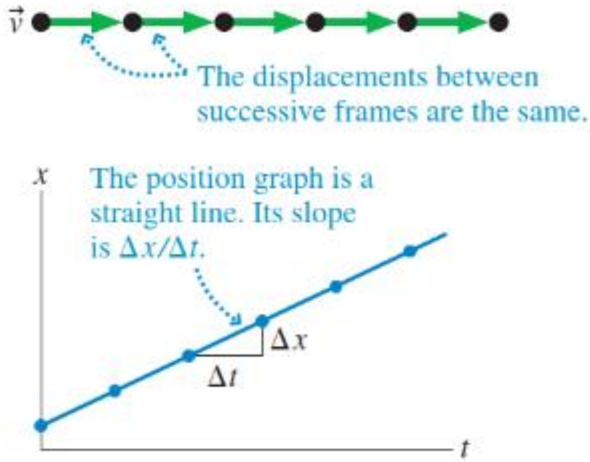
Conventions on spin Pythagorean Triangle side directions

With e𝕒 or e𝕙 these would be a vertical axis, these connect orthogonally to a e𝕪 or e𝕧 horizontal axis. Each pair would be easier to draw separately. The third orthogonal direction would be horizontal, for Roy electromagnetism this would contain the +𝕠d Pythagorean Triangle side connecting through the origin to the -𝕠d side. This is similar to the imaginary axis used in conventional mathematics. With Biv space-time this directions would have +𝕚d and -𝕚d.

Friendly names of spin Pythagorean Triangle sides

The square root of -1 is conventionally called imaginary to represent a difference from real numbers. The +𝕠d and -𝕠d numbers are here referred to as Obscure, because they start with O. The +𝕚d and -𝕚d numbers are referred to as Intangible to differentiate them from Imaginary.

FIGURE 2.1 Motion diagram and position graph for uniform motion.



The position versus time graphs would refer to Pythagorean Triangles that do not change their angles θ until the slope changes. Then this would be a change of impulse as a force from a derivative. When compared with a velocity and time graph these would be a second derivative with respect to the straight Pythagorean Triangle side. Because these lines are straight there are squared forces only, these would be the E𝕍/-𝕚d inertial impulse for example with a car's motion.

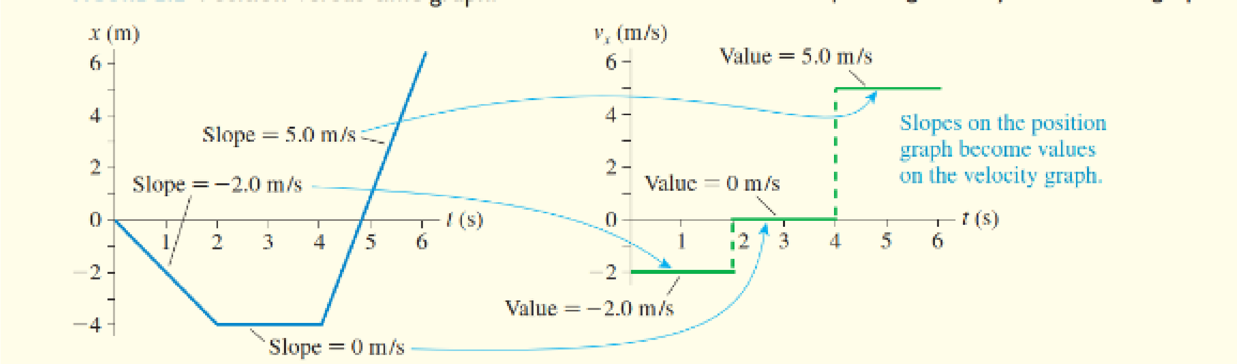


FIGURE 2.2 Position-versus-time graph.

FIGURE 2.3 The corresponding velocity-versus-time graph.

Uncertainty and a slope change

The change in slope would be uncertain at the angles because of the need to maintain a constant Pythagorean Triangle area and make one Pythagorean Triangle side a square. In this model that would require a change in Iners as -𝕘d×e𝕧 here.

Iners and virtual photons

This is not observable directly because inertia is a reactive force only, in this model the Iners would be subtracted from +𝕘d×e𝕓 Gravis or e𝕪×-𝕘d photons proportionally. Because Iners and e𝕣×+𝕘d virtual photons are not measured or observed separate to active forces they must be subtracted to those. For example if this was a car on a hill with a changing slope then the changes in E𝕍/-𝕚d inertial impulse would be accompanied by changes in the Eℍ/+𝕚d gravitational impulse, this is because at different slopes the car would experience a different gravitational force.

Gravis minus Iners

That would be calculated by +𝕘d×e𝕓 -𝕘d×e𝕧 to give the total Gravi, currently measurable as gravitational waves. If the E𝕐/-𝕠d kinetic impulse was being calculated from the car's engine energy, then the Iner would be subtracted from this as each change in velocity would have an equal and opposite reaction force.

Photons minus Iners

There would then be e𝕪×-𝕘d photons emitted and absorbed from these changes in kinetic energy, they would have corresponding Iners as -𝕘d×e𝕧 not directly measurable or observable. If the car If the car reached a steeper slope then it would need to absorb e𝕪×-𝕘d photons from its battery, with the example of an electric car. These would counteract the equal and opposite reaction from the Iner as the -𝕚d and e𝕧 Pythagorean Triangle also changed its slope. If the car reached a decline then it might emit e𝕪×-𝕘d photons to be stored in the battery, the Iner from the -𝕚d and e𝕧 Pythagorean Triangle would also oppose this as inertia would oppose any change in velocity as e𝕧/-𝕚d. This is similar to Lenz's Law with magnetism where a change in the motion of a magnet can be opposed by an electric field it creates. In that case as shown later there are e𝕣×+𝕘d virtual photons reacting against the e𝕪×-𝕘d photon changes in the coil.

Using impulse, work or the changes

In these examples the Iners, Gravis, photons, and virtual photons represent a difference between one Pythagorean Triangle and a change in its angle θ. These situations can also be analyzed directly from the impulse as it changes, the car then would have a change in its E𝕍/-𝕚d inertial impulse with a change of slope with a change in the observed Eℍ/+𝕚d gravitational impulse. There would also be a change in the E𝕐/-𝕠d kinetic impulse from the car battery.

Motion as Roy electromagnetism or Biv spacetime

The car's motion can then be described with Roy electromagnetism where the E𝕐/-𝕠d kinetic impulse and E𝔸/+𝕠d potential impulse represent kinetic and potential energy as it changes its height in conventional physics. It can be described as the E𝕍/-𝕚d inertial impulse versus the Eℍ/+𝕚d gravitational impulse as it changes its gravitational potential energy in conventional physics.

Four changing Pythagorean Triangles

It can also be described by changes in the four Pythagorean Triangles in between Roy electromagnetism and Biv space-time, these are e𝕪×-𝕘d, e𝕣×+𝕘d, -𝕘de𝕧, and +𝕘de𝕓. In the Pythagorean Theorem there is e^2-d^2 which represents Roy electromagnetism, 4ed as these four central Pythagorean Triangles, and e^2+d^2 as Biv space-time.

Each changing Pythagorean Triangle as ed

Each Pythagorean Triangle here such as e𝕪×-𝕘d represents xy where x as a straight Pythagorean Triangle side has a value of e and y as a spin Pythagorean Triangle side has a value of d. The difference then of these 4 Pythagorean Triangles are transmitted between Roy electromagnetism and Biv space-time so that each affects the other. That makes all the forces add up in this model.

The Pythagorean Theorem

This uses the Obscure and Intangible numbers in this model to give the same answers as in the conventional Pythagorean Theorem.

Roy electromagnetism as the left-hand side

The left-hand side of the Pythagorean Theorem would be Roy electromagnetism (e𝕒+𝕠d)(e𝕪-𝕠d) or E𝕐-𝕆D because these are the active Pythagorean Triangle sides and E𝔸+𝕆D could not be directly measured or observed. The E𝕐/-𝕠d kinetic impulse can be observed and the -𝕆D×e𝕪 kinetic work can be measured, the E𝔸/+𝕠d potential impulse and the +𝕆D×e𝕒 potential work cannot be.

The central Pythagorean Triangles

To this is added the central Pythagorean Triangles as e𝕪×-𝕘d, e𝕣×+𝕘d, -𝕘de𝕧, and +𝕘d×e𝕓 which is the same as 4ed. These add together because they are each Pythagorean Triangles that are different, they represent changes in the left-hand side and right-hand side and not changes in relation to each other.

Biv space-time as the right-hand side

This gives Biv space-time as (e𝕙+𝕚d)(e𝕧-𝕚d) or Eℍ+𝕀D because E𝕍-𝕀D would both not be directly measurable or observable. That means the Eℍ/+𝕚d gravitational impulse can be observed or the +𝕀D×e𝕙 gravitational work can be measured, the E𝕍/-𝕚d inertial impulse and the -𝕀D×e𝕧 inertial work cannot be. The mathematics here is consistent with the conventional Pythagorean Theorem.

A hyperbola as the difference of two squares

(e𝕒+𝕠d)(e𝕪-𝕠d) also equals a squared straight Pythagorean Triangle side minus a squared spin Pythagorean Triangle side which is the equation for a hyperbola. Then the same conic section would be formed by one axis being squared as in $x^2-y^2=0$ conventionally, the other axis acts as torque in this model to create the hyperbola shape.

The central Pythagorean Triangles propagate changes

When d and e change then this is propagated with the four central Pythagorean Triangles, this might be an active force change such as the electron from the -𝕠d and e𝕪 Pythagorean Triangle. It might be a reactive change from the proton as the +𝕠d and e𝕒 Pythagorean Triangle. It could also be a gravitational change from the +𝕚d and e𝕙 Pythagorean Triangle or a reactive change from the -𝕚d and e𝕧 Pythagorean Triangle. In all cases the Pythagorean Triangle retain the same areas as a conservation rule.

Mass as spin sides and energy as straight sides

In each case the changes in d and e are propagated through the four central Pythagorean Triangles so the left-hand side and right-hand side are rebalanced. Because of this all changes have a conservation of mass and energy. As a classical approximation mass and energy cannot be created, destroyed, or converted into each other. The changes in these eight Pythagorean Triangles then remain conserved. Later when particles are created or destroyed it will be shown how the Pythagorean Triangle areas remain conserved.

Changes need not be quantized.

When there are changes by 1 this means they are quantized, that is associated with work and a discrete spectrum. In this model impulse is not quantized so these need not be changes with integers such as 1. A change by 1 would be equivalent to using h as Planck's constant.

Impulse changes with E and work with D

The changes in the Pythagorean Triangle ratios can be from E as the square of e, that is from impulse which is not quantized, this still conserves the Pythagorean Triangle areas. If D changes as a square of d that is from work which is quantized also conserving Pythagorean Triangle areas. For example, there can be a change from the E𝕐/-𝕠d kinetic impulse or -𝕆D×e𝕪 kinetic work. These then propagate through the four central Pythagorean Triangles at the speed of c.

An example of a change

For example with Roy electromagnetism an electron might drop to a lower orbital so that -𝕠d decreases by 1 and e𝕪 increases by 1. Then the +𝕠d potential magnetic field increases by 1 and the e𝕒 potential electric charge decreases by 1. That is transmitted by a e𝕪×-𝕘d photon as this change by +1 in e𝕪 and -1 in -𝕘d, the e𝕣×+𝕘d virtual photon is subtracted from this as -1 in e𝕒 and +1 in +𝕠d.

Virtual photons

This virtual photon cannot be measured or observed directly, it might act for example by the proton reacting against the electron absorbing a e𝕪×-𝕘d photon and moving to a higher orbital. The e𝕣×+𝕘d virtual photon then causes the electron to emit the e𝕪×-𝕘d photon and drop back down to a lower orbital.

Virtual Iner

This emission of the e𝕪×-𝕘d photon causes the -𝕚d and e𝕧 Pythagorean Triangle, as the inertia of the electron, to have its -𝕚d inertial mass to decrease as -1 and its e𝕧 length to increase as +1. This might react against the change in inertia by a virtual Inertia, that might cause the electron to move to a higher orbital by absorbing another e𝕪×-𝕘d photon.

Changes in gravity and a Gravi

Its e𝕧/-𝕚d velocity would then increase in a lower orbital as its e𝕪/-𝕠d kinetic velocity did. The +𝕚d and e𝕙 Pythagorean Triangle as gravity would have its +𝕚d gravitational field increase as +1 as the electron is closer to the proton, the e𝕙 value decreases as -1 with this decrease in height. That would cause a +𝕘d×e𝕓 Gravi to be emitted like a gravitational wave. It might cause another proton to react against this change by moving the electron to a higher orbital again.

All changes are conserved

The four central Pythagorean Triangles then transmitted the changes from Roy electromagnetism to Biv space-time so all the Pythagorean Triangle changes are conserved. The two virtual Pythagorean Triangles as e𝕣×+𝕘d and -𝕘d×e𝕧 are not measured or observed directly, but the changes are measurable or observable from the active Pythagorean Triangles e𝕪×-𝕘d photons and +𝕘d×e𝕓 Gravis. The changes might occur in reversed order to this as the reactive forces restore the status quo.

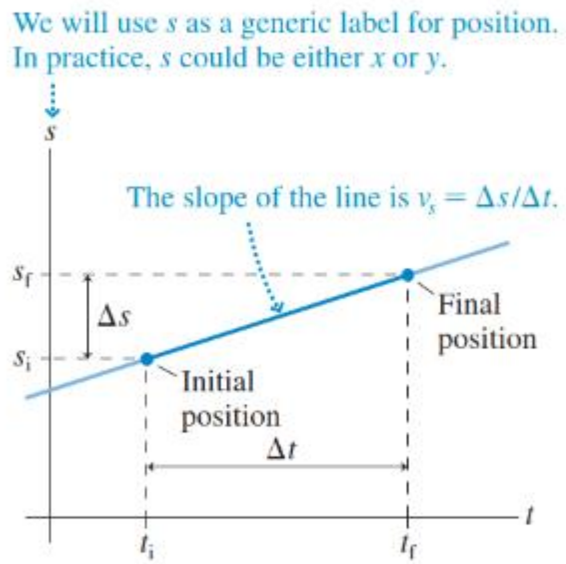
E𝕪×-𝕘d and +𝕘d×e𝕓 travel at c

Only the e𝕪×-𝕘d photons and +𝕘d×e𝕓 Gravis travel at c between iotas and atoms. The e𝕣×+𝕘d and -𝕘d×e𝕧 virtual Pythagorean Triangles act as a reaction to these and are not measurable or observed. If a e𝕪×-𝕘d photon is emitted by an electron, then is absorbed by an electron in another atom, then a e𝕣×+𝕘d virtual photon forms to react against this. If a +𝕘d×e𝕓 Gravi is emitted by a proton and absorbed by another, then a -𝕘d×e𝕧 Iner is formed in an electron to react against this Gravi lowering its orbital.

Rise and run

In this model the velocity e𝕧/-𝕚d can be written as $(e_s\text{-}e_f)$𝕧/$(d_s\text{-}d_f)$×-𝕚. If the slope remains the same, then this is still an infinitesimal divided by an instant or fluxion. The difference is the size of the -𝕚d and e𝕧 Pythagorean Triangle here, if the Pythagorean Triangle has a growing area along the position then it is not conserved. As a classical approximation it means there is no measurement of -𝕀D×e𝕧 inertial work or observation of an E𝕍/-𝕚d inertial impulse along this position or during the time of this motion.

FIGURE 2.4 The velocity is found from the slope of the position-versus-time graph.



Conserving mass and energy

If the Pythagorean Triangle could increase in size, then in this model the E𝕍/-𝕚d inertial impulse or -𝕀D×e𝕧 inertial work at the end of the journey would be much larger. There would be no mass and energy conservation.

$$v_s = \frac{\text{rise}}{\text{run}} = \frac{\Delta s}{\Delta t} = \frac{s_f - s_i}{t_f - t_i}$$

Dimensions in Biv spacetime

This is explained further in the section on Cosmology, here this is shown in relation to the +𝕚d and e𝕙 Pythagorean Triangle as gravity and the -𝕚d and e𝕧 Pythagorean Triangle as inertia in kinematics. In this model Biv space-time is conserved with straight Pythagorean Triangle sides e𝕙 and e𝕧 as positions, also with +𝕚d and -𝕚d as mass and/or time. The e𝕙 height above a mass extends out to other stars and galaxies, the +𝕚d gravitational mass extends inversely out to them. The e𝕧 lengths between stars give a velocity e𝕧/-𝕚d proportional to their Doppler shift, also they can have an inertial mass.

Light bends and loses energy in gravity

The +𝕚d and e𝕙 Pythagorean Triangle extends outwards from a mass in circular geometry. In this model the +𝕚d and e𝕙 Pythagorean Triangle has a constant area, as the e𝕙 height dilates then +𝕚d contracts. When e𝕪×-𝕘d photons are emitted in a +𝕚d gravitational field this can cause them to turn, just as they tend to curve around a +𝕚d gravitational mass. As they move outwards they lose -𝕘d rotational frequency proportional to the strength of this +𝕚d gravitational mass.

Light reaches a limit of its frequency

This -𝕘d rotational frequency decreases with this outward motion until the +𝕚d and e𝕙 Pythagorean Triangle approaches it limit at the CMB. Photons from there come from behind it according to this model, from galaxies at around this e𝕙 height from the observer and measurer. Because the variations in temperature come from the cosmic web, that appears like sound waves in the blackbody spectrum of the CMB.

The CMB as the limit of e𝕙 height

The e𝕙 height up to the CMB has an increasing redshift, this is proportional as e𝕪/-𝕘d to the e𝕙/+𝕚d gravitational speed from their height. It appears like an event horizon, the redshift of photons is like those escaping from the gravitational well of a black hole. The CMB can appear like a photosphere where the e𝕪 kinetic electric charge of the photons reaches its limit. It is not the same however, these photons are climbing a kind of gravitational well but not one caused by a +𝕚d gravitational mass. Instead this is close to the maximum e𝕙 height.

Exceeding c

In this model the limit of the +𝕚d and e𝕙 Pythagorean Triangle exceeds c, galaxies then can appear to be moving 3 times or more times the speed of light. This comes from their e𝕧/-𝕚d inertial velocity, the -𝕚d and e𝕧 Pythagorean Triangle is the inverse of the +𝕚d and e𝕙 Pythagorean Triangle. The ground state of an atom corresponds to α as a velocity, this is ≈ 1/137 of c. As the electron moves lower than this it can join with a proton and neutrino to become a neutron.

Inside the nucleus

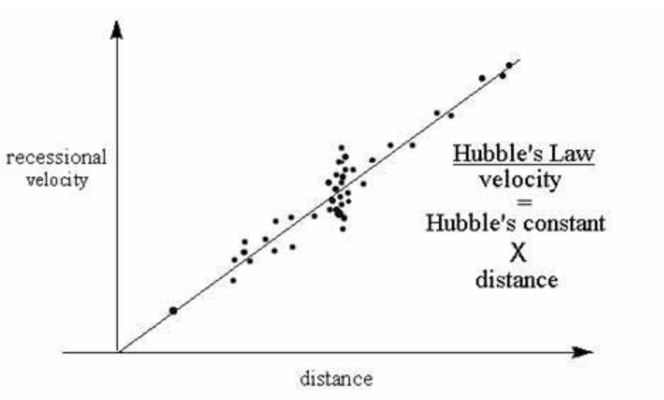
The speed exceeding c corresponds to the increase in gravity from the -𝕚d and e𝕧 Pythagorean Triangle. These galaxies can appear to have more neutron stars, as the e𝕙 height increases they seem to break up into a quark gluon plasma. That is like inside the nucleus, with this model the increased gravity inside the nucleus acts like the strong force, it is reacted against by the potential and the +𝕠d and e𝕒 Pythagorean Triangle of the proton. That appears as a repulsion, the two forces balance as the strong force, when a neutron leaves the atom it breaks up when the repulsion is stronger than gravity.

Changes in galaxies an illusion

The apparent greater than c velocity of the galaxies corresponds to looking inside the nucleus where short lived iotas appear with the three generations of quarks and gluons. These galaxies can retain some shape at higher heights because this is an illusion, they are normal galaxies that appear to observe a greater Eℍ/+𝕚d gravitational impulse.

The Hubble Constant

As the e𝕙 height increase so does the observed change in e𝕙/+𝕚d brevity. Stars appear to be moving away similar to in a +𝕚d gravitational field, the closer to the CMB the stronger the Eℍ/+𝕚d gravitational impulse is. This gives a constant value which in this model is proportional to the conserved area of the +𝕚d and e𝕙 Pythagorean Triangle.



Uniform motion

In Biv space-time objects can move with a constant velocity e𝕧/-𝕚d for long lengths e𝕧, or for long periods of time -𝕚d. This is written conventionally as $v_s=\Delta s/\Delta t$ which is the same as e𝕧/-𝕚d, an infinitesimal divided by an instant or fluxion. Newton used the term fluxion as an infinitesimal in relation to time, the terms instant and fluxions are used in this model interchangeably.

A Pythagorean Triangle is measured or observed once

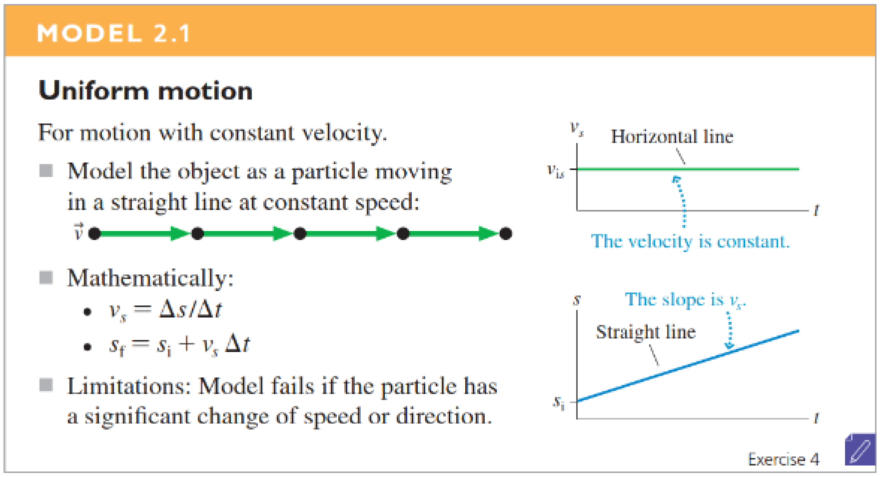
Here $s_f=s_i+v_s\Delta t$, this is equivalent to e$\mathbb{v}_f$=e$\mathbb{v}_i$+(e$\mathbb{v}_s$/-$\mathbb{i}d_s$)×-$\mathbb{i}d_t$. The d and e values can be different for each factor, so as -$\mathbb{i}d_t$ has t increasing then e$\mathbb{v}_f$ will also increase. In this model the equation is a classical approximation because there are two -𝕚d factors. Here a Pythagorean Triangle can only be measured as -𝕀D×e𝕧 inertial work or observed with its E𝕍/-𝕚d inertial impulse once before it changes with some uncertainty.

Square root sides cannot be measured or observed

The -𝕚d and e𝕧 Pythagorean Triangle here then cannot be measured or observed at different e𝕧 positions or -𝕚d times to check whether its velocity is constant. If this happens then the velocity is changed, this means velocity as e𝕧/-𝕚d is not measurable or observable as a definition because there is no force. This velocity is conserved because the ratios of d:e do not change without a force.

The final time or position as an estimate

The equation is equivalent to e$\mathbb{v}_i$/-$\mathbb{i}d_i$ leading to e$\mathbb{v}_f$/-$\mathbb{i}d_f$ where d and e remain in a constant ratio, at a time f the -𝕀D×e𝕧 inertial work can be measured to estimate if the velocity had changed. At a e𝕧 position the E𝕍/-𝕚d inertial impulse can be observed also to estimate if the velocity had changed. This would also occur at the initial time or position, there is then a force at the beginning and end of this velocity. If not then the initial velocity would not be estimable.



Intersecting -𝕚d and e𝕧 Pythagorean Triangles

This diagram shows the intersection of two -𝕚d and e𝕧 Pythagorean Triangles, they have a different slope so their e𝕧 lengths converge at the same -𝕚d time. If they pass by each other then neither measures the -𝕀D×e𝕧 inertial work of the other as the -𝕀D torque, this would be each rotating the other onto a new trajectory. They would also not observe each other with an E𝕍/-𝕚d inertial impulse with a collision. As a classical approximation the two might happen together, they collide and rotate each other to a new direction.

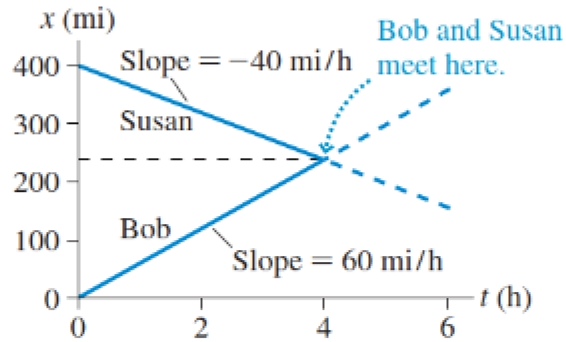
Gravitational torque as +𝕀D

This torque might occur with the +𝕚d and e𝕙 Pythagorean Triangle for example, Bob and Susan move towards each other with a constant velocity e𝕧/-𝕚d. Their +𝕚d and e𝕙 Pythagorean Triangles as gravity do work on each other as they get closer, this causes them to rotate around each other in a hyperbola. Their -𝕚d×e𝕧 inertial momentum would be stronger than the +𝕚d×e𝕙 gravitational momentum and so their trajectory is hyperbolic rather than being captured in a circular or elliptical orbit.

Kinetic torque as -𝕆D

If they were negatively charged then they might be repelled by each other with a -𝕆D kinetic torque, this would come from the -𝕠d and e𝕪 Pythagorean Triangles as electrons. This would also be a hyperbolic trajectory. If one was positively charged from the +𝕠d and e𝕒 Pythagorean Triangle, then the +𝕆D potential torque would be added to the -𝕆D kinetic torque. If the +𝕆D potential torque was larger than they might go into a circular or elliptical orbit in circular geometry. If smaller then it would be a hyperbolic trajectory.

FIGURE 2.6 Position-versus-time graphs for Bob and Susan.



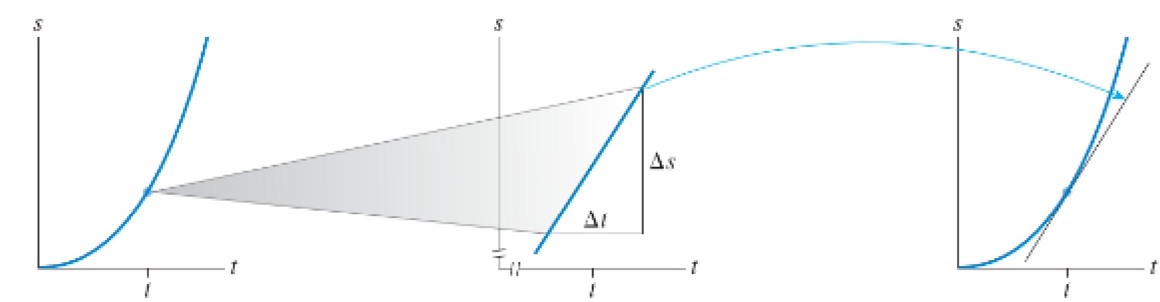
Instantaneous velocity as a classical approximation

The instantaneous velocity eⅴ/-ⅈd is the first derivative with respect to time as -ⅈd, this is a classical approximation as it should be with respect to eⅴ position here. Instead, it would be an instantaneous inertial momentum or first integral as -ⅈd×eⅴ with respect to -ⅈd. In this model the -ⅈd and eⅴ Pythagorean Triangle begins as a straight line because the -ⅈd and eⅴ Pythagorean Triangle has a constant area with straight sides. The hypotenuse ζ then would have to be straight.

Sines and cosines as classical approximations

In practice the hypotenuse is rarely used here, instead the slope is a first derivative in relation to the sizes of the Pythagorean Triangle sides. The angle θ is generally defined as a tangent not a sine or cosine except as a classical approximation. This is because a hypotenuse is not squared as a force in this model, only the straight or spin Pythagorean Triangle side.

FIGURE 2.8 Instantaneous velocity at time *t* is the slope of the tangent to the curve at that instant.



What is the velocity at time *t*?

Zoom in on a *very* small segment of the curve centered on the point of interest. This little piece of the curve is essentially a straight line. Its slope Δs/Δt is the average velocity during the interval Δt.

The little segment of straight line, when extended, is the tangent to the curve at time *t*. Its slope is the instantaneous velocity at time *t*.

Calculus

In this model velocity would be e𝕧/-𝕚d as a first derivative with respect to e𝕧. It might be preferred to write this in a conventional way as -𝕚d/e𝕧 in seconds/meter, as a classical approximation it is equivalent here. The particle's velocity can instead by a function of position or e𝕧 length, with a constant velocity the two are classically convertible into each other.

The Pascal's Triangle calculus

In this model Pascal's Triangle had each cell as a derivative times an integral. The formula for the derivative is shown below as nct^{n-1}.

The following result is proven in calculus:

$$\text{The derivative of } u = ct^n \text{ is } \frac{du}{dt} = nct^{n-1} \tag{2.6}$$

For example, suppose the position of a particle as a function of time is $s(t) = 2t^2$ m, where t is in s. We can find the particle's velocity $v_s = ds/dt$ by using Equation 2.6 with $c = 2$ and $n = 2$ to calculate

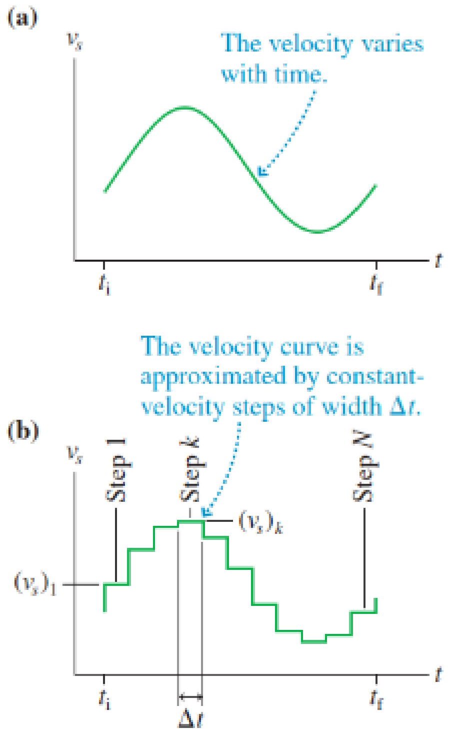
$$v_s = \frac{ds}{dt} = 2 \cdot 2t^{2-1} = 4t$$

This is an expression for the particle's velocity as a function of time.

Sine waves

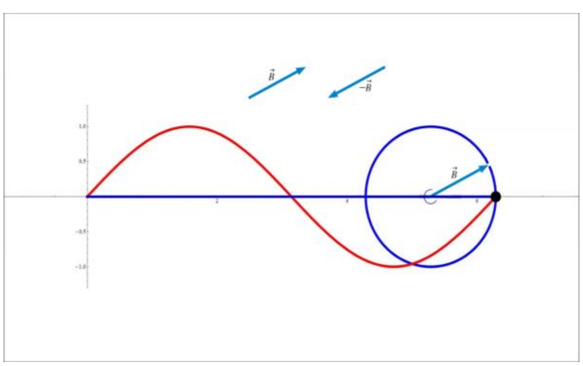
The velocity varying with time would a changing -𝕀D×e𝕧 inertial work. A sine wave can be drawn by a rotating wheel, a point on the rim traces out a sine wave as the wheel moves. Here the wave is broken up into a series of rectangles, on the top of them there are Pythagorean Triangles of -𝕀D×e𝕧 inertial work as integral areas. These are not slopes of E𝕍/-𝕚d inertial impulse because the time Pythagorean Triangle side as -𝕚d is squared not the e𝕧 length.

FIGURE 2.14 Approximating a velocity-versus-time graph with a series of constant-velocity steps.



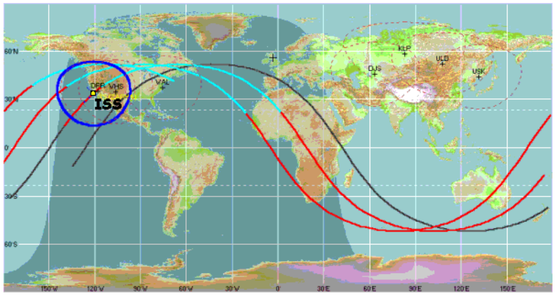
Balancing work

In this model the wheel turns with a constant angular velocity, there are no forces because there would be active work counterbalanced by reactive work. A planet might then spin with its -𝕚d and e𝕧 Pythagorean Triangle with inertia, the +𝕀D×e𝕙 gravitational work from its gravity would be partially counterbalanced by the inertial reduction in weight from the -𝕀D×e𝕧 inertial work. A circular s orbit of an electron might do -𝕆D×e𝕪 kinetic work as an active force balanced by the +𝕆D×e𝕒 potential work of the proton.



Satellite moving as a sine wave

A satellite at the end of the vector point might move in an orbit with a constant velocity, it experiences no force because the +𝕀D×e𝕙 gravitational work is added to the -𝕀D×e𝕧 inertial work the satellite does. If the satellite and planet go past the observer they would appear as a sine wave.



Sine waves as impulse

The sine wave is where the basis vectors are the vertical axis velocity as e𝕧/-𝕚d and the horizontal axis as -𝕚d. This would give integral areas as work, because the basis vectors are not with respect to -𝕚d as a rotation they shows this as an impulse. With a planet and a satellite then this appears as the Eℍ/+𝕚d gravitational impulse and the E𝕍/-𝕚d inertial impulse. Gravity seems to move the satellite up and down like water molecules in an ocean wave. Inertia appears to move the satellite forward as a reactive force also in a water wave.

No cosine waves

This makes the sine wave appear as impulse with a classical approximation, but sinθ only measures waves and integrals. There is no cosine wave in this model, instead cosθ would observe motion of a particle with impulse.

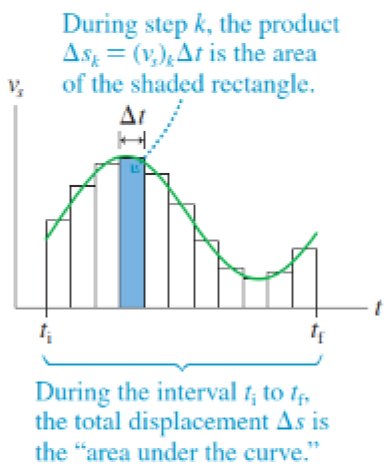
Gravitational and inertial torque

In this model the area under the curve would represent the integral -𝕀D as inertial torque with the -𝕚d and e𝕧 Pythagorean Triangle, if this was compared to gravity with the satellite then this would represent the integral +𝕀D as gravitational torque. As these vary in relation to each other the wave shape is formed.

Ocean waves

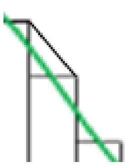
The same would occur with ocean waves, with increased +𝕀D×e𝕙 gravitational work a peak or trough is created as the forward -𝕀D×e𝕧 inertial work is decreased. The water is then moving closer to straight up or down. In between the +𝕀D×e𝕙 gravitational work is at a minimum and the water moves forward with more -𝕀D×e𝕧 inertial work. These two can average out to a flat sea because the +𝕀D gravitational torque and -𝕀D inertial torque both form a Gaussian integral or normal curve with an average value.

FIGURE 2.15 The total displacement Δs is the "area under the curve."



Pythagorean Triangles and sine waves

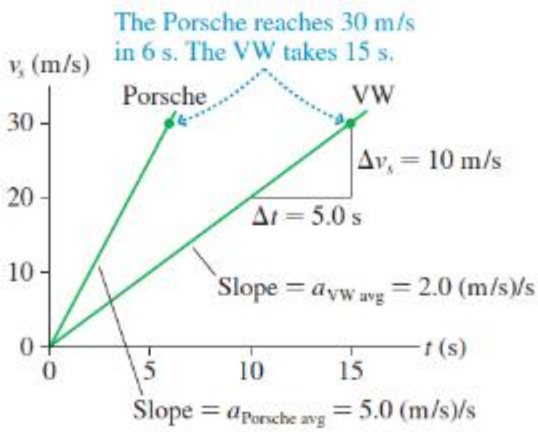
In this diagram the green curve is the sine wave, a Pythagorean Triangle is drawn. This would have a squared area represented by the rectangle below it as the +𝕀D gravitational torque or -𝕀D inertial torque. The vertical side could represent e𝕙 or e𝕧 so this would be measuring the e𝕙 and +𝕀D Pythagorean Triangle or the e𝕧 and -𝕀D Pythagorean Triangle. This slope could also be the e𝕙/+𝕚d brevity or the e𝕧/-𝕚d velocity as this varies. An ocean wave would then have a water molecule as a particle moving with a changing brevity and velocity. This changing slope then could also be observed as a Eℍ/+𝕚d gravitational impulse or E𝕍/-𝕚d inertial impulse.



Converting time to position

The Porsche and Beetle would also be compared as integral areas not slopes here. To use a slope they could convert this to the E𝕍/-𝕚d inertial impulse, this is in meters^2/second, that is classically equivalent to meters/second^2 with work. The time taken to reach a e𝕧/-𝕚d velocity would then be converted to a e𝕧 length, shorter for the Porsche.

FIGURE 2.19 Velocity-versus-time graphs for the Porsche and the VW Beetle.



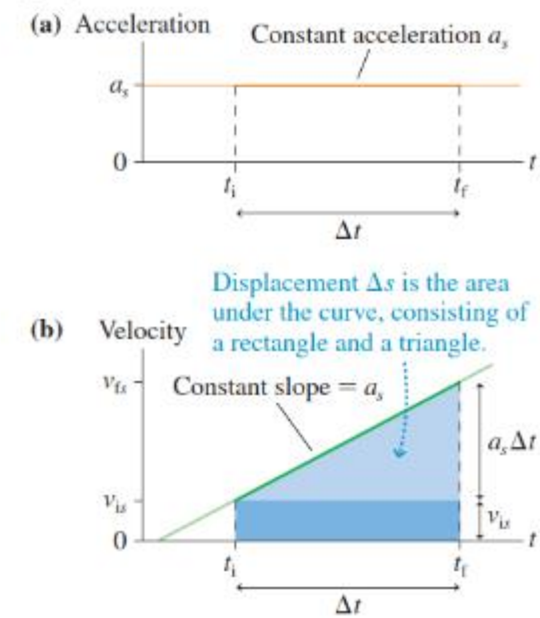
Constant acceleration as E𝕍 or -𝕀D

A constant acceleration is shown below in (a), with the E𝕍/-𝕚d inertial impulse this could use E𝕍 as the inertial length force, E would be a constant. If this is -𝕀D×e𝕧 inertial work then -𝕀D would be a constant as the inertial torque in a car, D would be a constant. The vertical axis could then represent E or D.

-𝕀D as an integral area

In (b) this could also be e𝕧 as the vertical axis and -𝕀D as the horizontal axis, shown as an integral area. This is where both axes are divided by the time or -𝕚d. The total area would be that of the -Id and e𝕧 Pythagorean Triangle, that would be the -𝕀D×e𝕧 inertial work done by a car. Comparing the smaller white Pythagorean Triangle on the left to the larger Pythagorean Triangle, which includes the blue area, this would be a start and final acceleration. In that case the starting and final values would have some uncertainty, there is a squared area being compared to the area of the Pythagorean Triangle. With a car this might be stopped or a small velocity and a final larger velocity.

FIGURE 2.22 Acceleration and velocity graphs for constant acceleration.



Subtracting two velocities

In this model 2.18 is a classical approximation, two velocities would be two angles θ which would have some uncertainty between them. The expression Δv_s would be e𝕧/-𝕚d because Δ represents an infinitesimal. When this is divided by the instant Δt this is the same as the e𝕧/-𝕀D inertial work. Taking two velocities and subtracting them would be like subtracting two -𝕚d and e𝕧 Pythagorean Triangles, to measure or observe each one there would have to be a force, then the uncertainty would mean this was no longer the -𝕀D×e𝕧 inertial work on the left-hand side of the equal sign.

Work versus impulse

When rearpositiond this gives an initial velocity e𝕧$_{is}$/-𝕚d$_{is}$ and to this would be added a second -𝕚d and e𝕧 Pythagorean Triangle, this might also be the first one after an uncertain change. This is the -𝕀D×e𝕧 inertial work arpositiond as a fraction e𝕧/-𝕀D as a classical approximation times an instant -𝕚d.

Rewritten as impulse

If this is written as the E𝕍/-𝕚d inertial impulse then the acceleration is the E𝕍/-𝕚d inertial impulse, this would be e𝕧/-𝕚d × e𝕧 where e𝕧 is the inverse of -𝕚d with a constant Pythagorean Triangle area. Then this would be (e𝕧$_{fs}$/-𝕚d$_{fs}$ – e𝕧$_{is}$/-𝕚d$_{is}$)e𝕧 to give the E𝕍/-𝕚d inertial impulse, also the use of a fraction as the slope makes this a first and second derivative with respect to e𝕧. Then e𝕧$_{fs}$/-𝕚d$_{fs}$ = e𝕧$_{is}$/-𝕚d$_{is}$ + (E𝕍/-𝕚d × 1/e𝕧) where the 1/e𝕧 factor is the inverse of -𝕚d. This is equivalent to the -𝕀D×e𝕧 inertial work except here derivatives can be used in this model to observe particles.

$$a_s = \frac{\Delta v_s}{\Delta t} = \frac{v_{fs} - v_{is}}{\Delta t} \tag{2.18}$$

which is easily rearranged to give

$$v_{fs} = v_{is} + a_s \Delta t \tag{2.19}$$

Position, velocity impulse

The equation below can then be either the E𝕍/-𝕚d inertial impulse or the -𝔻×e𝕧 inertial work, in this model the fractions denote a slope and so this would be impulse. Also, the denominator here is -𝕚d as Δt time. The first term as s_i in this model would be e𝕧$_I$ by itself, but this cannot be observed to be an initial state without a force.

Parabola

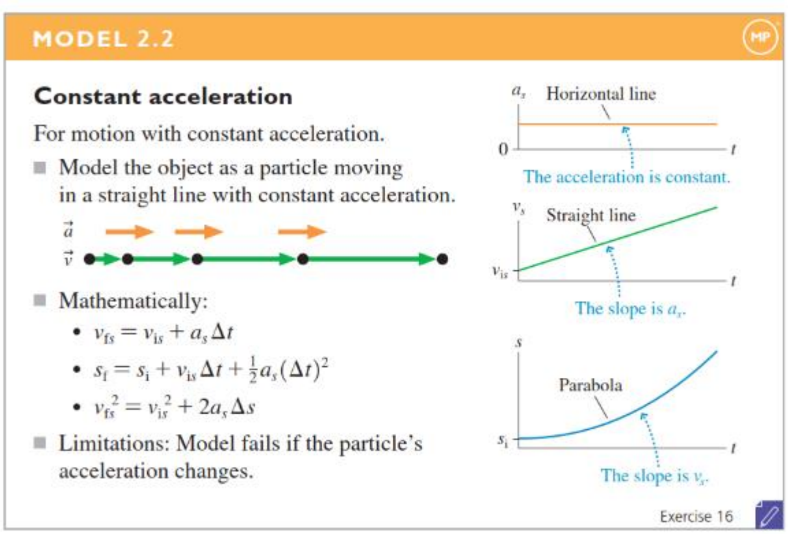
Here the Pythagorean Triangle is half the area of a rectangle as with the -𝔻 and e𝕧 Pythagorean Triangle. One side is -𝔻 the same, the other is a as e𝕧/-𝔻 so this is the same as E𝕍. S_f would then be e𝕧$_i$+(e𝕧$_{is}$/-𝕚d$_{is}$)×-𝕚d + ([e𝕧/-𝔻]×-𝔻)^2. The squared straight Pythagorean Triangle side E𝕍 would give a parabola with the E𝕍/-𝕚d inertial impulse.

The shaded area in Figure 2.22b can be subdivided into a rectangle of area $v_{is}\,\Delta t$ and a triangle of area $\frac{1}{2}(a_s \Delta t)(\Delta t) = \frac{1}{2}a_s(\Delta t)^2$. Adding these gives

$$s_f = s_i + v_{is}\Delta t + \frac{1}{2}a_s(\Delta t)^2 \tag{2.21}$$

Impulse in each Pythagorean Triangle

The acceleration here would be a changing slope, that would be impulse such as the E𝕍/-𝕚d inertial impulse. It could also be the E𝔸/+𝕠d potential impulse, the E𝕐/-𝕠d kinetic impulse, the Eℍ/+𝕚d gravitational impulse, the e𝕐/-𝕘d light impulse, or the e𝔹/+𝕘d Gravi impulse.



Action reaction pairs

In this model an active Pythagorean Triangle and a reactive Pythagorean Triangle form pairs, accelerating a car for example can be doing -𝕆D×e𝕪 kinetic work. The -𝕀D×e𝕧 inertial work done by the car has an equal and opposite reaction, the occupants experience -𝕀D×e𝕧 inertial work. If a spring scale is mounted orthogonal to the motion it will show an inertial weight.

Gravitational and inertial work

Gravity in Biv space-time comes from the +𝕚d and e𝕙 Pythagorean Triangle, with +𝕀D×e𝕙 gravitational work done on a falling ball and feather in a vacuum there is no inertial work slowing them. If there was then people falling would feel the same inertial weight as in an accelerating car.

Weightlessness

The +𝕀D×e𝕙 gravitational work has two variables, the D acts as a squared force which reduces as an inverse square with a higher e𝕙 as e contracts constantly. The -𝕀D×e𝕧 inertial work done by the ball and feather has an equal and opposite reaction to this, but as they fall their -𝕀D×e𝕧 inertial work has D contracted an inverse amount to D dilated in +𝕀D. This reduces the inertial weight by the same amount as the +𝕀D gravitational weight is increasing, people would feel neither weight as they fell. Also because of this the ball and feather fall at the same rate, their +𝕀D gravitational weight is larger with the ball but is proportional with the same ratio to their -𝕀D inertial weight.

Varying acceleration

If the ball and feather were in an elliptical orbit around an airless planet they would still be weightless, as they accelerated upwards towards the apogee or highest point. The gravitational momentum would be +𝕚d×e𝕙/+𝕚d with classical dimensions, the inertial momentum would be -𝕚d×e𝕧/-𝕚d. This is because momentum is mass times velocity classically, this is used here to make the dimensional analysis consistent.

Gravitational and inertial momentum

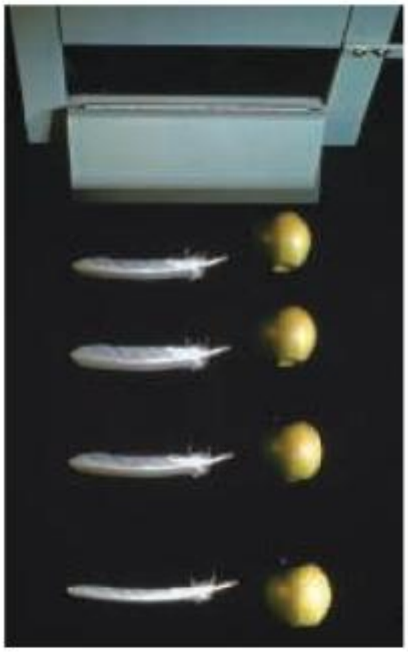
In this model this would be an integral and a slope of the +𝕚d and e𝕙 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle together. When these are not changing this is consistent with the model because neither can be measured or observed. If it changes in an elliptical orbit then this can become a Eℍ/+𝕚d gravitational impulse or +𝕀D×e𝕙 gravitational work, E𝕍/-𝕚d inertial impulse or -𝕀D×e𝕧 inertial work.

Balancing inertia and gravity

As the e𝕙 height increases the +𝕚d inertial mass increases, the +𝕚d gravitational field decreases by an inverse amount so -𝕚d/+𝕚d remains a constant with weightlessness. This also happens with -𝕀D/+𝕀D doing -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work. Because the straight Pythagorean Triangle sides are their inverses it also means with the Eℍ/+𝕚d gravitational impulse and -𝕀D×e𝕧 inertial work that e𝕙/e𝕧 is a constant.

Balancing magnetic fields

In Roy electromagnetism there is also a kind of weightlessness, an electron has a balance between its -𝕠d kinetic magnetic field and the proton's +𝕠d potential magnetic field. When the -𝕆D×e𝕪 kinetic work is measured the electron has an integer number of deBroglie waves around the orbital, these maintain a constant in comparison with the +𝕆D×e𝕒 potential work and the +𝕆D potential magnetic force. Here also then -𝕆D/+𝕆D is a constant as is e𝕪/e𝕒 as the kinetic electric chargedivided by the potential electric field.



In a vacuum, the apple and feather fall at the same rate and hit the ground at the same time.

Converting acceleration

Here g is in meters/second^2 which in this model would be the slope of the +𝕀D×e𝕙 gravitational work Pythagorean Triangle. As a second derivative with respect to e𝕙 this can be converted to Eℍ/+𝕚d as meters^2/second.

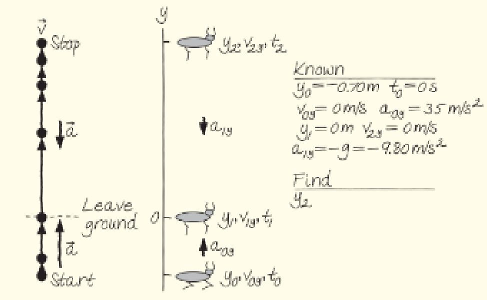
The length, or magnitude, of $\vec{a}_{\text{free fall}}$ is known as the **free-fall acceleration,** and it has the special symbol g:

$$g = 9.80 \text{ m/s}^2 \text{ (free-fall acceleration)}$$

Using impulse in the solution

The solution for the Springbok is the same with this model, the acceleration is converted into the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse as meters^2/second. As the Springbok rises and falls it experiences weightlessness as the -𝕚d/+𝕚d ratio remains constant without an external force.

FIGURE 2.27 Pictorial representation of a startled springbok.



The springbok leaves the ground with a velocity of 7.0 m/s. This is the starting point for the problem of a projectile launched straight up from the ground. One possible solution is to use the velocity equation to find how long it takes to reach maximum height, then the position equation to calculate the maximum height. But that takes two separate calculations. It is easier to make another use of the velocity-displacement equation:

$$v_{2y}{}^2 = 0 = v_{1y}{}^2 + 2a_{1y}\,\Delta y = v_{1y}{}^2 - 2g(y_2 - y_1)$$

where now the acceleration is $a_{1y} = -g$. Using $y_1 = 0$, we can solve for y_2, the height of the leap:

$$y_2 = \frac{v_{1y}{}^2}{2g} = \frac{(7.0\text{ m/s})^2}{2(9.80\text{ m/s}^2)} = 2.5\text{ m}$$

Freefall on an inclined plane

In this model θ is opposite the +ⅈd spin Pythagorean Triangle side, as θ decreases here then the +ⅈd gravitational field would appear to be weaker. The slope here is like the derivative of the Pythagorean Triangle with respect to eⅡ. The same occurs with the -ⅈd and eⅴ Pythagorean Triangle which would be orthogonal to this, the -ⅈd inertial mass would decrease more slowly and proportionally to +ⅈd so as before -ⅈd/+ⅈd is a constant. An objecting sliding down the slope with no resistance would also experience free fall, -ⅈd again decreases at the same rate +ⅈd increases.

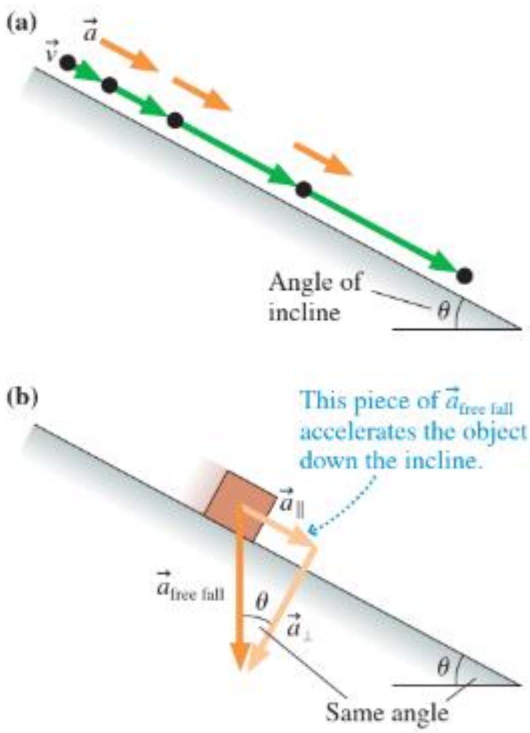
A slope as a derivative

Here using the slope implies a derivative and impulse, this would be observing the Eℍ/+ⅈd gravitational impulse and the E𝕍/-ⅈd inertial impulse. The ratio E𝕍/Eℍ is also a constant giving free fall, if this was an elliptical orbit for example then a satellite would move with a faster velocity eⅴ/-ⅈd closer to a planet. So E𝕍 increases here as a square when the Eℍ height squared decreases closer to the ground.

Equal areas in equal times

This also relates to Kepler's law where equal areas are swept out in equal times, a satellite in an elliptical orbit has a Eℍ/+ⅈd gravitational impulse in its orbit so that when the time +ⅈd is the same so is the area. This follows from the Pythagorean Triangle area being conserved. It also applies to the inertia of the satellite where the E𝕍/-ⅈd inertial impulse also has an area E𝕍 being swept out in equal times.

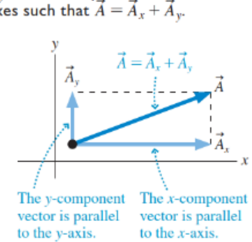
FIGURE 2.28 Acceleration on an inclined plane.



Vector components

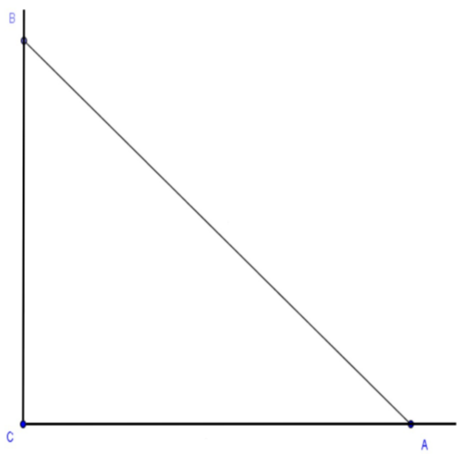
This diagram is a classical approximation to the +ⅈd and e𝕙 Pythagorean Triangle or the -ⅈd and e𝕧 Pythagorean Triangle. The vertical axis can be e𝕙 and the lower horizontal axis +ⅈd, the hypotenuse would come out of the origin so this is in circular geometry. The horizontal axis would also be regarded as e𝕧 where proportionally here d∝e, the proportion remains the same as a satellite changes its e𝕙 height above a planet for example. Then the vertical axis can also be -ⅈd as the inertial mass, so as the height changes so does the inertial mass.

FIGURE 3.10 Component vectors $\vec{A}_x$ and $\vec{A}_y$ are drawn parallel to the coordinate axes such that $\vec{A} = \vec{A}_x + \vec{A}_y$.



Hyperbolic geometry

In this model the -𝕚d and e𝕧 Pythagorean Triangle above would be in hyperbolic geometry, so the hypotenuse would not come out of the origin. Instead, the hypotenuse would connect the two axes as below. Here the Pythagorean Triangle is not necessarily rotating around the origin or going into the other 3 quadrants of a circle. It can be flipped over horizontally or vertically, that might change the direction of the straight or spin Pythagorean Triangle sides.

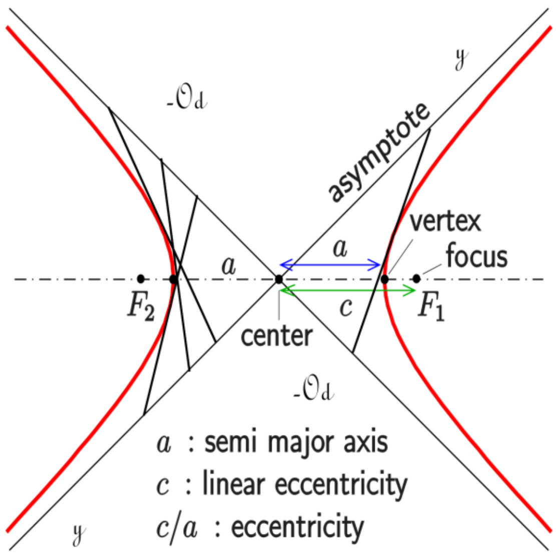


Spin up and spin down

Because of this innate handedness the Pythagorean Triangles have a spin in one direction similar to the proton and electron. This is referred to spin up or spin down in quantum mechanics, in this model it is usually clockwise or counterclockwise because the Pythagorean Triangles can be oriented in different directions.

Hyperbolas and Pythagorean Triangles

In the diagram below there are several Pythagorean Triangles under the hyperbola forming a tangent to it. Because of the hyperbola properties these all have the same Pythagorean Triangle area, that is the same as in this model. In circular geometry an +𝕠d and e𝕒 Pythagorean Triangle or +𝕚d and e𝕙 Pythagorean Triangle would have their straight Pythagorean Triangle sides pointing out of the center of a circle, but the areas also remain constant as their angle θ changes.



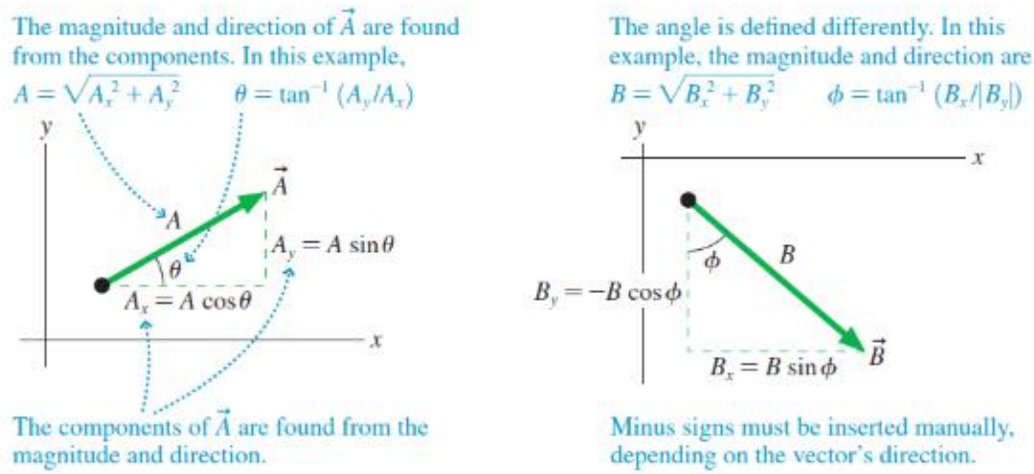
Special relativity

The constant Pythagorean Triangle area makes this model consistent with hyperbolic space in Special Relativity. The value γ represents the amount of -𝕚d inertial time dilation as a rocket increases its e𝕧/-𝕚d velocity. It also represents the amount of e𝕧 or length contraction of the rocket from the reference frame of a stationary observer.

Components

Here there can be the -𝕚d and e𝕧 Pythagorean Triangle as an example, or any other Pythagorean Triangle can be used. The angle θ would be opposite the spin Pythagorean Triangle side -𝕚d which is vertical. The straight Pythagorean Triangle side would be horizontal as the e𝕧 length. These are not components, they are the Pythagorean Triangle itself. In this model the vector shown here is the hypotenuse, this is rarely used. Instead the components as the Pythagorean Triangle sides are what is observed and measured. Using components like this can be a classical approximation, but in this model separating them from the Pythagorean Triangle itself can lead to inaccuracies later.

FIGURE 3.12 shows how this is done.



The Pythagorean Theorem

Here there are two velocities as e𝕧/-𝕚d components, the third velocity is found by the Pythagorean Theorem. This can also be calculated with the E𝕍/-𝕚d inertial impulse, the time here is a second for each which can also be a constant scale not a square. That gives 6^2+4^2 as $E\mathbb{V}_1+E\mathbb{V}_2$, the square root of this gives e𝕧 in the final velocity e𝕧/-𝕚d. It is then like two forces which increase a velocity from zero to a new velocity.

Using the hypotenuse

Here the hypotenuse represents a slope of a Pythagorean Triangle, a derivative. The velocity however is not a hypotenuse, it is the ratio of the Pythagorean Triangle sides. That gives a velocity e𝕧/-𝕚d. This final result can be drawn as an -𝕚d and e𝕧 Pythagorean Triangle with the e𝕧 horizontal axis by convention as 7.2 meters, or 7.2𝕧. The vertical axis of time would be -𝕚d where d=1 second. Now the final velocity is not the hypotenuse, that is rarely used in this model. A first -𝕚d and e𝕧 Pythagorean Triangle would have a e𝕧 axis and Pythagorean Triangle side value of 4 and the second -𝕚d and e𝕧 Pythagorean Triangle a value of 6 meters. Each of these is a constant velocity.

Using work or impulse

From these two Pythagorean Triangles the third can be calculated with impulse or work, the impulse calculation is the same as above. The e𝕧 axis has its value squared as an impulse force, then the square root of this gives the final velocity after the impulse. With work this would use a constant e𝕧 length of 1, the velocity would then be a different amount of time per meter. Then these two are squared with the -𝕀D×e𝕧 inertial work and the square root taken to give the new velocity with e𝕧 having e=1 meter and -𝕚d having the new time the car travels in 1 meter.

Not using sines and cosines

By not using the hypotenuse here the Pythagorean Triangles can describe any forces as work or impulse. This also means sines and cosines are not needed to describe these forces. The E𝕍/-𝕚d inertial impulse here then can calculate a series of changes in velocity and direction, the -𝕀D×e𝕧 inertial work can calculate this from a change in inertial momentum. That would assume here the car had a constant mass such as 1 tonne.

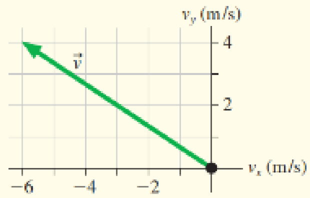
Using tanθ

The angle can be calculated from tanθ without using sines and cosines. This change of the angle θ in the -𝕚d and e𝕧 Pythagorean Triangle would correspond to the change of the E𝕍/-𝕚d inertial impulse or -𝕀D×e𝕧 inertial work giving the final velocity. This can be done by making the first -𝕚d and e𝕧 Pythagorean Triangle have a side e𝕧 with e=4 meters and a -𝕚d side with d=1 second. The second Pythagorean Triangle side would have a e𝕧 side with e=1 meter and -𝕚d with d=1/6 seconds. Then the new -𝕚d and e𝕧 Pythagorean Triangle has a tanθ angle as 4×1/6.

EXAMPLE 3.4 | Finding the direction of motion

FIGURE 3.14 shows a car's velocity vector $\vec{v}$. Determine the car's speed and direction of motion.

FIGURE 3.14 The velocity vector $\vec{v}$ of Example 3.4.

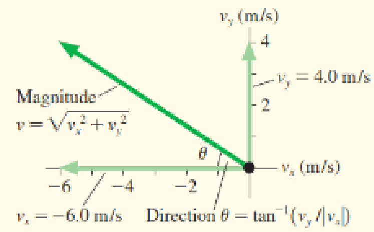


VISUALIZE **FIGURE 3.15** shows the components v_x and v_y and defines an angle θ with which we can specify the direction of motion.

SOLVE We can read the components of $\vec{v}$ directly from the axes: $v_x = -6.0$ m/s and $v_y = 4.0$ m/s. Notice that v_x is negative. This is enough information to find the car's speed v, which is the magnitude of $\vec{v}$:

$$v = \sqrt{v_x^2 + v_y^2} = \sqrt{(-6.0\text{ m/s})^2 + (4.0\text{ m/s})^2} = 7.2\text{ m/s}$$

FIGURE 3.15 Decomposition of $\vec{v}$.



From trigonometry, angle θ is

$$\theta = \tan^{-1}\left(\frac{v_y}{|v_x|}\right) = \tan^{-1}\left(\frac{4.0\text{ m/s}}{6.0\text{ m/s}}\right) = 34°$$

The absolute value signs are necessary because v_x is a negative number. The velocity vector $\vec{v}$ can be written in terms of the speed and the direction of motion as

$$\vec{v} = (7.2\text{ m/s, }34°\text{ above the negative }x\text{-axis})$$

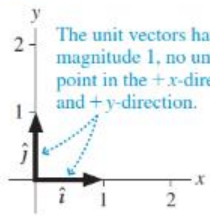
Unit vectors and unit spin

In this model a Pythagorean Triangle has sides that are infinitesimal and instants or fluxions when e𝕧 for example has e=1 meter then this is a unit vector. When -𝕚d has d=1 seconds this is not a vector because it represents rotation not direction. Instead, it acts as unit spin with no direction other than clockwise or counterclockwise. It can also represent a unit of time as an instant or fluxion. A unit of spin can be regarded as of torque such as in -𝕀D×e𝕧 inertial work, that can be 1^2, a unit as an instant would be a constant rotation such as the hands of a clock.

Adding the same or different straight Pythagorean Triangle sides

In the diagram these might be a e𝕙 height vertically and a e𝕧 length orthogonal to it, these might be where a satellite is moving over a planet. As a classical approximation they can also be both e𝕧 or e𝕙, then the vectors can be added or subtracted. The unit spin here might be where î is rotated into ĵ. In this model adding vectors can also be observing or measuring the impulse or work as they change.

FIGURE 3.16 The unit vectors $\hat{\imath}$ and $\hat{\jmath}$.



Decomposing vectors

In this model a velocity cannot be decomposed into two other vectors as a coordinate system. This is because the two velocities would be separate -𝕚d and e𝕧 Pythagorean Triangles, to join to create a new velocity would mean a force is observed or measured. That would introduce uncertainty. This can be done as a classical approximation but runs into problems in quantum mechanics.

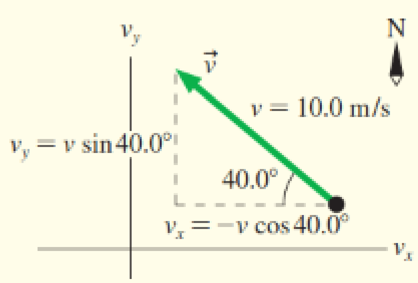
Separate reference frames

The two -𝕚d and e𝕧 Pythagorean Triangles could also be regarded as being separate reference frames, then the adding together to make a new velocity would look different according to Special Relativity. This is because the time taken for the light to come from the new velocity path would be different to the older ones. If a person was on one -𝕚d and e𝕧 Pythagorean Triangle then the light would be received quickly, and more slowly from the second -𝕚d and e𝕧 Pythagorean Triangle.

Synchronized clocks

If clocks on each were synchronized then the second would appear to be slower, this is because it would show when the light left it. The third -𝕚d and e𝕧 Pythagorean Triangle would show a different time as well as a different series of positions. Also this process necessarily involves observation of the E𝕍/-𝕚d inertial impulse or measurement of the -𝕀D×e𝕧 inertial work, that would define when the light was emitted which increases the uncertainty.

FIGURE 3.18 The velocity vector $\vec{v}$ is decomposed into components v_x and v_y.



Adding vectors and uncertainty

Adding three vectors like this would introduce uncertainty. Each would be added by putting the vector's head to the tail of another. The components of each vector can make -𝕚d and e𝕧 Pythagorean Triangles, when the Pythagorean Triangle areas are not conserved then this can be noted as energy going in an out of the system.

Components as straight and spin Pythagorean Triangle sides

The horizontal vectors here are velocities, they can also be regarded as e𝕧 lengths. The vertical axes would then be -𝕚d times, the vectors would then represent different velocities according to the slope of the -𝕚d and e𝕧 Pythagorean Triangles. Each vector appears to be the same vector, as if it was rotated clockwise or counterclockwise and then increased or decreased in magnitude.

Transforming vectors

This can be converted into the -𝕚d and e𝕧 Pythagorean Triangle sides so that -𝕀D×e𝕧 inertial work causes each vector to be rotated by a -𝕀D inertial torque onto the next. The E𝕍/-𝕚d inertial impulse would be a force that increases or decreases the magnitude of the vector. Here the equations refer to adding these components as velocities not e𝕧 and -𝕚d, these Pythagorean Triangle sides can be converted to velocities as a classical approximation.

Converting components to velocities

The -𝕚d Pythagorean Triangle sides can have their inverse as e𝕧, this makes all sides e𝕧 lengths. These can then be divided by equal times -𝕚d where d=1 second so they all become velocity components as e𝕧/-𝕚d. Where this changes the constant areas of the -𝕚d and e𝕧 Pythagorean Triangles then this would represent forces, this could be observed as E𝕍/-𝕚d inertial impulse and measured as -𝕀D×e𝕧 inertial work. In this model only one can occur in a position or time, with a classical approximation both might occur in the same place simultaneously.

Components î and ĵ

Here î would be vertical as -𝕚d and ĵ would be horizontal as e𝕧.

To see this, let's evaluate the vector sum $\vec{D} = \vec{A} + \vec{B} + \vec{C}$. To begin, write this sum in terms of the components of each vector:

$$\begin{aligned}\vec{D} &= D_x\hat{\imath} + D_y\hat{\jmath} = \vec{A} + \vec{B} + \vec{C} \\ &= (A_x\hat{\imath} + A_y\hat{\jmath}) + (B_x\hat{\imath} + B_y\hat{\jmath}) + (C_x\hat{\imath} + C_y\hat{\jmath})\end{aligned} \tag{3.8}$$

We can group together all the x-components and all the y-components on the right side, in which case Equation 3.8 is

$$(D_x)\hat{\imath} + (D_y)\hat{\jmath} = (A_x + B_x + C_x)\hat{\imath} + (A_y + B_y + C_y)\hat{\jmath} \tag{3.9}$$

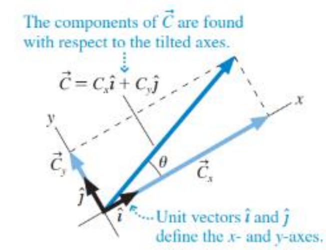
Comparing the x- and y-components on the left and right sides of Equation 3.9, we find:

$$\begin{aligned}D_x &= A_x + B_x + C_x \\ D_y &= A_y + B_y + C_y\end{aligned} \tag{3.10}$$

Component axes

The component axes can also be tilted, this is where each -𝕚d and e𝕧 Pythagorean Triangle is rotated such as with a -𝕀D inertial torque. These basis vectors can also have one rotated with a torque so they are no longer orthogonal, they can be converted back to -𝕚d and e𝕧 Pythagorean Triangles. These changes can also introduce forces and uncertainties

FIGURE 3.20 A coordinate system with tilted axes.



General relativity

In General Relativity this model uses circular geometry, the e𝕙 height radiates outward from a +𝕚d gravitational mass. Using Schwarzschild's equation this works like the equation for γ in Special Relativity. A stronger mass has a larger d value in +𝕚d, this makes it dilated also as slower time. It is then similar to slower time on a rocket approaching c. The e𝕙 height also contracts as +𝕚d dilates, this is like the e𝕧 length contraction with the rocket.

Schwarzschild's equation

Here G is the gravitational field +𝕚d which is proportional to the mass M. Together they make a square which is divided by c^2 as in Special Relativity. The time dilation as +𝕚d and e𝕙 height contraction are equivalent to γ, the equation is the same because the +𝕚d and e𝕙 Pythagorean Triangle with gravity in General Relativity works with active forces while the -𝕚d and e𝕧 Pythagorean Triangle with Special Relativity works with reactive forces.

$$T = \frac{T_0}{\sqrt{1 - \frac{2GM}{Rc^2}}}$$

This is distinct from the time dilation from relative motion

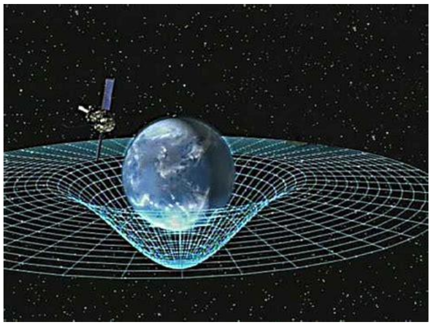
where T is the time interval measured by a clock far away from the mass. For a clock on the surface of the Earth, this expression becomes

Gravitational time dilation on the Earth's surface:

$$T = \frac{T_0}{\sqrt{1 - \frac{2gR}{c^2}}}$$

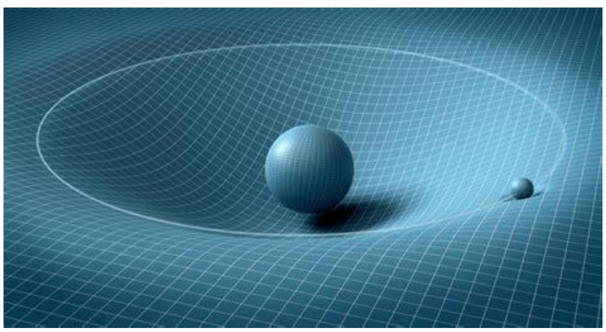
Circular geometry

This model uses a constant area of the +𝕚d and e𝕙 Pythagorean Triangle in General Relativity, just as it uses a constant area of the -𝕚d and e𝕧 Pythagorean Triangle in Special Relativity. Because the +𝕚d and e𝕙 Pythagorean Triangle is in circular geometry it is usually shown by lines of e𝕙 height radiating out from a +𝕚d gravitational mass.



Circles and straight Pythagorean Triangle sides

When a square coordinate system is used this does not fit the circles well, to adjust this a metric is used. That gives small corrections to the grid to make it fit better to the circles. If each square shown is regarded as +𝕚d and e𝕙 Pythagorean Triangles when they are distorted in shape, also the right angle often is changed. This means the basis vectors or components e𝕙 and +𝕚d are no longer at right angles to each other, the +𝕚d and e𝕙 Pythagorean Triangle no longer has a constant area, and the results are a classical approximation. That is because any change in a Pythagorean Triangle in this model must be from a force.



Approximations obscure some physics

In this model then there are classical equivalents to the Pythagorean Triangles which give approximate answers, these are also in General Relativity with the curved lines. It is important here to differentiate when a classical approximation is used and when the model is using these Pythagorean Triangles. That is because the nature of these Pythagorean Triangles often gives answers that would otherwise be lose with these approximations.

Lines mean a force

For example where this grid or metric is shown there may not be a E𝕀/+𝕚d gravitational impulse or +𝕀D×e𝕙 gravitational work. If not then there is no change and no force, the metric should not then be changing shape. This is why spherical works better for the +𝕚d and e𝕙 Pythagorean Triangle as gravity and the +𝕠d and e𝕒 Pythagorean Triangle as the proton, the straight Pythagorean Triangle sides can radiate out without being bent.

Circles as torque

Orthogonal to this is the +𝕚d gravitational field, because this is a rotation Pythagorean Triangle side it represents a +𝕆D gravitational torque It can then be shown as a curve connected to the straight Pythagorean Triangle side meaning it would be from +𝕀D×e𝕙 gravitational work.

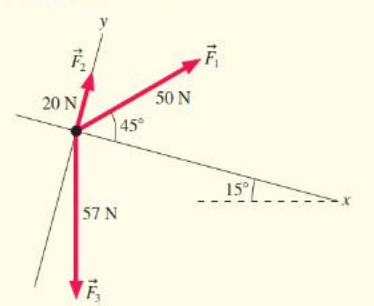
Adding forces

Here three forces are added together as vectors, these might be three versions of E𝕍 from -𝕚d and e𝕧 Pythagorean Triangles. It might be as another example three vectors of E𝕐 as the kinetic electric force from the negative electric charge of electrons. They could also classically represent three work forces such as +𝕀D×e𝕙 gravitational work or +𝕆D×e𝕒 potential work from protons. Adding forces in this way would not be possible from a single Pythagorean Triangle so there are uncertainties in the values of the straight and spin Pythagorean Triangle sides associated with each.

Reduction to Pythagorean Triangles

Each might be reduced to components as Pythagorean Triangle sides, the vectors in this model would not be the hypotenuse of these. Instead with the -𝕠d and e𝕪 Pythagorean Triangles as electrons they might be three of E𝕐 as the kinetic electric force. Because these electrons have a constant Pythagorean Triangle area then with three electrons these areas would not change, as e𝕪 increased then -𝕠d as potential magnetic field would contract. As a classical approximation the areas of the Pythagorean Triangles are often ignored here.

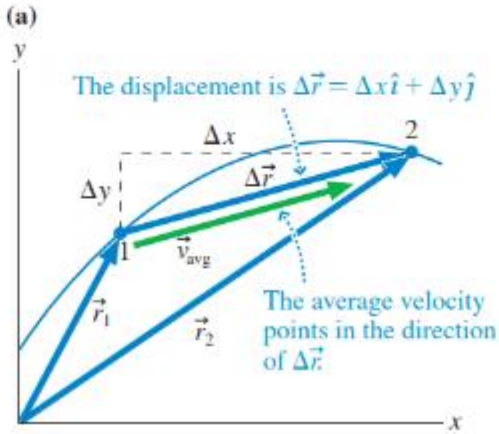
FIGURE 3.22 Three forces.



Instantaneous velocity

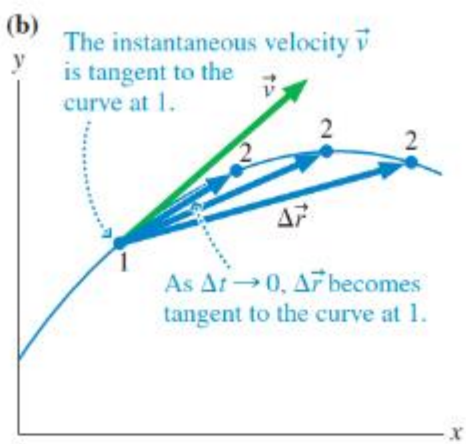
The instantaneous velocity e𝕧/-𝕚d is like a Pythagorean Triangle on a curved slope. In this model the calculus Pythagorean Triangle is not an instantaneous section of the acceleration, the Pythagorean Triangle is observed with an E𝕍/-𝕚d inertial impulse or measured with -𝕀D×e𝕧 inertial work and this cause the curve from the force created. That impulse or work can occur before or after the Pythagorean Triangle which has no forces, but not in the same position or time.

FIGURE 4.2 The instantaneous velocity vector is tangent to the trajectory.



Instantaneous velocity

Here Δt→0, but in this model Δt is -𝕚d assuming this is the inertia of the object from the -𝕚d and e𝕧 Pythagorean Triangle. It also has a downward acceleration from gravity with the +𝕚d and e𝕙 Pythagorean Triangle. These two Pythagorean Triangles would have no forces initially with a velocity e𝕧/-𝕚d and a gravitational speed or brevity of e𝕙/+𝕚d. The Eℍ/+𝕚d gravitational impulse pulls the object downward which changes the -𝕚d and e𝕧 Pythagorean Triangle with its inertia as the E𝕍/-𝕚d inertial impulse. Then the object is observable and can appear on this graph. There can be a series of observations pointing to the unobservable calculus Pythagorean Triangle shown as Δt→0.



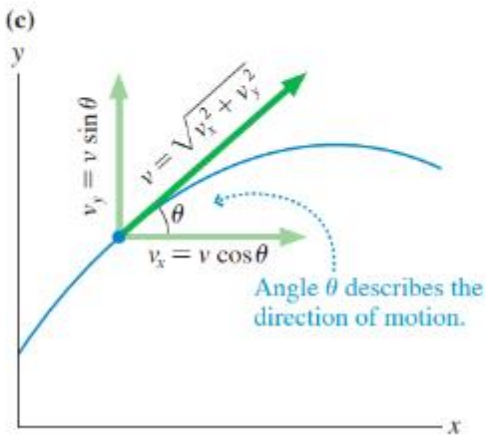
Sinθ and cosθ

In this model sinθ would be the spin Pythagorean Triangle side divided by the hypotenuse ζ, cosθ as the straight Pythagorean Triangle side divided by ζ. The hypotenuse is not used because there is a conflict between the curved force line and the straight hypotenuse. This would change the

Pythagorean Triangle area to be not constant, that leads to the emission or absorption of a e𝕪×-𝕘d photon or +𝕘d×e𝕓 Gravi.

Orthogonal Pythagorean Triangles

The angle θ here would be from the -𝕚d and e𝕧 Pythagorean Triangle where the height e𝕙 of the object is proportional to the spin Pythagorean Triangle side as the -𝕚d inertial mass. With the +𝕚d and e𝕙 Pythagorean Triangle as gravity this angle would be ϕ because the two Pythagorean Triangles would be orthogonal to each other here.



Scalars and directions

In this model the two Pythagorean Triangle sides would be scalars, the -𝕚d and e𝕧 Pythagorean Triangle for example has no direction other than to continue with its same path. If this is regarded as a velocity e𝕧/-𝕚d then this is still two scalars divided by each other, the velocity value depends on the reference frame as well as its direction. With a parabola there can be an impulse force, then the scalar would be time such as -𝕚d in the E𝕍/-𝕚d inertial impulse. This would be a reaction against a projectile being accelerated into this parabolic shape from inertia.

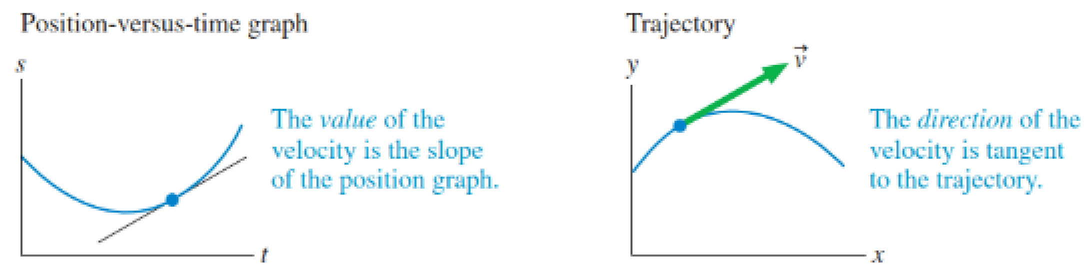
The Eℍ height force

The acceleration here then would be Eℍ downwards with the Eℍ height force. As the object falls there would be an opposing -𝕀D×e𝕧 inertial work where the inertial mass reacts against the downward motion. This would have D contracting with the same rate as E in Eℍ, because of this there is no inertial resistance to free fall and the object would experience weightlessness.

Opposing forces

If these two forces did not remain the same, then the object would experience the difference between those forces. If the object was in an elliptical orbit here its e𝕧/-𝕚d velocity would increase as its -𝕚d inertial mass contracted, that would maintain a constant -𝕚d and e𝕧 Pythagorean Triangle area.

FIGURE 4.3 Two different uses of tangent lines.

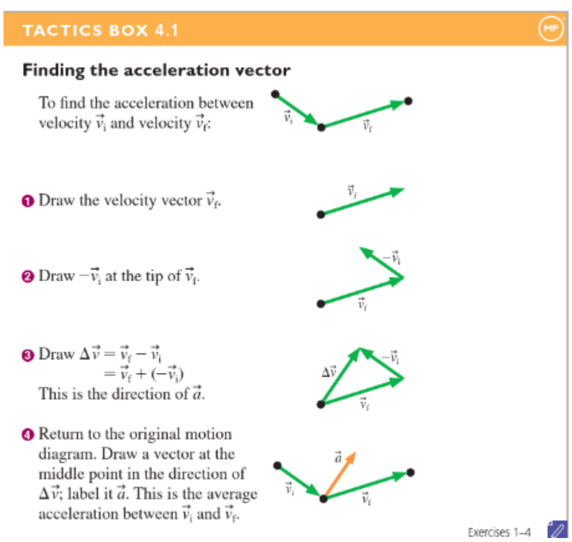


Adding vectors with no signs

Adding vectors is using straight Pythagorean Triangle sides only, these would be $e\mathbb{v}_1$ and $e\mathbb{v}_2$. The direction of acceleration is also from straight Pythagorean Triangle sides only, here as E𝕍 the inertial length force. Vectors in this model have no positive or negative sign like +𝕚d or -𝕚d, instead they are added and subtracted by their directions.

Including spin Pythagorean Triangle sides

Each can then be the side of a Pythagorean Triangle, here if the -𝕚d and e𝕧 Pythagorean Triangle each vector would be e𝕧 with an orthogonal -𝕚d inertial mass or time side. This would give the amount of rotation to go from one vector to the next. The acceleration can then be E𝕍 but it can also be classically -𝕀D as an inertial torque to twist a vector to the new direction, this is like a wrench turning a nut.



Acceleration as adding vectors

The acceleration direction would come from the Eℍ/+𝕚d gravitational impulse, this is downward except there is a constant e𝕧/-𝕚d velocity to either side. In conventional physics acceleration denotes work, for example +𝕀D×e𝕙 gravitational work but taken as a derivative e𝕙/+𝕀D.

Acceleration as a derivative or integral

In this model work is an integral not a derivative because it represents a field with an area not a particle. Impulse acts as a derivative because on a slope there is a point where a Pythagorean Triangle has sides which are an infinitesimal and an instant.

A particle as a minimum consistent size

This point acts as a particle because before and after it there can be an impulse force, the Pythagorean Triangle changes in time with a squared straight Pythagorean Triangle side. The position of the point cannot be moved elsewhere without losing some of its Pythagorean Triangle characteristics, so in this model it is a particle.

Integrals as fields

The integral described by the same Pythagorean Triangle acts as a field, it is measured as work. This can be increased in area without changing its work done, for example a curved force line might be moved up and down.

Changing a field

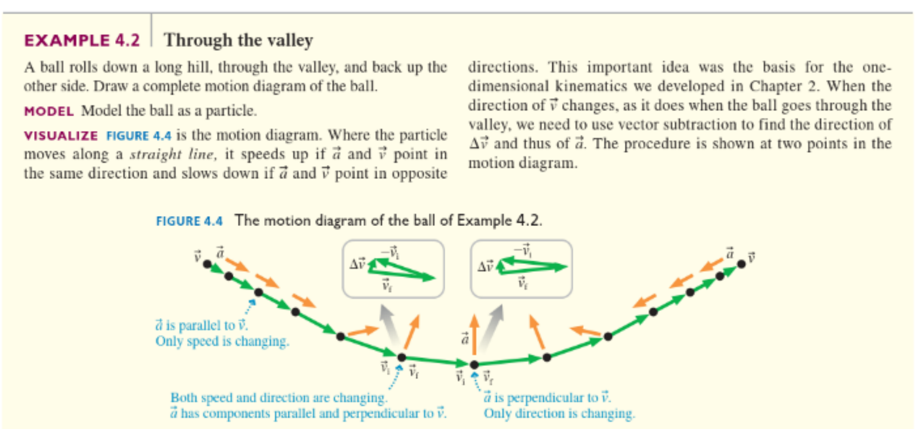
A Pythagorean Triangle as a point on the curve can have an area under it of any size, this is why an integral has a +C after it as a constant. This is different from a particle where changing the e𝕧 length divided by the -𝕚d inertial mass for example changes it.

Adding a constant C

Taking the inertial momentum as -𝕚d×e𝕧 this can be at any e𝕙 height in Biv space-time with the same momentum by adding the constant C, that makes it a field. Dividing something up then makes it smaller, taking a derivative divides it.

Multiplication versus division

When this division cannot be continued without changing it then this is called a particle in this model. Multiplying something cannot reduce down to a particle, it can only get bigger like a field.



EXAMPLE 4.2 | **Through the valley**

A ball rolls down a long hill, through the valley, and back up the other side. Draw a complete motion diagram of the ball.

MODEL Model the ball as a particle.

VISUALIZE **FIGURE 4.4** is the motion diagram. Where the particle moves along a *straight line*, it speeds up if $\vec{a}$ and $\vec{v}$ point in the same direction and slows down if $\vec{a}$ and $\vec{v}$ point in opposite directions. This important idea was the basis for the one-dimensional kinematics we developed in Chapter 2. When the direction of $\vec{v}$ changes, as it does when the ball goes through the valley, we need to use vector subtraction to find the direction of $\Delta\vec{v}$ and thus of $\vec{a}$. The procedure is shown at two points in the motion diagram.

FIGURE 4.4 The motion diagram of the ball of Example 4.2.

Opposing forces

There can also be opposing forces in physics, in the diagram above there is a Eℍ/+𝕚d gravitational impulse downwards and an E𝕍/-𝕚d inertial impulse which reacts against it. If this was not so then the ball would move to the bottom of the valley and stop instantly.

Swinging a bucket

These can be illustrated by swinging a bucket with water in it. When the bucket is swung around this creates inertia with the -𝕚d and e𝕧 Pythagorean Triangle, the water reacts against going around in a circle. It has an E𝕍/-𝕚d inertial impulse which would go in a straight line, this is called the centrifugal force.

Reactive force from the protons

Against this there is another reactive force from the protons, the +𝕠d and e𝕒 Pythagorean Triangles react against the electrons and their molecular bonds being torn apart by the swinging bucket. Each then reacts against a change from the other.

Kinetic energy and inertia

The bucket would be increased in its angular velocity by a kinetic energy, this comes from the -𝕠d and e𝕪 Pythagorean Triangle as the active force from electrons. This is reacted against by the -𝕚d and e𝕧 Pythagorean Triangle which tries to go in a straight line, that makes it more difficult to spin the bucket more quickly. It reacts against being accelerated like a car reacts against accelerating, people in it feel an inertial weight -𝕀D pushing them backwards as the speed increases.

Gravity and the bucket

The bucket also experiences gravity, the Eℍ/+𝕚d gravitational impulse tries to pull the bucket and its rope down to point at the ground. This is an active force but is opposed by the accumulated kinetic energy and E𝕐/-𝕠d kinetic impulse from having swung the bucket around.

Flat water

When the bucket swings the water in it remains approximately flat, this comes from the E𝕍×-𝕚d inertial impulse pointing outwards. It acts in a similar way to a bucket of water on the ground, the Eℍ/+𝕚d gravitational impulse also causes the water in it to remain flat.

In a vacuum

If the bucket was spun in a vacuum, for example on the Moon, then this would continue for a long time without any apparent forces. Work can be opposed and canceled out, here the -𝕀D×e𝕧 inertial work of the bucket would be canceling out the +𝕆D×e𝕒 potential work of the protons in the rope. The +𝕀D×e𝕙 gravitational work of the Moon would be canceled by the -𝕆D×e𝕪 kinetic work of having spun the bucket. These are classical approximations, in this model only a Pythagorean Triangle can have its force observed or measured producing uncertainty.

Canceled forces

In this model forces can be opposed and cancel each other out, this can be a stable configuration. An example is a pair of electrons with opposing spins in a boson. These do -𝕆D×e𝕪 kinetic work in opposing directions, the -𝕀D kinetic torque or probability is canceled out so they can drop to a lower orbital. Electrons move to higher orbitals with a -𝕆D kinetic torque, not directly upwards with a E𝕐/-𝕠d kinetic impulse.

Kinetic torque

Satellites in an orbit around a planet also do this, they would fire rockets to move upwards in an exponential spiral. If they went directly upwards then they would tend to fall down again, that would create an oscillation as an elliptical orbit. When the electron have opposing spins this -𝕆D kinetic torque is removed, they can then share an orbital. This might be the ground state or filled orbitals below them would also have boson pairs like this.

Two fermions

In molecules there can also be opposing electrons spins, the -𝕆D kinetic torque acts as a kinetic probability. When these are opposed as in a boson then the kinetic probability is reduced, this makes it less likely for the electrons to be found there. For example a fermion electron in an upper orbital might have a clockwise spin, when approached by a similar atom its fermion electron would appear counterclockwise as a mirror image.

Destructive interference not kinetic torque

That causes a destructive interference as they do -𝕆D×e𝕪 kinetic work, this is not -𝕆D kinetic torque because they are not orbiting the same proton. This destructive interference makes the electrons repel each other and the two atoms might not form a molecule.

Sharing an electron

If the two atoms can share an electron then the electron from one atom fits into a gap in the orbital shell with a second atom. This acts like a boson pair with another electron there, the reduction in -𝕆D kinetic torque causes them to drop to the lowest orbital. That binds the two atoms together in a molecule.

Modeling with four Pythagorean Triangles

Different points as the bucket as swung can be modeled with these four Pythagorean Triangles, also the electrons would be emitting and absorbing e𝕪×-𝕘d photons from these changing forces. The protons would be emitting and absorbing +𝕘d×e𝕙 Gravi as the different e𝕙 heights between atoms changed with these forces.

Space station

On a space station artificial gravity would use this E𝕍/-𝕚d inertial impulse to substitute for the Eℍ/+𝕚d gravitational impulse, it is not known how this substitution might work in the long term. In this model they are different forces.

Perpendicular component

The perpendicular component associated with a change of direction would be torque in this model, for example -𝕀D inertial torque in the -𝕚d and e𝕧 Pythagorean Triangle. This would give a change in the inertial momentum -𝕚d×e𝕧 with the -𝕀D×e𝕧 inertial work. It can then be converted classically into the E𝕍/-𝕚d inertial impulse to be shown with vectors.

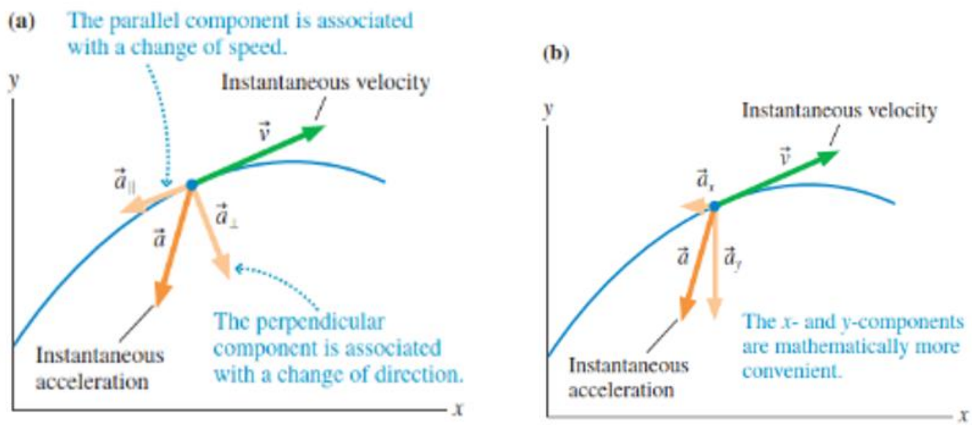


FIGURE 4.6 The instantaneous acceleration $\vec{a}$.

A parabola as a Pythagorean Triangle force

Here the initial speed is the velocity e𝕧/-𝕚d moving to the right, this comes from the -𝕚d and e𝕧 Pythagorean Triangle. The e𝕙 height is the vertical axis on the left, the horizontal axis is the +𝕚d gravitational mass. Because the +𝕚d and e𝕙 Pythagorean Triangle has a constant area as the e𝕙 height contracts the +𝕚d gravitational field dilates inversely to it. A parabola is formed where one axis is constant and the other is a square, this represents a force in this model.

Combining velocity and brevity

The acceleration is combined with the velocity in the diagrams, but in this model that is a classical approximation. The velocity e𝕧/-𝕚d is subtracted from the +𝕀D×e𝕙 gravitational work here, the -𝕚d and e𝕧 Pythagorean Triangle has reactive forces and can only affect the total amount of gravity. They are not then subtracted in the conventional sense here, the -𝕚d inertial mass is subtracted from the +𝕚d gravitational mass at each point to give the overall gravity there.

Reactive inertial forces

There is also an inertial force even though the sideways velocity is constant, the changing e𝕙 height means the -𝕚d inertial mass is dropping as the projectile falls downward. The E𝕍/-𝕚d inertial impulse points against the active Eℍ/+𝕚d gravitational impulse because it is reactive, when the projectile moves up then the E𝕍/-𝕚d inertial impulse reacts against the Eℍ/+𝕚d gravitational impulse slowing its upward motion. When the projectile goes downwards the E𝕍/-𝕚d inertial impulse reacts against this increasing acceleration.

Speed versus velocity or brevity

At each point as an infinitesimal and an instant there is a gravitational speed or brevity of e𝕙/+𝕚d and a velocity or inertial speed of e𝕧/-𝕚d. The difference between a speed and a velocity or brevity in this model is the direction, when this is being observed then it becomes the Eℍ/+𝕚d gravitational impulse or E𝕍/-𝕚d inertial impulse. When these are not observed they become speeds because the measurement is based on the times elapsed not how far they went on a constant scale.

Roy electromagnetism

In Roy electromagnetism there is a kinetic velocity e𝕪/-𝕠d which would be measured with the -𝕆D×e𝕪 kinetic work, it might also be called the kinetic velocity when the e𝕪 kinetic electric chargeis being observed with the E𝕐/-𝕠d kinetic impulse. With the potential speed e𝕒/+𝕚d this again is referring to the time elapsed not the distance or position change of the e𝕒 potential electric field. It would be associated with the +𝕆D×e𝕒 potential work, the potential brevity would be the observation of the change in this e𝕒 kinetic electric chargeover time with the E𝔸/+𝕠d potential impulse.

Terminology

In most cases this distinction would not be important, it allows for each Pythagorean Triangle to use the same terminology. Each of these fractions is a velocity or brevity in the sense that being a fraction is relates to impulse not work. With classical approximations this is not important, however in this model the momentum could also be used as for example -𝕚d×e𝕧 versus the velocity e𝕧/-𝕚d.

Pythagorean Triangles without forces

Both of these cannot be observed or measured without forces so the definition may not be relevant in most cases. There is no actual speed, velocity, brevity or momentum in this model except for a precursor of what might be observed or measured with impulse or work. Instead the Pythagorean Triangles are not changing and so they are not yet derivatives or integrals. There might also be a gravitational velocity e𝕙/+𝕚d, the inertial velocity e𝕧/-𝕚d, the potential speed e𝕒/+𝕠d and the kinetic velocity e𝕪/-𝕠d.

FIGURE 4.10 A projectile launched with initial velocity $\vec{v}_0$.

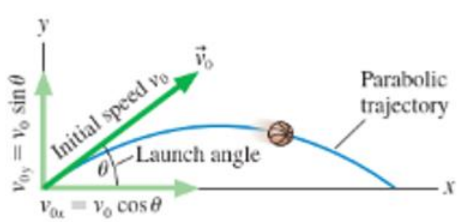
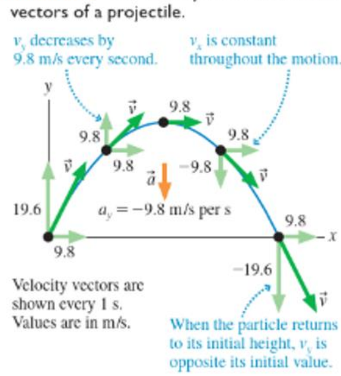


FIGURE 4.11 The velocity and acceleration vectors of a projectile.



A parabola as a derivative

The +𝕀D×e𝕙 gravitational work is consistent with conventional physics as a first derivative, the slope of the +𝕀D and e𝕙 Pythagorean Triangle is this gravitational acceleration e𝕙/+𝕀D in meters/second^2. The Eℍ/+𝕚d gravitational impulse is used in this model because it already is a fraction. The parabola is a conic section, each of these sections provides the Pythagorean Triangles used here. The circle and ellipse are from adding squares in Biv space-time, the hyperbola comes from subtracting squares in Roy electromagnetism.

A parabola as an integral

Its integral is not the same, this goes back to Archimedes. If $y=x^2$ then y/x^2 is 1 as impulse, but to make yx^2 then it must be $1/y = x^2$. This can give the inverse square rule so that e𝕙 as the height x above a planet, and +𝕀D as the gravitational mass force or torque, would have its +𝕀D×e𝕙 gravitational work decrease as a square further from it. The +𝕀D×e𝕙 gravitational work then acts as an inverse to the E𝕳/+𝕚d gravitational impulse just as the parabolic equation is the inverse of the inverse square law.

The inverse square law is not observable

This parabola as an integral is not observable like a ball falling with a parabolic trajectory, this is because the +𝕀D×e𝕙 gravitational work is a field or wave not a particle. The field then from a conic section represents the area, a circle would have this parabolic integral in between it and the next circle. This would be -𝕆D×e𝕪 kinetic work as the difference between electron orbitals, the parabolic trajectory acts as a particle and so it is not quantized. It does not produce this inverse square law except as a classical approximation.

Planets and moons resonating

With gravity this inverse square law from the +𝕀D×e𝕙 gravitational work leads to resonations between planets and moon because of the same kind of quantization as in electron orbitals. A meteor moving with a E𝕳/+𝕚d gravitational impulse resonates less with other bodies and is more likely to have a chaotic trajectory. This is seen in the three-body problem where two opposing spins of those bodies tend to cancel the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work. That leaves more of a E𝕳/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse making the motion less probable and more chaotic.

The parabola as a conic section

The parabola as a conic section means that only one Pythagorean Triangle side can be squared to be consistent with the other sections. The central Pythagorean Triangles can have a double square such as e𝕪×-𝕘d being squared, but this only refers to the difference between Roy electromagnetism on the left and Biv space-time on the right-hand side.

Inverted squares

If a circle is $x^2+y^2=1$ then this relates to impulse and a parabola, the equation $1/x^2 +1/y^2$ relates to work from this inverted parabolic equation. This would also apply to the hyperbola as $x^2-y^2=1$ for the E𝕐/-𝕠d kinetic impulse and the E𝕍/-𝕚d inertial impulse, when used as $1/x^2-1/y^2=1$ this refers to the -𝕆D×e𝕪 kinetic work and the -𝕀D×e𝕧 inertial work.

Hyperbolic integrals and logarithms

This connects the concept of exponents to base e to representing Pythagorean Triangle sides, the integral area under a hyperbola represents -𝕆D×e𝕪 kinetic work or -𝕀D×e𝕧 inertial work, it is also the area up to a line 1/x as a logarithm. An exponent value log x then acts as a spin Pythagorean Triangle side, when the derivative is taken of this it gives 1/x. In this model that would be a classical approximation, instead the integral of 1/x would be log x. So with the -𝕚d and e𝕧 Pythagorean Triangle for example the value -𝕚d with d as an inverse 1/x, taking the integral of the Pythagorean Triangle with respect to -𝕚d would give log -𝕚d. While the logarithm uses real numbers generally, in this model the spin Pythagorean Triangle sides are the inverse of the straight Pythagorean Triangle side values because of the constant area.

Deriving logarithms from Pythagorean Triangles

In this model the forces in physics are derived from squaring one Pythagorean Triangle side and maintaining a constant Pythagorean Triangle area. Then changing the constant Pythagorean Triangle side causes the square to change inversely. This also gives an exponential and a log curve.

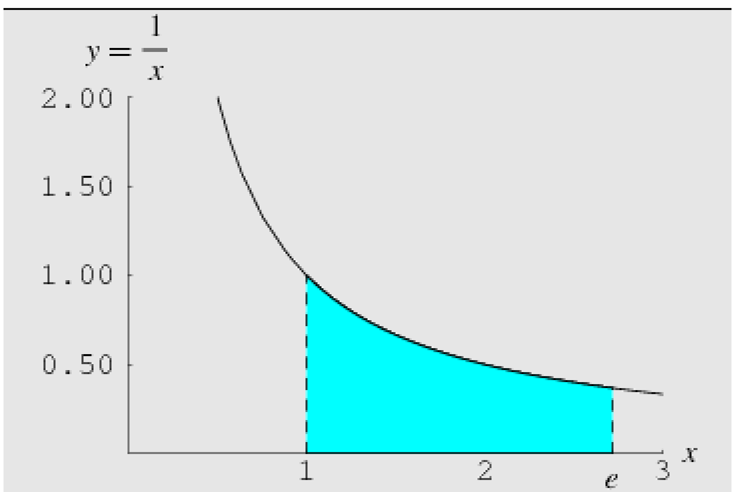
For example an exponential decay curve is where over a constant time -𝕠d the energy E𝕐 as the kinetic electric force decreases as a square. This connects the forces in a hyperbola to logarithms, it is the difference between two squares. That area as a square is compared to a constant value 1/x.

Exponentials from circles

This also happens in circular geometry, taking the +𝕠d and e𝕒 Pythagorean Triangle as the proton or the +𝕚d and e𝕙 Pythagorean Triangle as gravity. The +𝕚d and e𝕙 Pythagorean Triangle for example has a height e𝕙 so squaring this is Eℍ, as this grows as a square outwards the +𝕚d gravitational field contracts constantly. Comparing the two gives an exponential curve with the Eℍ/+𝕚d gravitational impulse, this is the same as the exponential curve from a hyperbola used in logarithms. If this +𝕚d value is taken as rotation then Eℍ increases outwards as a square forming an exponential spiral. In this model that is why galaxies form these spirals.

Logarithms from circles

If the +𝕚d gravitational field is squared as an integral +𝕀D gravitational torque then there is the inverse as a logarithmic curve with its area as the integral. This is formed by comparing e𝕙 with +𝕀D with a constant Pythagorean Triangle area. Because the exponential and log curves are formed in circular geometry as well this model can use exponents like $e^{e𝕙+𝕚d}$ as well as $e^{e𝕧-𝕚d}$.



Squaring the exponent

These areas can then be added together in the exponent as work in this model, when squared as a work measurement in the exponent they give a Gaussian integral. When the exponents are negative squares then the different values of those squares plot the normal curve. This is why in this model work is associated with randomness and the normal curve. Impulse when observed is the absence of randomness which is chaos.

Exponents as hyperbolic

If the exponent is then $e^{e𝕪-𝕠d}$ for example then taking the -𝕆D×e𝕪 kinetic work as this exponent is associated with the area under a hyperbola, the -𝕠d and e𝕪 Pythagorean Triangle has a constant area under the hyperbola. If the -𝕆D×e𝕪 kinetic work is taken as $e^{e𝕪-𝕆D}$ then the measurement gives the Gaussian integral or normal curve for different values of d.

Eigenvalues

If the E𝕐/-𝕠d kinetic impulse is taken as $e^{E𝕐\text{-}𝕠d}$ this does not give an integral area, in quantum mechanics taking the derivative of a vector as the hypotenuse of the -𝕠d and e𝕪 Pythagorean Triangle would be a force on this factor. That would give a coefficient or Eigenvalue as e𝕪$e^{e𝕪\text{-}𝕠d}$ where a particle is observed.

Exponents and circles

With the +𝕠d and e𝕒 Pythagorean Triangle and +𝕚d and e𝕙 Pythagorean Triangle these are both in circular geometry, the hyperbola then cannot be used in their exponents as logarithms. They instead use a circle where a pie slice represents an area +𝕠d or +𝕚d. These can be represented as $e^{e𝕪+𝕚d}$ where the +𝕚d pie slices act like integral areas in the circle. As these add up they can come to 2π as the full circle, if this is squared as the +𝕀D×e𝕙 gravitational work with $e^{e𝕙+𝕀D}$ then the changes in +𝕀D also give a Gaussian integral in this model.

The circle and the hyperbola

Because these are both conic sections they have similar properties. The circle uses π with he inverse square rule, if the radius is 1/x like with the hyperbola then the circumference increases as 2πx. The 1/x refers to an inverse relationship so if this is a field like +𝕚d gravity then the circumference always contains the same amount of gravitational flux. This is the same as Gauss's electric or magnetic flux. e𝕙 here has the same inverse relationship to +𝕚d as with the e𝕒 potential electric charge and the +𝕠d potential magnetic field. The +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle giving gravity are both in this circular geometry.

Pythagorean Triangles and circles

The circle has a relationship with the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity. This is not the same as the area of a circle, the +𝕚d and e𝕙 Pythagorean Triangle for example can rotate around the origin forming a circle. Its area is not the same as the circle, this model uses the Pythagorean Triangles but the conic sections are related to them.

Euler Formula

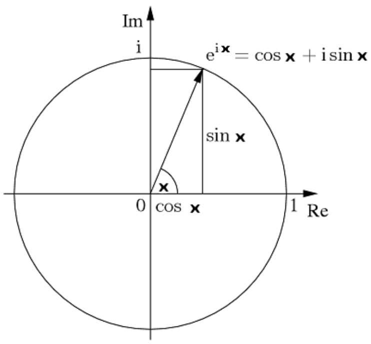
For example the Euler Formula has a Pythagorean Triangle inscribed in a circle, this does not have a constant area like in this model. The Pythagorean Triangle below has a constant hypotenuse ζ, this makes it impossible for it also to have a constant Pythagorean Triangle area. If the e𝕙 side of the +𝕚d and e𝕙 Pythagorean Triangle acted as the radius then this has a similar relationship to the diagram. Because the constant area Pythagorean Triangles give exponential curves then they must be transformable into the Euler Formula.

Constant rotation

Instead of using ni in the exponent as a constant rotation this model uses the spin Pythagorean Triangle side value. As n increased constantly then this would be a constant rotation, if +𝕠d is in the exponent, and d increases constantly, this is not constant rotation. If required each can be transformed into the other, a value of n will correspond to d and vice versa. As a classical approximation the Euler formula can be used, it does not have a constant Pythagorean Triangle area and so some of the characteristics of this model are not available. Here $e^{e𝕒+𝕠d}$ gives an exponential curve with E𝔸 if the E𝔸/+𝕠d potential impulse is observed, a log curve with +𝕆D is the +𝕆D×e𝕒 potential work is measured.

Inverse relationships

The difference is then the Pythagorean Triangle can have a constant conserved area. That allows for the electric flux as e𝕒 and the magnetic flux as +𝕠d to vary inversely with each other. It also allows for the e𝕙 height and the +𝕚d gravitational field to vary inversely with each other. The Euler Formula is adapted in this model, but the main difference is the Pythagorean Triangle area is conserved. Because these Pythagorean Triangles are connected to conventional mathematics like the logarithms and hyperbolas, also this Euler Formula, they can be converted from one to other.



The same answers

This model intends to give the same answers as in conventional mathematics, also as those in relativity and quantum mechanics. The difference is using these Pythagorean Triangles additional properties are available that may resolve unanswered questions in physics.

Derivatives as coefficients

Taking the exponent as 1/e𝕙 gives $e^{e\mathbb{h}+\mathbb{i}d}$ where e𝕙 acts like the radius not an area. When this is observed as the Eℍ/+𝕚d gravitational impulse then $e^{E\mathbb{H}+\mathbb{i}d}$ does not give a Gaussian integral, with this randomness its changes are chaotic. Taking this as a derivative then would give an Eigenvalue or coefficient as $e\mathbb{h}e^{e\mathbb{h}+\mathbb{i}d}$ with respect to e𝕙, in quantum mechanics this is again like observing a vector when there is a force moving it in the same direction. The vector does not turn because the straight Pythagorean Triangle side is squared with a force, its magnitude increases instead as Eℍ from e𝕙.

Derivatives separate from integrals

Taking a derivative of an exponent can then be done with the straight Pythagorean Triangle side, that multiplies e by that side value. Taking the integral of that to return to the exponent is not allowed in this model because that is making an integral out of a straight Pythagorean Triangle side. For example the derivative of $e^{e\mathbb{h}+\mathbb{i}d}$ with respect to e𝕙 is $e\mathbb{h}e^{e\mathbb{h}+\mathbb{i}d}$, but the integral of this with respect to e𝕙 would not reverse it back to $e^{e\mathbb{h}+\mathbb{i}d}$. This can be referred to as an antiderivative.

Spin and normal curves

In this model spin as a force becomes torque, that in the exponent gives the normal curve such as with $e^{-\mathbb{O}D}$. The straight Pythagorean Triangle sides cannot give an area and so cannot act like a field as this area under the normal or Gaussian curve. This separates the concepts of chaos which comes from straight Pythagorean Triangle sides and randomness which comes from spin Pythagorean Triangle sides.

Exponential slopes and integrals

It also means that straight Pythagorean Triangle sides can increase exponentially, the spin Pythagorean Triangle sides can create randomness but not an exponential. Work can appear as an exponential such as the exponential decay curve in radioactivity, there the decays are random but fall on a log curve as the inverse of an exponential curve. In this model it would be referred to as being on a log curve not an exponential decay curve because work is being measured.

Log curves and exponential curves

The exponential curve in this model gives the changes with respect to the straight Pythagorean Triangle sides as a slope. The log curve is the inverse of this, the area under the log curve relates to the area under a hyperbola as an integral. In this model a logarithm is two separate processes, the straight Pythagorean Triangle sides act as an exponent with an exponential curve. The spin Pythagorean Triangle sides act as an exponent with a log curve. Because the Pythagorean Triangles have a constant area the exponential and log curves are also inverses, the exponential increases while the log curve is flattening out and vice versa. Classically they work the same, the difference comes in this model when relativity and quantum mechanics are analyzed.

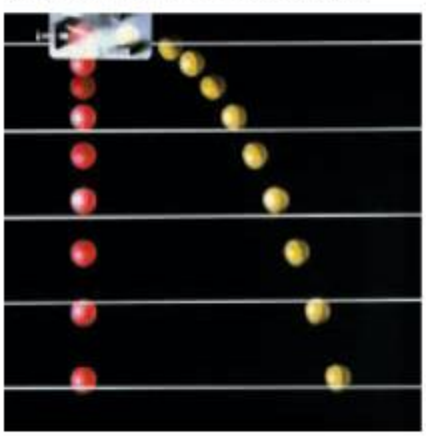
Antiderivatives and antiintegrals

In this model it is not necessary to change the conventional mathematical rules except with some definitions to use in physics, the derivative is observed as the straight Pythagorean Triangle side squared, the integral is measured as the spin Pythagorean Triangle side squared. The terms antiderivative and antiintegral are better to use here to avoid confusing particles and fields.

Weightlessness

In the diagram the ball experiences weightlessness, the Eℍ/+ⅈd gravitational impulse pulling downwards is an active force. The E𝕍/-ⅈd inertial impulse reacts against this going upwards to maintain the current position. This is the same as in Newton’s first law, there is an equal and opposite reaction to the force. Because these forces oppose each other on the ball they cancel out giving weightlessness.

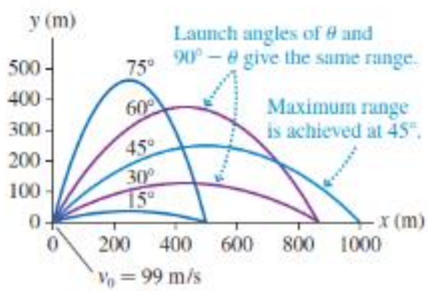
FIGURE 4.13 A projectile launched horizontally falls in the same time as a projectile that is released from rest.



Launch angles

The different angles refer to a different angle θ in the +𝕚d and e𝕙 Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle. This gives a ratio between the two, with a smaller angle there is more inertia with the -𝕚d and e𝕧 Pythagorean Triangle. Because the two Pythagorean Triangles are inversely correlated an increased e𝕧 length in the velocity e𝕧/-𝕚d connects to a inversely decreased upward gravitational speed or brevity of e𝕙/+𝕚d. It follows that the +𝕚d gravitational mass would be inversely correlated with the -𝕚d inertial mass, the higher the +𝕚d value is the lower e𝕙 height is to the ground. That makes the -𝕚d inertial mass proportional to this e𝕙 height value, this can be written as the gravitational potential energy.

FIGURE 4.16 Trajectories of a projectile launched at different angles with a speed of 99 m/s.



Reference frames

The two reference frames here can be a Pythagorean Triangle moved as a position with its straight Pythagorean Triangle side, also as a change in its time with the spin Pythagorean Triangle side. With the -𝕚d and e𝕧 Pythagorean Triangle as an example, the x axis would be e𝕧 as length. From the different reference frames C would appear to be a different length or position away from it. This would also take a different time to get to C at a constant velocity e𝕧/-𝕚d.

Moving between reference frames

To get from one reference frame to another requires a force, this might be from the E𝕍/-𝕚d inertial impulse so the new inertial reference frame can be observed. It might be -𝕀D×e𝕧 inertial work so the new inertial reference frame can be measured. This difference in work or impulse creates some uncertainty, the two reference frames cannot observe a particle simultaneously or in the same -𝕚d instant because of this.

Simultaneity and impulse

Because of the simultaneity problem these reference frames are implicitly observing particles with impulse. If this was measuring work then it would have a scale based on a position or e𝕧 length. Then this can only be measuring work between reference frame positions, for example there might be a reference frame at the start and final e𝕧 length position. The uncertainty then becomes probability, the -𝕀D×e𝕧 inertial work has a -𝕀D inertial probability of where the wave is being measured. A different reference frame then implies a different amount of -𝕀D×e𝕧 inertial work to get there.

Relative position and time

Two inertial reference frames cannot observe a particle simultaneously with impulse, this would make -𝕚d in the E𝕍/-𝕚d inertial impulse zero. They also cannot measure a wave in the same position because this would make e𝕧 in the -𝕀D×e𝕧 inertial work zero. This follows from the Pythagorean Triangles having constant area, a zero side would change this. The E𝕍/-𝕚d inertial impulse then makes time relative, it also makes a e𝕧 length or position relative.

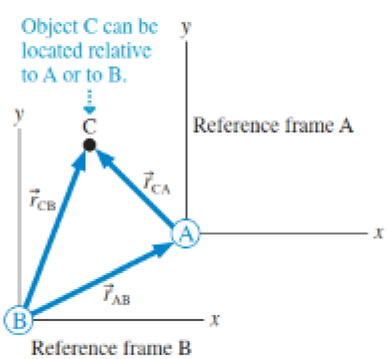
Uncertainty between reference frames

A different reference frame cannot use -𝕚d time or e𝕧 length as an unchanging scale because of uncertainty. If one reference frame has a straight transformation this is from impulse, if the second reference frame is rotated then this comes at least partially from work.

Reference frame types

There can be a potential reference frame from the +𝕠d and e𝕒 Pythagorean Triangle, a kinetic reference frame from the -𝕠d and e𝕪 Pythagorean Triangle, an inertial reference frame from the -𝕚d and e𝕧 Pythagorean Triangle, and a gravitational reference frame from the +𝕚d and e𝕙 Pythagorean Triangle. Light can also form a reference frame from the e𝕪 and -𝕘d Pythagorean Triangle, Gravi from the +𝕘d and e𝕓 Pythagorean Triangle. Light would then have an initial reference frame where it might be emitted from an electron, then a final reference frame when it is absorbed. Gravi would also have a Gravi reference frame when a +𝕚d and e𝕙 Pythagorean Triangle changed its e𝕙 height or inversely e𝕓 depth in relation to other +𝕚d and e𝕙 Pythagorean Triangles.

FIGURE 4.18 Two reference frames.



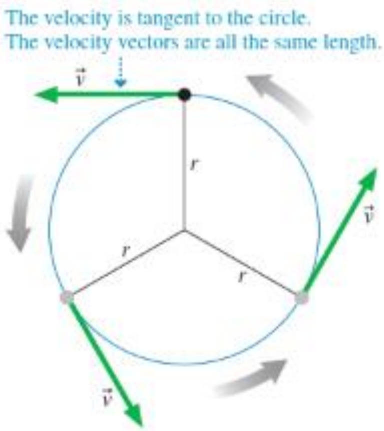
Balancing two forces

In this model a circular motion comes from the spin Pythagorean Triangle sides, it represents a balance between two forces such as in Roy electromagnetism with -𝕆D×e𝕪 kinetic work and a reaction force such as +𝕆D×e𝕒 potential work. In Biv space-time this would be -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work. The two forces cancel because a reactive force is only observed or measured by its change in an active force. The +𝕆D×e𝕒 potential work is added to the -𝕆D×e𝕪 kinetic work and the -𝕀D×e𝕧 inertial work is subtracted from the +𝕀D×e𝕙 gravitational work.

Removing a force

If one force was removed, such as the +𝕀D×e𝕙 gravitational work, then the -𝕀D×e𝕧 inertial work would carry a satellite outwards in a straight line e𝕧. The circle is from work because of quantization, the +𝕆D potential torque must have D as an integer, so d in +𝕠d as the potential magnetic field is the square root of an integer. If there was the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse this cannot be in a circular orbit, instead it moves chaotically creating an electron cloud. This is because is the E𝔸 and E𝕐 forces were balanced it would be the same as +𝕆D and -𝕆D being balanced, then they would be identical.

FIGURE 4.21 A particle in uniform circular motion.



$$v = \frac{1 \text{ circumference}}{1 \text{ period}} = \frac{2\pi r}{T}$$

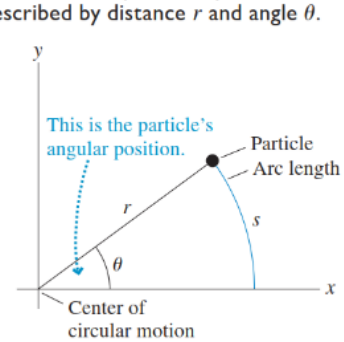
Measuring rotation

Here the motion is described by an arc, in this model that must comes from the spin Pythagorean Triangle side. A straight Pythagorean Triangle side can only move in a straight line. The position then is on a scale e𝕒 as the altitude above a proton, it is also proportional to e𝕙 height. This circular motion is a property of the +𝕠d potential magnetic field and the +𝕚d gravitational field. To know this arc exists requires it to be measured, that creates a torque and the rotary motion.

A circle without forces

Each can also exist without the Pythagorean Triangles in hyperbolic geometry, a bare proton would have this +𝕠d potential magnetic field with a flux in the circle without an electron. A +𝕚d gravitational mass would have this field without a satellite to provide the inertia to be subtracted from it. In those cases there is no force, the +𝕠d and e𝕒 Pythagorean Triangle and the +𝕚d and e𝕙 Pythagorean Triangle have a constant angle θ.

FIGURE 4.22 A particle's position is described by distance r and angle θ.



Angular momentum

Because this is a position in time it is observing a particle with impulse. In this model it could not stay in a perfect circle because the only force is from the straight Pythagorean Triangle side. The angular momentum here would be measured by a torque, otherwise it would not be known. An angular momentum then implies a constant rotation not a force, an electron in a circular orbital might be described by a potential momentum e𝕒×+𝕠d balanced by a kinetic momentum of e𝕪×-𝕠d.

Momentum and velocity

When an electron is not being observed or measured it can have a constant kinetic momentum, this is balanced by the potential momentum. It can also have a kinetic velocity e𝕪/-𝕠d balanced by the potential speed e𝕒/+𝕠d, the two arise from an integral and a derivative respectively. The integral would be the first integral with respect to +𝕠d of the +𝕠d and e𝕒 Pythagorean Triangle, this gives the +𝕠d potential magnetic field because it is an area. The derivative with respect to e𝕒 would give the e𝕒 potential electric charge because the slope gives a particle.

Dimensional analysis and momentum

In this model some Pythagorean Triangles are also given classically, this to maintain a compatibility with dimensional analysis. Inertial momentum then might be written as -𝕚d×e𝕧/-𝕚d, this would be the inertial mass times the velocity. Here the -𝕚d factor appears twice because when multiplied as an integral it acts as mass. It is not spinning, but when divided as a derivative it can represent time and spin like in angular velocity with a clock.

Mass and time equivalence

With this inertial momentum -𝕚d×e𝕧/-𝕚d doubling d gives the same momentum, the mass is doubled while the motion occurs in double the time. In this model then momentum is conserved when either the mass or time is calculated.

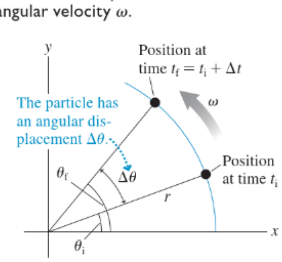
Not measured or observed

Neither -𝕚d×e𝕧 or e𝕧/-𝕚d is being measured or observed respectively because momentum has no force. These would both then be not knowable, a second integral and a second derivative respectively would give a measurement and an observation.

A second integral or derivative

A second integral would give the +𝕆D×e𝕒 potential work and the second derivative would give the E𝔸/+𝕠d potential impulse.

FIGURE 4.23 A particle moves with angular velocity ω.



Opposing spin

The instantaneous angular velocity would be where Δt as -𝕠d is an instant. In this model a fermion can be measured with its -𝕆D×e𝕪 kinetic work in an orbital. A boson as a pair of electrons have opposing spin, because of this their -𝕆D×e𝕪 kinetic work is canceled. In Biv space-time a bike wheel turning in space might have an angular velocity.

Bike wheels and opposing spin

If there are a pair of bike wheels in parallel with opposing spins then these would not have an inertial force, each would be canceled with the opposing -𝕀D×e𝕧 inertial work. The bike wheels would not stay in the same orientation, in this model it is like a boson pair that can fit lower in between other electrons. A single electron as a fermion acts more like a single bike wheel, as a gyroscope it has more -𝕆D kinetic torque,

Quantization

The two electrons in a boson pair are still quantized, their -𝕆D×e𝕪 kinetic work opposes each other. The direction of the e𝕪 kinetic electric charge is opposed in the boson pair, with electrons as rolling wheels one is rolling clockwise and the other counterclockwise.

Electrons not entangled

These need not be entangled as in EPR, the phasors may not be pointing in opposite directions.

In analogy with linear motion, let's define the *average angular velocity* to be

$$\text{average angular velocity} = \frac{\Delta\theta}{\Delta t} \qquad (4.24)$$

As the time interval Δt becomes very small, $\Delta t \to 0$, we arrive at the definition of the instantaneous **angular velocity:**

$$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt} \qquad \text{(angular velocity)} \qquad (4.25)$$

Avoiding confusion

In this model clockwise and counterclockwise are preferably used, positive and negative can cause confusion with +𝕚d and -𝕚d for example. They can also be +(ω) and −(ω). This area would act as work in this model to be an integral, for example in Biv space-time an orbit would have +𝕀D×e𝕙 gravitational work minus -𝕀D×e𝕧 inertial work. Taking time as a variable makes this impulse in this model, that would not use an integral but a derivative here.

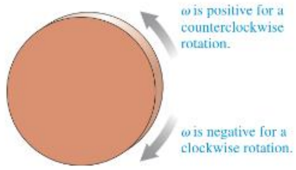
Circumference versus area

An electron does -𝕆D×e𝕪 kinetic work with deBroglie waves, these are an oscillation along a circular orbital. There must be an integer number of these in the orbital because the electron oscillates so as to connect with its starting point. That makes D in -𝕆D an integer and -𝕠d has d as the square root of an integer. The angle change here can then be defined as a segment or pie slice of an integral area inside that orbital, but in this model that is not a Pythagorean Triangle.

deBroglie waves

Because these waves are quantized there cannot be a half number for example, ½×D would not be a square. This model than cannot define an arbitrary time period Δt or -𝕠d giving this area. It can be regarded as a constant kinetic momentum -𝕠d×e𝕧 with a segment of this, but this is not measurable. The concept of it being measurable then is a classical approximation, it can be useful with larger objects, but it obscures some of the model's advantages later in quantum mechanics.

FIGURE 4.24 Positive and negative angular velocities.



$$\begin{aligned} \omega &= \text{slope of the } \theta\text{-versus-}t \text{ graph at time } t \\ \theta_f &= \theta_i + \text{area under the } \omega\text{-versus-}t \text{ curve between } t_i \text{ and } t_f \qquad (4.26) \\ &= \theta_i + \omega \Delta t \end{aligned}$$

Quantized angular momentum

An angle can represent an instant of spin, angular momentum in quantum mechanics is quantized as h. To begin spinning there must be a +𝕆D potential torque for the proton or a +𝕀D gravitational torque proportional to this proton. This initial torque can start a rotation, for example an electron might absorb a e𝕪×-𝕘d photon which increases its -𝕆D×e𝕪 kinetic work, that moves it into a spherical orbital. From there it would stay in this orbital for a time -𝕠d, the angle could be said to change classically like in the diagram.

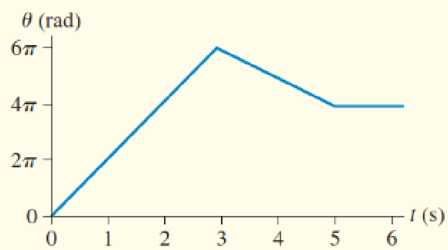
Standing waves

But the electron in doing quantized work acts as a standing wave, there is no particle which is spinning around. If that happens then it is a E𝕐/-𝕠d kinetic impulse and the force acts in a straight line, that takes it out of the circle.

Change of spin and torque

When the spinning stops below this would be from a +𝕆D potential torque or a +𝕀D gravitational torque, also there would be a -𝕆D kinetic torque with an electron where it might slow to drop to a lower orbital. There would be a -𝕀D inertial torque as well, the electron would emit a e𝕪×-𝕘d photon with a +𝔾D light torque as the difference between its starting and final orbital.

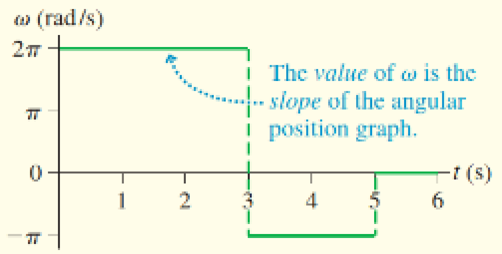
FIGURE 4.25 Angular position graph for the wheel of Example 4.10.



Accelerating waves

This can be shown classically as rads/sec which is for example a e𝕒×+𝕠d potential momentum and a e𝕙×+𝕚d gravitational momentum. When this is over time the denominator is 1/+𝕆D as seconds^2 but this is a second derivative instead of a second integral. A wave cannot change like a particle with an acceleration in this model, for example trying to accelerate an ocean wave would destroy it.

FIGURE 4.26 ω-versus-t graph for the wheel of Example 4.10.



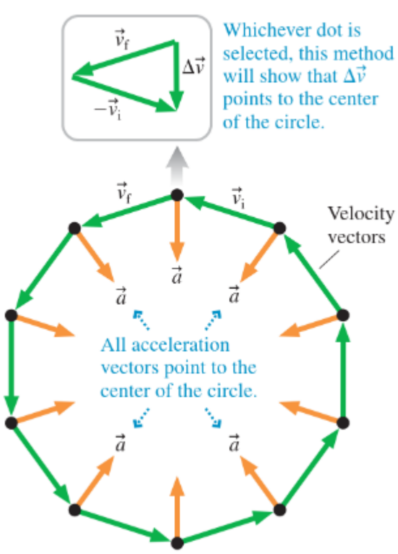
Straight forces

In this model a Ferris Wheel has a centrifugal force, this is an E𝕍/-𝕚d inertial impulse where segments tend to move outwards in a straight line. Against this is +𝕆D×e𝕒 potential work from the molecular bonds protons have, these force the wheel segments to move in a circle. As the molecular bonds are stretched by this E𝕍/-𝕚d inertial impulse there is also a E𝔸/+𝕠d potential impulse pulling downwards towards the proton, these can be added together as a force $\vec{a}$ below.

A rotation as straight lines

The diagram converts a rotation into a series of straight forces and constant velocities, this is viewing the wheel according to impulse as particles. When the velocities e𝕧/-𝕚d are reduced downwards they become a calculus -𝕚d and e𝕧 Pythagorean Triangle, the e𝕧 becomes an infinitesimal in this wheel and the -𝕚d inertial mass an instant or fluxion.

FIGURE 4.27 Using Tactics Box 4.1 to find Maria's acceleration on the Ferris wheel.



Gravitational and magnetic fields

The acceleration would be an integral because it is work, here it can be classically the area inside the circle. That can relate to a +𝕚d gravitational or a +𝕠d potential magnetic field. When these act as a torque creating the rotary motion there is an acceleration, when decomposed into straight line accelerations it can be transformed into a series of E𝔸/+𝕠d potential impulse and Eℍ/+𝕚d gravitational impulse.

Converting work into impulse

The meters/second^2 are then converted into seconds/meter^2, the seconds and meters are inverses of each other because the +𝕚d and e𝕙 Pythagorean Triangle here for example has a constant Pythagorean Triangle area.

Inverted accelerations

This is transformed below into velocity squared as E𝕍/-𝕀D divided by e𝕙 as the radius. Because the +𝕚d and e𝕙 Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle are inverses of each other, as an example of a satellite around a planet in Biv space-time, e𝕙 is proportional to -𝕚d. This then becomes an acceleration of E𝕍/-𝕚d as meters^2/second. The +𝕚d and e𝕙 Pythagorean Triangle as gravity has an acceleration the inverse of this as Eℍ/+𝕚d, when the satellite was closer to the planet then Eℍ decreases as a square and +𝕚d as the gravitational field increases constantly.

By definition, the acceleration is $\vec{a} = d\vec{v}/dt$. We can see from the inset to Figure 4.28 that $d\vec{v}$ points toward the center of the circle—that is, $\vec{a}$ is a centripetal acceleration. To find the magnitude of $\vec{a}$, we can see from the isosceles triangle of velocity vectors that, if $d\theta$ is in radians,

$$dv = |d\vec{v}| = v\,d\theta \qquad (4.29)$$

For uniform circular motion at constant speed, $v = ds/dt = r\,d\theta/dt$ and thus the time to rotate through angle $d\theta$ is

$$dt = \frac{r\,d\theta}{v} \qquad (4.30)$$

Combining Equations 4.29 and 4.30, we see that the acceleration has magnitude

$$a = |\vec{a}| = \frac{|d\vec{v}|}{dt} = \frac{v\,d\theta}{r\,d\theta/v} = \frac{v^2}{r}$$

Observations versus measurements

Conversely with a closer orbit the E𝕍 factor increases as a square, the satellite moves faster with a velocity e𝕧/-𝕚d while -𝕚d as the inertial mass contracts at a lower e𝕙 height. With a constant circular orbit, the satellite can be regarded as having an E𝕍/-𝕚d inertial impulse trying to move in a straight line, the Eℍ/+𝕚d gravitational impulse is trying to move the satellite downwards in a straight line. Both of these are observations of particles.

Vectorless and weightless

It can also be regarded as measurements of -𝕀D×e𝕧 inertial work versus +𝕀D×e𝕙 gravitational work, the inertial field acts as a reactive force against the gravitational field. Because these Pythagorean Triangles are inverses of each other the satellite measures weightlessness. It also observes no straight motion, a kind of vectorless balancing of the two straight Pythagorean Triangle sides. This is because both straight forces are canceled out, there is no tendency to move with these forces in a straight line as the inverse of weightlessness.

Geodesics

In relativity a circular or elliptical orbit like this would be a straight-line motion in curved space, that would come from the +𝕚d gravitational field warping the space around the planet. In this model it can also be a straight space as in Newtonian gravity, the eℍ Pythagorean Triangle sides extend outward from the mass as straight lines. Then the satellite moves with a curved trajectory from +𝕚d in eℍ straight space, or it moves with a straight trajectory from eℍ in +𝕚d curved space. In this model the two are equivalent classically because the +𝕀D gravitational and -𝕀D inertial torque are canceled, as are the Eℍ straight and E𝕍 length forces.

General relativity versus special relativity

Curved space then acts with a measurable force, straight space acts with an observable force. Each can be converted into the other, relativity is where the angle θ in the +𝕚d and eℍ Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle becomes dilated. Then closer to a large planet the gravitational field and time +𝕚d becomes dilated, eℍ becomes contracted. With higher velocities the -𝕚d inertial mass becomes dilated and the e𝕧 length becomes contracted.

A straight space or Newtonian relativity

As eℍ contracts then it can also be a Eℍ height force in straight space observing the Eℍ/+𝕚d gravitational impulse, conventionally the increasingly curved space has a +𝕀D gravitational torque. Approaching c a rocket can be said to have a contracted E𝕍 length force as well as a dilated -𝕀D inertial torque. This model can then describe relativity in Newtonian terms with impulse, by how eℍ height and e𝕧 length contract in straight space.

Newtonian relativity from a constant area Pythagorean Triangle

The +𝕚d and eℍ Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle in Biv space-time also describe a Newtonian relativity, this comes from the constant area of the Pythagorean Triangles. Approaching c then has e𝕧/-𝕚d where in terms of e𝕧 in Newtonian or straight space, -𝕚d must contract as e𝕧 dilates with a higher velocity. This is equivalent to a contraction of the angle θ opposite the spin Pythagorean Triangle side -𝕚d.

Length contraction from fuel burning

It appears as a e𝕧 length contraction because of Newtonian straight space with the +𝕠d and e𝕒 Pythagorean Triangle as the proton. The increased velocity comes from burning fuel, this involves electrons moving upwards in their orbitals or leaving their atoms. That causes e𝕒 as the altitude of the electron above the proton to dilate in an analogue of straight Biv space-time, straight Roy electromagnetism.

Electric fields like straight space

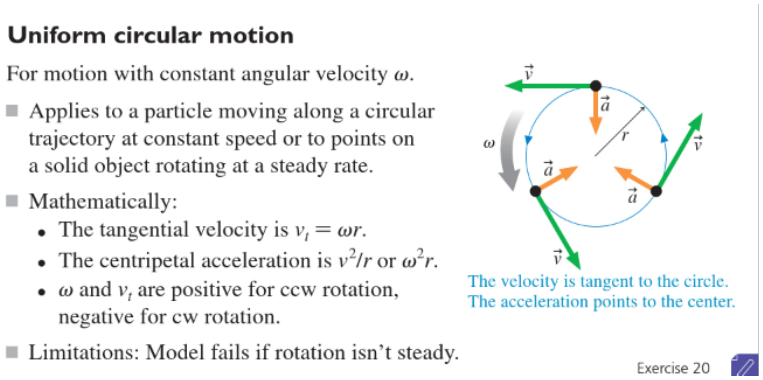
Just as straight space comes from the straight Pythagorean Triangle sides, in Roy electromagnetism the straight motion comes from the e𝕒 potential electric charge and the e𝕪 kinetic electric charge . As e𝕒 dilates with the burning of fuel then e𝕪 contracts inversely, as these add up then e𝕪 contracting is proportional to e𝕧 length contracting with higher velocities.

Higher electrons

With eℍ the higher the electrons get then proportionally the more dilated eℍ becomes and the more contracted e𝕧 is in the electrons, giving relativistic length contraction.

Orthogonal Pythagorean Triangles

In the diagram the velocity $e\vec{𝕧}$ moves in a straight line orthogonal to $e\vec{ℍ}$ which is directly towards a +𝕚d gravitational mass. This can be described as a centripetal acceleration from the Eℍ/+𝕚d gravitational impulse or a centrifugal acceleration from the E𝕍/-𝕚d inertial impulse. It can then be v^2/r or (E𝕍/-𝕀D)e𝕙, also a e𝕙/+𝕚d brevity squared times a e𝕧 length or (Eℍ/+𝕀D)e𝕧.



Ellipses in circular geometry

In this model an ellipse is also in circular geometry, this is found in Roy electromagnetism where an electron as the -𝕠d and e𝕪 Pythagorean Triangle rotates around the +𝕠d and e𝕒 Pythagorean Triangle as the proton in an orbital. In Biv space-time this is where a satellite, with inertia from the -𝕚d and e𝕧 Pythagorean Triangle, would rotate around the +𝕚d and e𝕙 Pythagorean Triangle and its gravity in an orbit.

Changing angular velocity

The angular velocity used in conventional physics is not constant, in Roy electromagnetism this is a quantized orbital like the circular orbitals. The equation for an ellipse is E𝔸+𝕆D =1, this implies the +𝕠d and e𝕒 Pythagorean Triangle has a constant area because doubling E𝔸 halves +𝕆D. As the e𝕒 altitude above a proton increases then the +𝕠d potential magnetic field decreases inversely, the rotation rate also slows because the electron is moving outward more and around less. Conversely when the e𝕒 altitude or potential electric charge contracts the rotation increases.

Elliptical and hyperbolic equations

Using the -𝕠d and e𝕪 Pythagorean Triangle for the electron this elliptical orbital is described by E𝕐+ -𝕆D=1. A problem here is the negative sign of the -𝕆D kinetic electric force turns this into a hyperbola as E𝕐-𝕆D=1. This makes the -𝕠d and e𝕪 Pythagorean Triangle act in hyperbolic geometry.

Ellipses becoming hyperbolas

However, when the electron is in an orbital it is moving in an ellipse not a hyperbola, the -𝕆D value of D is always smaller than the D value in +𝕆D. That means the sum is always positive and the electron is dominated by the reactive forces of the proton, it remains in an orbital unless -𝕆D exceeds +𝕆D. If this happens then the hyperbolic trajectory dominates, and the electron leaves the atom.

Electrons in elliptical orbitals

In this case then the -𝕠d and e𝕪 Pythagorean Triangle is in an elliptical orbital with the inverses of the +𝕠d and e𝕒 Pythagorean Triangle. When the e𝕒 altitude is contracted then the e𝕪 kinetic electric chargeis dilated, that makes the e𝕪/-𝕠d kinetic velocity of the electron faster. When the e𝕒 altitude is higher then the kinetic velocity is lower as e𝕪 is contracted and -𝕠d is dilated.

Combining Pythagorean Triangles classically

The ellipse can also be described by combining the +𝕠d and e𝕒 Pythagorean Triangle and the -𝕠d and e𝕪 Pythagorean Triangle, because E𝕐 is the inverse of E𝔸, and +𝕆D is also the inverse, then E𝕐 is proportional to E𝔸. That allows for an ellipse to be described in Roy straight space, with the e𝕒 potential electric charge and the e𝕪 kinetic electric chargegiving E𝔸+E𝕐=1. It can also be described as +𝕆D +(-𝕆D)=1 as a proportional ellipse.

Quantized elliptical orbitals

When this orbital is quantized with +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work then the D values are also the squares of square root integers. This allows for h as Planck's Constant later to be quantized with elliptical orbitals too. The same can be done with each to by changing the positive sign to a negative, that gives a hyperbola where the electron leaves the atom.

Biv ellipses

In Biv space-time the ellipse can then also be Eℍ+𝕀D=1, E𝕍+(-E𝕍)=1, Eℍ+E𝕍=1, and +𝕀D+(-𝕀D)=1. The ellipse can sometimes be quantized like in Roy electromagnetism, this is where it sets up a resonation with other planets and moons. With a negative sign this becomes a hyperbola, this would be like a satellite having enough inertia to leave a planet's gravitational field.

The uncertainty principle and θ

In this model both Pythagorean Triangle sides cannot be measured and observed in the same time and position, this is because of the uncertainty principle. That is where squaring one Pythagorean Triangle side and not the other makes the Pythagorean Triangle area uncertain, it then must emit or absorb a e𝕪×-𝕘d photon here to change its angle θ. This does not change its Pythagorean Triangle area, only the angle.

A force on a Pythagorean Triangle side

So a force on one Pythagorean Triangle side tends to make it contract or dilate, since the Pythagorean Triangle area cannot change this forces a change in the angle θ opposite the spin Pythagorean Triangle side. The ellipse is then described in this model as two kinds of forces interacting, a measurement of -𝕆D×e𝕪 kinetic work and an observation of the E𝕐/-𝕠d kinetic impulse.

Ellipses, work and waves

In this model the ellipse must describe the +𝕆D×e𝕒 potential work from the proton minus the -𝕆D×e𝕪 kinetic work from the electron. It is then a wave, if it was a particle then only straight-line forces would be observed. That means it could not also be in a smooth curve. However, because the E𝕐/-𝕠d kinetic impulse forces are canceled by the E𝔸/+𝕠d potential impulse forces of the proton the ellipse remains in this shape.

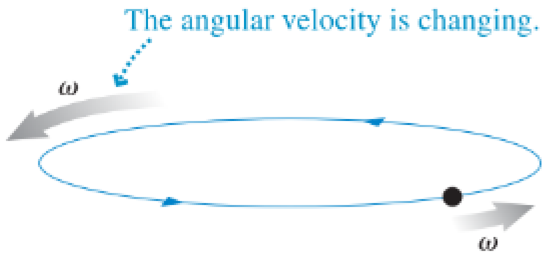
Ellipses are not measured in total

So if the electron is being measured then the +𝕆D×e𝕒 potential work of the proton, and the -𝕆D×e𝕪 kinetic work of the electron can describe an ellipse which is quantized. But the measurement is not of the whole ellipse, only of the +𝕆D potential probability and -𝕆D kinetic probability of where the electron is. This probability then does not give the whole ellipse because of uncertainty.

Ellipses are not observed in total

If the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse is being observed then the electron might break out of the elliptical orbital, for example it might collide with a e𝕪×-𝕘d photon acting as a particle with a e𝕐/-𝕘d light impulse. In this case also the whole ellipse is not being observed. This makes the ellipse itself uncertain.

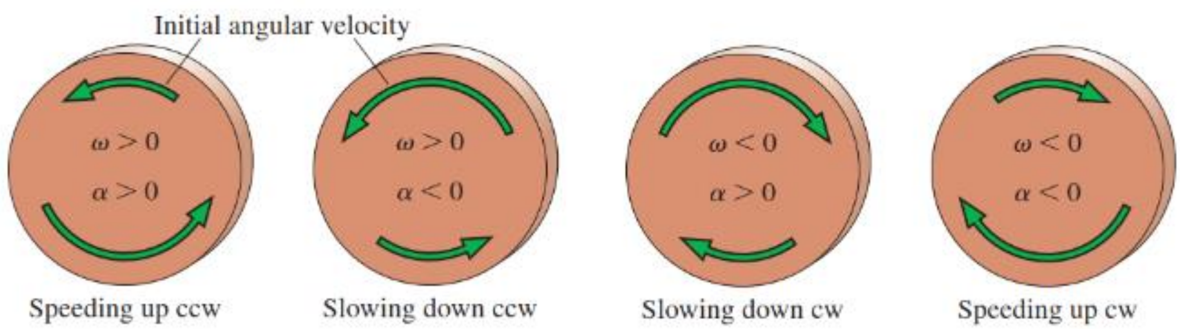
FIGURE 4.29 Circular motion with a changing angular velocity.



$$\alpha \equiv \frac{d\omega}{dt} \qquad \text{(angular acceleration)}$$

In this model using the positive and negative signs can be confusing, this is because +𝕠d as the potential magnetic field, -𝕠d as the kinetic magnetic field, +𝕚d as the gravitational field, and -𝕚d as the inertial field or mass are so often used. The cases below are classical approximations as in this model only Pythagorean Triangles are observed or measured.

FIGURE 4.30 The signs of angular velocity and acceleration. The rotation is speeding up if ω and α have the same sign, slowing down if they have opposite signs.



Denumerable measurements

In this model when a Pythagorean Triangle side remains a square root it can change continuously, when squared it becomes a rational integer that can be measured or observed. A e𝕪×-𝕘d photon emitted from a -𝕆D×e𝕪 kinetic work orbital then is quantized, the -𝕆D kinetic probability is a rational number that is denumerable. That means it can be measured as separate from other D values. A collision between two electrons might result in a change with their E𝕐/-𝕠d kinetic impulse, that can give a continuous spectrum of the e𝕪×-𝕘d photon frequencies. This is because -𝕠d changes of d give -𝕘d as the rotational frequency of the photon.

Discrete and continuous spectrums

An orbital then by its nature is a rotation, this means that work and probability comes from spin. The quantization leads to an emission or absorption of e𝕪×-𝕘d photons which changes the number of standing deBroglie waves in an orbital. Because a straight Pythagorean Triangle squared is not rotational it cannot give discrete orbitals and so the spectrum it gives is continuous.

Cantor and denumerable numbers

In this model a d or e value is not denumerable, as a square root it cannot be separated from other square roots larger or smaller than it. This comes from Cantor's discovery of transfinites, a list of irrational square roots would still have other square roots that are not on the list. This allows for the Pythagorean Triangles to not be measurable or observable without a force that makes them rational.

Rational versus irrational numbers

A constant angular acceleration would be an increasing +𝕆D potential or +𝕀D gravitational torque, each are classical approximations because being squared makes them rational numbers. Then they cannot vary continuously.

Exponential and log spirals

This can form an exponential spiral, the Eℍ/+𝕚d gravitational impulse if it continuous would have the Eℍ height increasing as a square while the time period remains constant. This exponential spiral is a consequence of the constant area, here of the +𝕚d and e𝕙 Pythagorean Triangle. If the wheel has its angular velocity ω increasing as a square, denoted by capitalizing this as Ω, then it forms a spiral. Conversely if the time period +𝕚d is squared as a +𝕀D gravitational torque and e𝕙 changes constantly this gives a logarithmic spiral. The two are the inverses of each other.

Rotational and linear kinematics

Rotational kinematics comes from the spin Pythagorean Triangle sides, here +𝕠d as the potential magnetic field and +𝕚d as the gravitational field. The linear kinematics as Pythagorean Triangle sides are the inverse of this and so it has the same equation form.

Associated Pythagorean Triangles

These are inversely correlated with another two Pythagorean Triangles, the +𝕠d and e𝕒 Pythagorean Triangle has the -𝕠d and e𝕪 Pythagorean Triangle or electron with its own rotational and linear kinematics. The +𝕚d and e𝕙 Pythagorean Triangle has its -𝕚d and e𝕧 Pythagorean Triangle with inertia, that also has its own rotational and linear kinematics.

Rotating wheel or satellite

This can be illustrated with the -𝕚d and e𝕧 Pythagorean Triangle using a rotating wheel or a satellite orbiting a planet. Here θ would be the spin orientation. To change this an inertial torque from -𝕀D×e𝕧 inertial work is needed, it is like a nut being turned by a wrench from a starting to a final orientation. The -𝕀D×e𝕧 inertial work as e𝕧/-𝕀D occurs for a -𝕚d time, this makes it the classical equivalent of a velocity e𝕧/-𝕚d.

Inertial torque and uncertainty

The inertial acceleration here can be written as e𝕧/-𝕀D in meters/second^2 as a classical approximation. After a number of -𝕚d seconds this leads to the change in orientation of θ. Classically this is equivalent to an angular velocity as e𝕧/-𝕚d between the starting and final orientation, the inertial torque -𝕀D would be from the wrench. In this model a force creates uncertainty, the -𝕀D×e𝕧 inertial work here has a -𝕀D inertial probability of where the final orientation is.

Replacing the Pythagorean Triangle sides

With linear kinematics in the first equation each term needs to be replaced by its other Pythagorean Triangle side. This because the final e𝕧 length which equals the starting e𝕧 length times the -𝕚d/E𝕍 inertial impulse times e𝕧 as a length. This is e$𝕧_f$=e$𝕧_I$ × -𝕚d/E𝕍 × e𝕧 where the last e𝕧 is a duration the inverse of -𝕚d time. The final position then comes from the initial position after it is accelerated by an impulse over a e𝕧 length. This also creates uncertainty.

A rolling wheel

Linear kinematics is straight-line motion, rotational kinematics in rotary motion. The wheel below might roll from an initial e𝕧 length to a final e𝕧 length, the inertial impulse starts it rolling and then this stops as the acceleration is removed. The wheel can be like the nut turned by the wrench, instead of it rotating the wrench makes it roll.

Acceleration creates uncertainty

In both cases the acceleration creates uncertainty, how long it takes to start with an E𝕍/-𝕚d inertial impulse and how far the acceleration goes for with the -𝕀D×e𝕧 inertial work. There is also the problem of deceleration in both cases, how long or how far this happens for with additional uncertainty.

Second equation

In the second equation the final orientation can again be like a nut turned by a wrench, it begins to spin by itself with an angular velocity, then it is accelerated again with -𝕀D×e𝕧 inertial work. With linear kinematics the wheel is rolled with an initial e𝕧 position to a final one, it has a constant e𝕧/-𝕚d velocity and then has an additional E𝕍/-𝕚d inertial impulse.

Converting to circular geometry

These can be converted to the +𝕚d and e𝕙 Pythagorean Triangle with gravity as the inverse, e𝕧 length becomes e𝕙 and the +𝕚d inertial mass becomes the +𝕚d gravitational mass as time. The first equation can then become an initial period of rotation of a satellite, it is accelerated with -𝕀D×e𝕧 or e𝕧/-𝕀D inertial work for a time -𝕚d to a higher orbit. There the -𝕚d period is dilated because the e𝕧/-𝕚d velocity is slower in higher orbits. This acceleration is then e𝕧/-𝕀D multiplied by a time -𝕚d to give a velocity e𝕧/-𝕚d.

Inverting the Pythagorean Triangle sides

This is inverted for the +𝕚d and e𝕙 Pythagorean Triangle, these equations would also apply to the -𝕠d and e𝕪 Pythagorean Triangle in relation to the -𝕚d and e𝕧 Pythagorean Triangle. Then this +𝕚d and e𝕙 Pythagorean Triangle example would also apply to the +𝕠d and e𝕒 Pythagorean Triangle.

Velocity becomes brevity

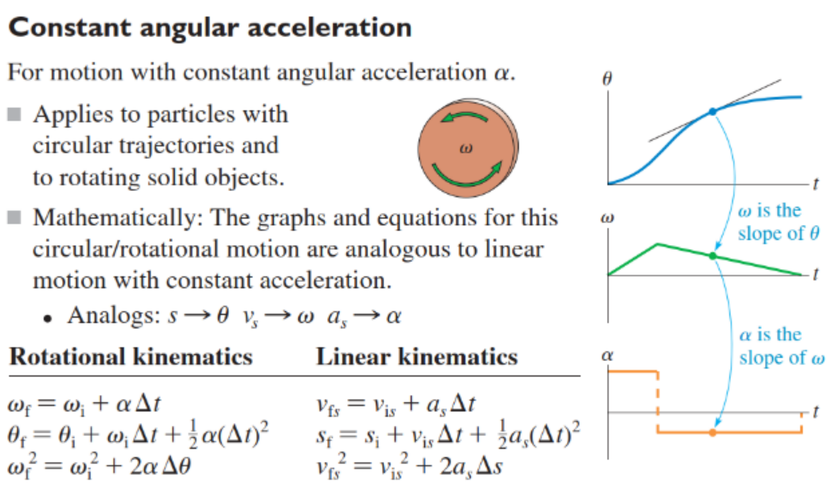
With rotational kinematics the orbital period -𝕚d$_f$ becomes its inverse as the +𝕚d$_f$ gravitational mass. This is also a component of the brevity e𝕙/+𝕚d, with a change there is a stronger or weaker gravitational attraction. The inverse of -𝕚d$_i$ then becomes +𝕚d$_i$ to which is added the acceleration downward as e𝕙/+𝕀D for a time +𝕚d. If the satellite then accelerates downward then its brevity decreases, because e𝕙 contracts and +𝕚d dilates in e𝕙/+𝕚d.

e𝕧 length becomes e𝕙 height

As linear kinematics this would have a final velocity having e𝕧$_f$, then initial velocity has e𝕧$_I$ to which is added an E𝕍/-𝕚d inertial impulse written as -𝕚d/E𝕍 times a e𝕧 length. That gives a change in velocity as -𝕚d/e𝕧 to the new length e𝕧. That gives e𝕙$_f$=e𝕙$_i$+e𝕙/+𝕀D × +𝕚d, the brevity changes from the acceleration so the e𝕙 height of the satellite also changes with its velocity. That e𝕧/-𝕚d has as its inverse the brevity e𝕙/+𝕚d, a lower orbit has a weaker brevity because e𝕙 is contracted and +𝕚d is dilated, there the satellite moves faster because e𝕧 is dilated and -𝕚d is contracted.

The second equation

This can again be a final -𝕚d period of rotation -𝕚d$_f$, this comes from adding an initial period -𝕚d$_i$ to a velocity e𝕧/-𝕚d for a e𝕧 length to give a change in -𝕚d, then an acceleration as e𝕧/-𝕀D for a time -𝕀D with the inverse of e𝕧 being -𝕚d. The inverse of this with the +𝕚d and e𝕙 Pythagorean Triangle gives +𝕚d$_f$=+𝕚d$_i$+e𝕙/+𝕚d × e𝕙 + (e𝕙/-𝕀D × -𝕀D =e𝕙 =1/+𝕚d)



Tangential acceleration

Here the tangential acceleration acts like -𝕆D×e𝕪 kinetic work, when written as e𝕪/-𝕆D this is proportional to e𝕧/-𝕀D in meters/second^2. This creates a kinetic torque, it causes a satellite for example to move in a log spiral outwards. As this kinetic torque increases the e𝕪 and proportionally e𝕧 length with the -𝕀D inertial torque contracts, without additional energy from outside this would show possible orbital velocities along the spiral.

Fibonacci and log spirals

In Biv space-time for example the planets fall approximately on a Fibonacci spiral which is an exponential or log spiral depending on the forces. Planets further out are slower, so this is a log curve. When this has a fixed e𝕙 radius in the diagram then the -𝕆D kinetic torque increases the e𝕧/-𝕚d velocity. This would also associate a spiral with the -𝕠d and e𝕪 Pythagorean Triangle electron orbitals, additional -𝕆D×e𝕪 kinetic work might be done by absorbing a e𝕪×-𝕘d photon. This causes the electron to spiral outward to a higher orbital, because this is a log spiral the integral area is wavelike. That means the electron changes from one quantized orbital to another as the absorbed e𝕪×-𝕘d photon creates a measurement.

Decaying to lower orbitals

It is also an exponential curve which describes how long before the electron decays downwards into a lower orbital. This is an exponential because it is observing the electron in a time -𝕠d. The log curve was measuring the outward motion of the electron to a change in e𝕒 altitude or e𝕙 height which is a position. When this happens can also be regarded as a log spiral as the inverse of the exponential, with a -𝕆D kinetic probability of the electron dropping a position amount e𝕪 to a lower orbital.

Inverse spirals

Because the exponential and log spirals are inverses of each other, it appears classically that the probability of an electron decay increases with a constant time period. This would be comparing a -𝕆D kinetic probability with a -𝕠d constant time scale which are the same Pythagorean Triangle sides.

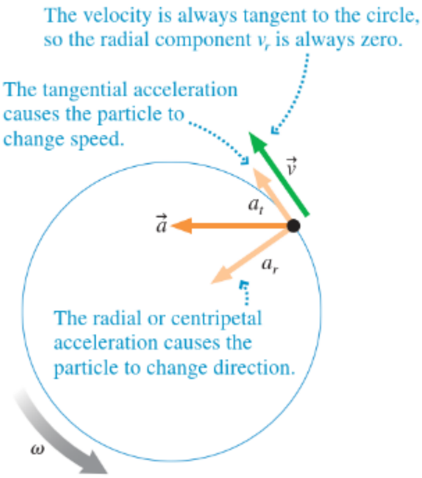
Chaotic or random orbital changes

The decay of an orbital could then be chaotic with a E𝕐/-𝕠d kinetic impulse, that would cause the emission of a e𝕪×-𝕘d photon which can move the electron back into a quantized orbital or into a chaotic one. For example a collision with another electron or a photon acting with a e𝕐/-𝕘d light impulse might cause the electron to act as a particle and decay. If the electron decays with a log curve as a -𝕆D kinetic probability then it would move downwards into a quantized orbital.

Spirals as approximations

These are classical approximations, in this model the Pythagorean Triangles change and do not depend on exponential or log curves, circles, etc. The uncertainty of measuring and observing them means one Pythagorean Triangle side is squared, that gives a classical approximation of exponentials, log curves, as well as π with circles and ellipses. While these curves do not describe the Pythagorean Triangles and their changes, over enough -𝕠d time and e𝕪 positions the law of large numbers makes them better classical approximations.

FIGURE 4.32 Acceleration in nonuniform circular motion.



Force and Motion

Subjectivity and objectivity

In this model the object is a particle, that makes the force impulse. The word impulse acts as a noun being an object, it is an objective observation. The word work acts as a verb, so it is not a work like an impulse, instead work is done and the word is subjective not objective. Because this subject is not observed the word measured is used, a subject is about knowledge but it is not clearly definable as a series of objects. In that sense it acts like a field, such as physics being a subject or field of study.

Force and Pythagorean Triangles

A force on a Pythagorean Triangle leads to a conflict when it has a constant area. This area acts like an integral field, the slope of the Pythagorean Triangle acts like a derivative. While the area remains constant the slope also is conserved because as it changes the Pythagorean Triangle sides in the numerator and denominator must change inversely. This is another conservation law in this model like the constant Pythagorean Triangle area, it relates to the straight Pythagorean Triangle sides while the constant area relates to the spin Pythagorean Triangle sides.

Two conservation laws

So if the numerator as the spin Pythagorean Triangle side for example doubles the denominator as the straight Pythagorean Triangle side must halve to preserve the Pythagorean Triangle area. This implies a constant Pythagorean Triangle area, but this conservation law does not need to refer to integrals as being more fundamental.

Derivatives and integrals

In conventional physics the straight Pythagorean Triangle side is the numerator, and the spin Pythagorean Triangle side is the denominator such as in meters/second. However, with derivatives this is usually in the denominator such as the slope being ∂-𝕚d/∂e𝕧 with respect to e𝕧. That would refer to seconds/meter which is not commonly used, but it is equivalent to meters/second as an inverse. In this model the derivative must be with respect to e𝕧 or the straight Pythagorean Triangle side, a slope does not refer to an integral area. This integral then must be ∫-𝕚d×e𝕧 with respect to -𝕚d. Either derivatives or integrals can be used as classical approximations, these distinctions become more important in relativity and quantum mechanics later.

The Pythagorean Theorem

As an example $3^2+4^2=5^2$, this can be drawn by squared areas on each Pythagorean Triangle side. The areas act as integral fields and so are associated with work, but the straight Pythagorean Triangle side such as in the -𝕚d and e𝕧 Pythagorean Triangle becomes an integral area or field which is not allowed in this model. Instead another Pythagorean Theorem is derived from difference related to derivatives.

1 4 9 16 25

3 5 7 9

2 2 2

Squares from differences

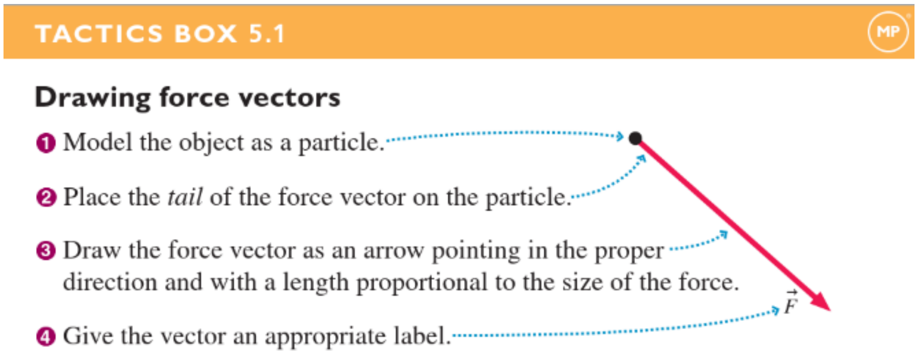
In this model the 9+16=25 is related to impulse here not work, there are no integral areas or fields used. Instead this comes from a change of slope, the first difference gives 3, 5, 7, 9, … and the second difference gives 2, 2, 2, … There is a difference here then between the squares and the first difference which are the integers.

Vector magnitude

The object as a particle is associated with a straight Pythagorean Triangle side not a spin Pythagorean Triangle side, E𝕍 for example would be the inertial length force. The magnitude of this vector can then be E𝕍 as a square. A straight Pythagorean Triangle side squared becomes longer, a spin Pythagorean Triangle side squared becomes an area or field. The differences in the magnitudes of these vectors then give the Pythagorean Theorem, the orientation of the vectors comes from a constant scale with the spin Pythagorean Triangle sides.

Adding and subtracting impulse

They can then show forces in a single direction, be added up or subtracted as vectors to give an overall straight Pythagorean Triangle side force such as the E𝕍 inertial length force. But the rotations and angles between them need not also be a force with this classical approximation.



Arrows of time

In this model time works differently when it is measured as work to where it is a scale in impulse. When the -𝕀D×e𝕧 inertial work is done for example the probability of where it is measured is -𝕀D. This is a square which relates to the -𝕆D kinetic probability used in quantum mechanics. A fraction of the time then an object might be measured on a e𝕧 position length scale in one position versus another. Probability is different from the more linear perception of time, often referred to as an arrow of time or a timeline.

Timelines and impulse

In this model the timeline comes from the observation of impulse such as the E𝕍/-𝕚d inertial impulse. Here the time scale changes in constant increments of d, this is not referred to as linear because it is from a spin Pythagorean Triangle side not a linear or straight-line. The term linear can be used for constant incremental changes of e in e𝕧 for example, there is also be a constant acceleration with E𝕍 where E is the square of a square root integer. This would be for example 1, $\sqrt{2}^2$, $\sqrt{3}^2$, ... With e𝕧 where e is changing as 1, √2, √3, ... this is referred to as constant because there is no force changing e.

Not denumerable

That is because d and e here are not denumerable as separate number, the square roots cannot be listed as Cantor showed. Another example is with a Dedekind Cut where a cut in a line with a square root value has a value with an infinite number of decimals in it.

Impulse and time

With impulse in this model time acts as a scale not a force, because of this it has some unusual effects in the double split and quantum eraser experiments. If e𝕪×-𝕘d photons go through a double slit then they might form interference fringes on a screen. This comes from the -𝔾D×e𝕪 light work the e𝕪×-𝕘d photons are doing, there is a probability -𝔾D as to which slit they went through.

Measuring photons and interference

That is because which path the photons took is not being measured, instead the time the photons hit the screen is being measured. Because of this the photons can form an interference pattern even when going through at long intervals. There is no impulse being observed because no positions are being squared as forces. There then is only work and probability otherwise the e𝕪×-𝕘d photons would not be observed or measured at all.

Which path is an observation

When it is attempted to observe which slit the photon goes through then the time is not also being measured except as a scale, then the photons are being observed according to a straight Pythagorean Triangle side such as a e𝕧 length. The observation then cannot be of both a e𝕧 length and a -𝕚d time, so when they are observed as impulse the photons act as particles and no longer give an interference pattern.

Quantum eraser

This also acts like a quantum eraser because the timeline as -𝕚d, or e𝕪 in the case of e𝕪×-𝕘d photons, is not being measured itself. It cannot then act as a probability, the observations of the e𝕐/-𝕘d light impulse as photon particles must be deterministic. The timeline must be consistent with this and so it appears as if the photons knew whether they were going to be observed or not and changed into particles.

A vanishing position

In this model it is like deciding to observe which slit the photons go through. By looking at one slit the distance between them is no long as scale and it also seems to vanish. It seems as if this e𝕧 length knew we were going to look only at one slit with a position between them, then this position vanished.

Delayed choice

Whenever the decisions are made to observe which path the e𝕐/-𝕘d light impulse photon particles took then, the timeline must be consistent with the motion of particles and not waves with interference patterns. They cannot then act as if they took two paths and then interfered with each other like waves. If they did they would be doing -𝔾D×e𝕪 light work and then the probabilities are being measured not the path. It is then not possible to observe which path and still have a probability because this has become a certainty.

Photons are from a change

A photon in this model is a e𝕪×-𝕘d Pythagorean Triangle as the difference between two orbitals of an electron, it can also come from a change in motion of an electron acting as a particle. This can then be the difference between an electron, acting as a particle with a E𝕐/-𝕠d kinetic impulse, or acting as a wave doing -𝕆D×e𝕪 kinetic work.

Photons have no force

While the photon exists it has no force, it is a record of either work or impulse, the time it takes even from a distant star is deterministic. Also, the position from that star is also deterministic, the photon rotates with a frequency -𝕘d and a wavelength e𝕧 proportional to e𝕪. This counts off an exact number between where it was emitted and where it is absorbed. This count is conserved, if not then there would not be consistent positions and times between stars.

The photon source does not change the force

If photons from a distant star then go through a double slit experiment, they act the same as if they were from a light source near the apparatus. The double slit can even be done by gravitational lensing with the photons bending around a galaxy as Wheeler found.

Determining the photon path

When the e𝕐/-𝕘d light impulse is observed this determines which path the e𝕪×-𝕘d photon took, whether it is which slit or which way around a galaxy. Both Pythagorean Triangle sides cannot be observed and measured in the same position and time, it must be one or the other for the photon. Because of this it must be observed as a particle and so cannot form an interference pattern. If it did form a probability wave with -𝔾D×e𝕪 light work, then it must be a probability not a certainty which slit it went through. More will be discussed on this in the sections of quantum mechanics and cosmology.

Diagrams as impulse for vectors

For these forces to be impulse they would have to change over time not a position. The diagrams are implying the position is the scale. In the first diagram the rope puller would exert an E𝕐/-𝕠d kinetic impulse, the magnitude would be E𝕐. Against his impulse there would be an E𝕍/-𝕚d inertial impulse where the box reacts against being moved with an equal and opposite impulse. The rope would exert a reactive E𝔸/+𝕠d potential impulse where its orbitals are being pulled apart, it would be reacting against the e𝕒 altitude of the electrons above the protons being increased. There is also a Eℍ/+𝕚d gravitational impulse where the weight of the block increases the friction making it harder to move.

Work and impulse together

As a classical approximation these are all described as impulse, there would also be -𝕆D×e𝕪 kinetic work, -𝕀D×e𝕧 inertial work, +𝕆D×e𝕒 potential work, and +𝕀D×e𝕙 gravitational work being done as well. This would then be observed with all four Pythagorean Triangles as well as being measured.

Central Pythagorean Triangles

The four central Pythagorean Triangles would give the changes, the motions of the electrons would be measured by -𝔾D×e𝕪 light work and observed by e𝕐/-𝕘d light impulse from e𝕪×-𝕘d photons. There would also be Gravis as +𝕘d×e𝕓 where the +𝔾De𝕓 Gravi work as gravity waves and a +𝕘de𝔹 Gravi impulse like a graviton is being produced.

Second diagram

The second diagram would have a stored E𝕐/-𝕠d kinetic impulse from then the spring was compressed, this has a reactive E𝔸/+𝕠d potential impulse where the protons react against the deformation of the electron orbitals. The box would react against this motion with an E𝕍/-𝕚d inertial impulse and the friction would depend on the Eℍ/+𝕚d gravitational impulse downwards. The wall connection would also have a E𝔸/+𝕠d potential impulse against the spring coming loose, it would also react against this motion with an E𝕍/-𝕚d inertial impulse.

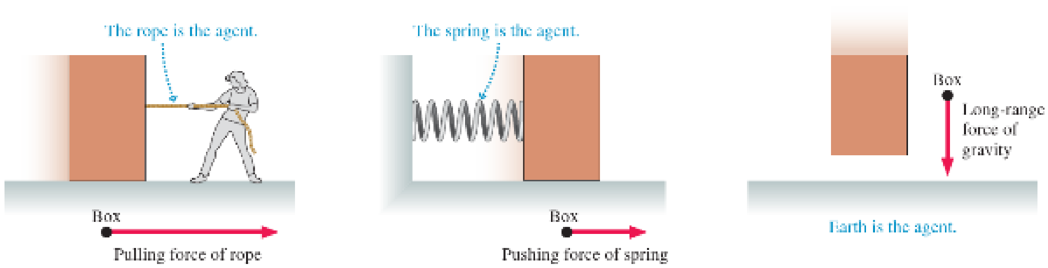
The third diagram

The gravitational attraction here would also be observed with a scale of +𝕚d time, that would make it a Eℍ/+𝕚d gravitational impulse. Against this there would be an E𝕍/-𝕚d inertial impulse reacting against the downward acceleration.

Agents

In each case the agent is described as the magnitude of the vector so this is the squared Pythagorean Triangle side. In Aperiomics the word agent is sometimes used to describe the work done, that would be the +𝕀D×eℍ gravitational work in the third diagram for example. It depends whether the agent can be observed as an object such as the stretching of the rope with a E𝕐/-𝕠d kinetic impulse against a E𝔸/+𝕠d potential impulse. If the agent is a subject and not observed, but measured, then it might be considered to be from a field. In this model the words and symbols from the straight and spin Pythagorean Triangle sides are kept separate where possible to avoid ambiguity.

FIGURE 5.1 Three examples of forces and their vector representations.



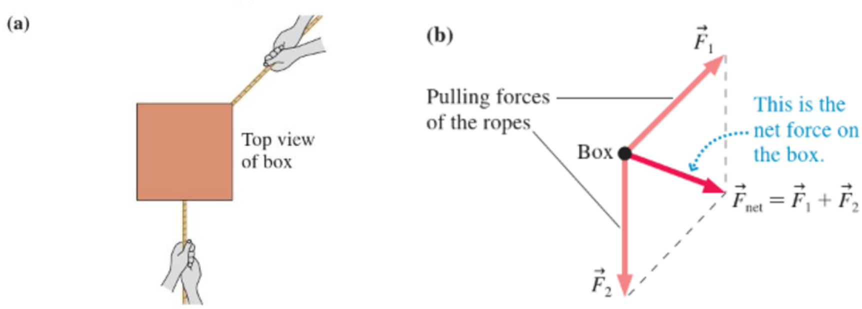
Adding vectors

Here two forces are applied to a box, if the scale as a position such as with the -𝕚d and e𝕧 Pythagorean Triangle, then this might be -𝕀D×e𝕧 inertial work. Because vectors are being used this would be the E𝕍/-𝕚d inertial impulse. With work the squared force would be represented by an integral, for example a square on the side of the -𝕚d and e𝕧 Pythagorean Triangle. The angle between the forces would be from the spin Pythagorean Triangles sides as -𝕚d, this would also be proportional to the velocity the box moved from each force with respect to time.

Time as a derivative

That would be a classical approximation because time acts as part of a derivative slope in this model, it can also be proportional to the inertial mass of the box. The angle of the forces then would cause the box to move with a -𝕚d×e𝕧 inertial momentum where -𝕚d is proportional to the time in the velocity. So if the inertial momentum was larger in one direction then the velocity would be slower with e𝕧/-𝕚d having -𝕚d in the denominator.

FIGURE 5.2 Two forces applied to a box.



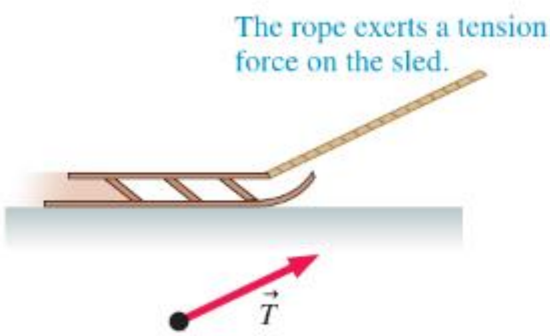
Tension

A tension force can be reactive, the active force is not strong enough to overcome it. An example would be the +𝕠d and e𝕒 Pythagorean Triangles as protons, they maintain molecular bonds in the rope preventing it from breaking. They also have these bonds with the ground under the sled, they react against an active force from the -𝕠d and e𝕪 Pythagorean Triangles pulling the sled. A person then might eat food, that creates chemical energy as a E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work in muscles to pull the sled.

Gravity and inertia

It can also have the rope connected to a weight hanging off a cliff, then the active forces are Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work. Against this there is an E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work against the sled moving. Even if the Eℍ/+𝕚d gravitational impulse causes the sled to move, the tension would be maintained by this E𝕍/-𝕚d inertial impulse reacting against a continuing acceleration.

FIGURE 5.5 Tension.



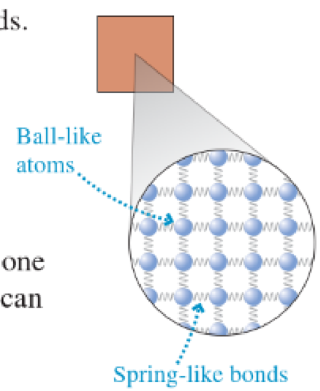
A spring mattress

In this model the balls act like the +𝕠d and e𝕒 Pythagorean Triangles as protons, the springs are the reactive forces from the protons holding the molecular bonds together. The spring then reacts against a change, such as if -𝕆D×e𝕪 or a E𝕐/-𝕠d kinetic impulse distorts the shape like pulling a rope. The springs restore the original shape when the active force is released, a spring mattress can act like this when a weight is put on it. Then there is a Eℍ/+𝕚d gravitational impulse downward which the springs react against.

Ball-and-spring model of solids

Solids consist of atoms held together by molecular bonds.

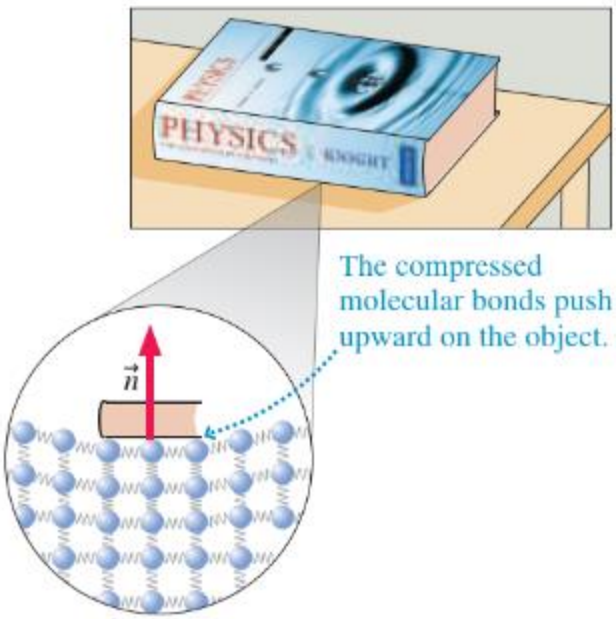
- Represent the solid as **an array of balls connected by springs.**
- Pulling on or pushing on a solid causes the bonds to be stretched or compressed. **Stretched or compressed bonds exert spring forces.**
- There are an immense number of bonds. The force of one bond is very tiny, but the combined force of all bonds can be very large.
- Limitations: Model fails for liquids and gases.



The normal force

The normal force comes from the +𝕠d and e𝕒 Pythagorean Triangles in this model, the springs are like the +𝕆D×e𝕒 potential work of holding electrons in quantized orbitals. There is also a E𝔸/+𝕠d potential impulse where the e𝕒 altitude of electrons above the protons is maintained. The +𝕆D×e𝕒 potential work acts with probability so there is an average e𝕒 altitude proportional to a e𝕙 height. The E𝔸/+𝕠d potential impulse does not work with probability so there is not average for the springs to return to, the motion is chaotic but the conservation of energy means the springs regain their shapes.

FIGURE 5.6 The table exerts an upward force on the book.



Friction is randomizing

In this model friction is a randomizing process, this comes from work. The spin Pythagorean Triangle sides in an exponent can be squared as a measurement. When a spin Pythagorean Triangle side is squared as a measurement it can be represented in an exponent, for example $e^{\mathbb{v}-\mathbb{I}D}$ where the different values of D give the Gaussian integral or normal curve. As these -𝕀D values increase then e𝕧 here would contract to give a constant Pythagorean Triangle area, the relationship between the square -𝕀D and the constant scale of e𝕧 gives a logarithmic or exponential decay curve.

Exponential decay

Friction then occurs with random forces as torque in -𝕆D×e𝕪 kinetic work turns the atoms and the molecular bonds away from the sled's straight-line motion. Without a continuing impulse the sled will slow with this exponential decay curve. In this model the logarithmic curve would be best used as this comes from the integral area under a hyperbolic curve, the electrons as -𝕠d and e𝕪 Pythagorean Triangles are in hyperbolic geometry.

Quantization and randomness

Work then can dissipate a E𝕐/-𝕠d kinetic impulse such as a sled being pulled or gravity as a Eℍ/+𝕚d gravitational impulse pulling a frog downwards as in the diagram. When there are quantized orbitals in atoms, and molecular bonds, then breaking these requires e𝕪×-𝕘d photons to be emitted and absorbed. As this happens the kinetic energy is progressively lost through this randomizing process.

Reacting against randomizing

The potential entropy of the proton bonds, from the +𝕠d and e𝕒 Pythagorean Triangles, reduce this randomizing process. For example the sled can be eroded while being pulled along, this would be an increase in kinetic entropy. But the protons tend to hold onto the electrons and other molecular bonds, this is a potential entropy reacting against this randomization.

Two kinds of randomness

A random process can scatter molecules in a gas evenly, this is an increase in entropy from the -𝕆D×e𝕪 kinetic work done in a gas. It comes from the Boltzmann distribution which is a Gaussian integral or normal curve. The opposite random process to scattering is in returning to the mean. A solid might encounter an erosional process from -𝕆D×e𝕪 kinetic work, it reacts against this with +𝕆D×e𝕒 potential work maintaining the molecular bonds.

Normal curve spread

A normal curve has spin which can cause the Gaussian integral to spread out more or to become narrower. This is modeled by the squares in the exponent, they can be multiplied or divided by a number to do this. Also the -𝕆D squares in the exponent give a wider normal curve as a kind of scattering, when +𝕆D is added to this then the overall values are reduced causing the normal curve to become narrower.

Wave function

When a particle such as an electron is modeled as a wave function this is a Gaussian, it tends to spread out over time. This is because the -𝕆D exponent values increase, the electron has an increasing kinetic probability for being found in a widening area. Conversely with the electron being captured by a proton this probability narrows, it has a higher potential probability of being found near the proton. This narrowing of the wave function acts as a potential entropy or decrease in the spread of the randomization.

Back and forwards in time

These are opposing processes, in this model they act like going forward and backwards in time. In conventional physics for example an electron can be modeled as going forward in time as -𝕠d, a positron can be modeled as the electron going backwards in time as +𝕠d. The -𝕠d and e𝕪 Pythagorean Triangle as the electron and the -𝕚d and e𝕧 Pythagorean Triangle as inertia appear to move forward in time with this randomizing process. This is widening these Gaussian wave functions as the time increases as -𝕠d.

Observing a particle over time

This is where the particle is being observed, its E𝕐/-𝕠d kinetic impulse for example has a timeline with constant increments as -𝕠d. This observation creates a widening of the -𝕆D Gaussian integral in the -𝕆D×e𝕪 kinetic work or wave function of the electron. This is because the increase in time is connected to the square of this time as -𝕆D where the wave function probability is increasing as a square.

A particle to a spreading wave

By observing the particle at a narrow position E𝕐 then this is over an increasing time in the E𝕐/-𝕠d kinetic impulse. This increasing time when measured as a wave function is the -𝕆D×e𝕪 kinetic work, so -𝕆D is also increasing as the wave spread out. Making the particle be confined to a small e𝕪 position then leads to it spreading out with this kinetic entropy or kinetic probability.

A Gaussian around the electron

This -𝕆D×e𝕪 kinetic work extends around the -𝕠d and e𝕪 Pythagorean Triangle that was observed as a particle, further out as e𝕪 or proportionally e𝕧 from it the -𝕆D kinetic probability decreases as a square. This means the Gaussian of the electron is still centered around where the particle was with some uncertainty from the observation and measurement.

Pilot waves

In Bohm's pilot wave theory this would be analogous to a particle disturbing space around it creating a pilot wave. In this model the E𝕐/-𝕠d kinetic impulse observing the electron particle is separate from the -𝕆D×e𝕪 kinetic work measuring the wave. These cannot be in the same position and moment because then the two Pythagorean Triangle sides would both be squared together. That would mean the Pythagorean Triangle area was no longer constant.

Probabilities as now

The -𝕆D×e𝕪 kinetic work done by the electron gives a kinetic probability of where it is, this is not a deterministic timeline from a past to a future. Instead in this model it acts as a perception of now which is measurable, the past and future on timelines are not measurable because they are not squared as forces. They are then not accessible in this model.

Here and now

The E𝕐/-𝕠d kinetic impulse creates particles as electrons, this acts to create positions from the -𝕠d and e𝕪 Pythagorean Triangles giving an observation of here. There is also a position in between these observations but that is a constant scale in between these uncertain positions. With the -𝕆D×e𝕪 kinetic work giving a measurement of probability this gives a consciousness of a here and now. The proton with its +𝕠d and e𝕒 Pythagorean Triangle also has a here with its E𝔸/+𝕠d potential impulse and a now with its +𝕆D×e𝕒 potential work.

Expanding and contracting

These positions as here can expand and contract, the probabilities as now can also expand and contract. An example is an observation of stars, their impulse over time might show a scattering with the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse such as with a supernova. This is a kinetic and inertial entropy that increases.

Forming stars

This can go in the opposite direction of time with a potential entropy and gravitational entropy. This is where new stars coalesce from dust to a higher probability density and a smaller size. Their here and now which is observed and measured becomes more concentrated, with the kinetic entropy as -𝕆D and inertial entropy as -𝕀D this became more scattered. The increase in kinetic energy then increases this scattering effect with heat, the decrease in energy comes as the stars form because energy can be lost as e𝕪×-𝕘d photons.

Reversal is not deterministic

This is not the same as going back in time though it is partially like reversing a movie. That is because there is still a randomizing going on with potential and gravitational entropy.

Entropy as microstates

An increasing entropy also increases the number of states that particles can be observed in, with this model that would be impulse while entropy is work. It is related to the density of states in atoms, these are all the possible orbitals electrons can be in. With increased energy the electrons move into higher orbitals with more possible microstates, this is similar to a scattering or widening of the Gaussian.

Reducing entropy

Friction then reduces the number of states or destinations the sled or frog can go to. This comes from the potential entropy of the molecular bonds preventing these different states, also from the gravitational entropy. This is where the heaviness of the sled and the frog make the friction stronger.

Spin and the Gaussian integral

The negative -𝕆D kinetic probabilities in the exponent give an increased number of states, this is like widening and flattening a normal curve. Gas molecules for example can become more spread out with a wider Gaussian integral as they bounce more off each other. This increases the rotation of the gas molecules in the collisions making them go in different directions increasing disorder.

Entropy versus impulse

For example, gas released into a tank with a vacuum would spread out randomly with this kinetic and inertial entropy. This would be the opposite of a E𝕐/-𝕠d kinetic impulse where the gas might be moved in a straight-line direction such as through a pipe. This impulse is decreasing randomness because the -𝕠d and e𝕪 Pythagorean Triangles for example have a constant area.

Impulse decreases randomness

As the air is directed through a pipe with an impulse then the e𝕧/-𝕚d velocity increases and -𝕚d contracts. This means the -𝕀D×e𝕧 inertial work and inertial entropy is also decreasing. This is not the same as adding +𝕀D gravitational entropy to it as that is changing the width of the normal curve, impulse is replacing the entropy with chaos.

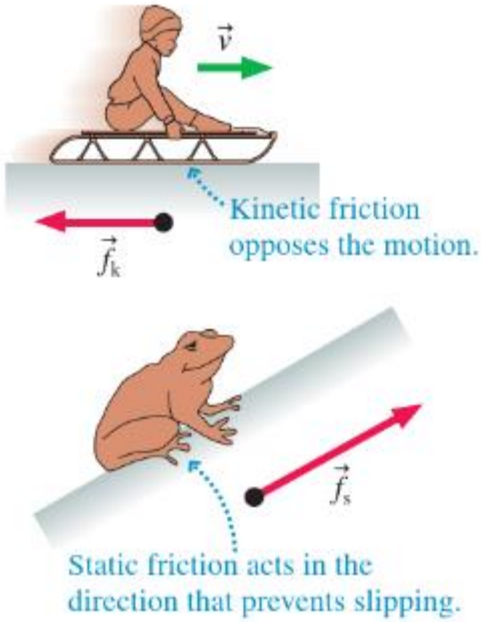
Cooling and order

If the gas was cooled this -𝕆D kinetic torque from the molecules colliding would decrease, it can become a liquid or solid as the molecular bonds reduce their number of possible states with the potential and gravitational entropy increasing. The normal curve becomes narrow and taller, there is more of an average motion such as a vibration of molecules rather than a scattering in a gas.

Coalescing versus scattering

The +𝕆D potential probabilities of where the molecules are is increased, they are denser closer together and have a lower -𝕆D kinetic probability of scattering or eroding. The potential entropy has increased, proportionally the +𝕀D gravitational entropy has also increased.

FIGURE 5.8 Kinetic and static friction.



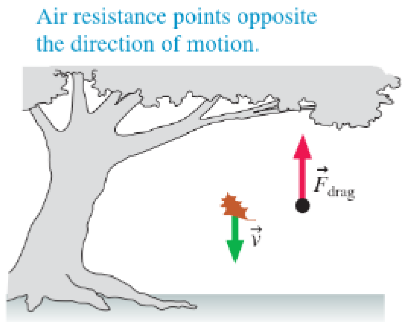
Gravitational entropy

With air resistance the gravitational entropy is increasing, instead of the leaves scattering in the wind with a higher kinetic entropy and inertial entropy, they fall into a more concentrated randomness with the +𝕀D×e𝕙 gravitational work. This would lead to a pile of leaves under the tree for example. These entropy changes are not described as vectors in this model because they would then be impulse from straight Pythagorean Triangle sides. Instead work is a field, this would be represented by different sized areas.

Potential entropy

There is also impulse being observed while work is being measured, in classical physics the uncertainty is harder to determine. The vectors then from the Eℍ/+𝕚d gravitational impulse point downwards, the drag against this would come from the +𝕆D×e𝕒 potential work as the protons react against the air molecules being displaced by the falling leaves. The air also does -𝕀D×e𝕧 inertial work, this randomizes the downward motion of the leaves.

FIGURE 5.9 Air resistance is an example of drag.



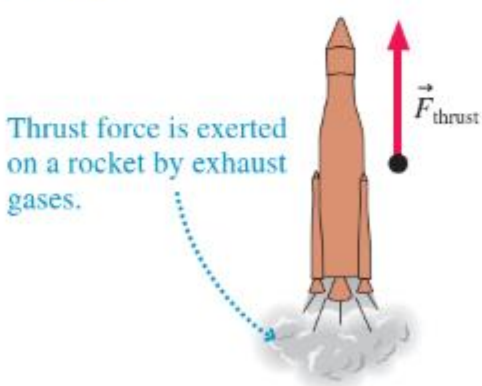
Observing impulse

Here there in an E𝕍/-𝕚d inertial impulse as the gases are expelled below the rocket with an equal and opposite reaction. The E𝕐/-𝕠d kinetic impulse is where the fuel is burned by breaking up molecular bonds releasing energy, this is reacted against with the E𝔸/+𝕠d potential impulse of the protons. The Eℍ/+𝕚d gravitational impulse pulls the rocket downwards against this E𝕐/-𝕠d kinetic impulse.

Measuring work

This can also be described in terms of work and entropy. The burning of the fuel scatters the molecules in an increasing randomness or -𝕆D kinetic entropy, this also happens with inertial entropy or -𝕀D as the gases are expelled from the rocket. The gravitational entropy as +𝕀D pulls the rocket downwards, this is against the fuel trying to move the rocket to different states or destinations. The potential entropy as +𝕆D reduces the scattering of the burning fuel by trying to hold together its molecular bonds.

FIGURE 5.10 Thrust force on a rocket.



Classifying forces

In conventional physics work and impulse are both described as vectors, in this model that is a classical approximation. A straight-line force generally comes from squaring a straight Pythagorean

Triangle side. It is also related to a position or concentrated area. A spin Pythagorean Triangle side also acts as a force when squared, this can appear as a mass or a magnetic field attraction or repulsion. The forces below were already described in the previous diagrams. If the forces acts over a position then this is work, if it acts over time it is impulse. A gravitational force can then be +𝕀D×e𝕙 gravitational work or a Eℍ/+𝕚d gravitational impulse depending on whether it is measured or observed.

Springs and drag

A spring might move with +𝕆D×e𝕒 potential work or a E𝔸/+𝕠d potential impulse. It reacts against being deformed by oscillating over a position as work or over a time period as impulse. Drag is generally reactive, this can be an E𝕍/-𝕚d inertial impulse or -𝕀D×e𝕧 inertial work for example. A falling leaf can be slowed by having to displace the air under it, this can be observed in a time as impulse or over a position as work.

Force	Notation
General force	$\vec{F}$
Gravitational force	$\vec{F}_G$
Spring force	$\vec{F}_{Sp}$
Tension	$\vec{T}$
Normal force	$\vec{n}$
Static friction	$\vec{f}_s$
Kinetic friction	$\vec{f}_k$
Drag	$\vec{F}_{drag}$
Thrust	$\vec{F}_{thrust}$

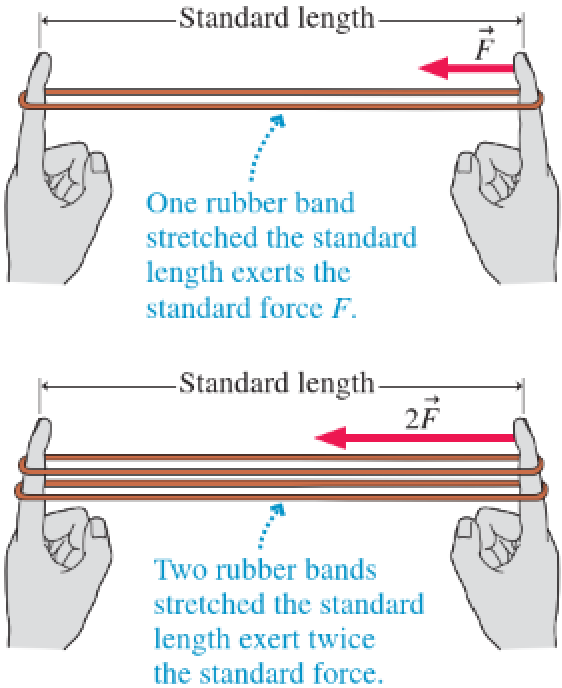
Work from position

The force reacting against stretching the rubber band would be +𝕆D×e𝕒 potential work, this is measuring the increase in states from the kinetic entropy increasing. So the rubber band can grow to different sizes from -𝕆D×e𝕪 kinetic work being done. It can also be observed as a E𝕐/-𝕠d kinetic impulse by how faster the rubber band is stretched, the band would snap back as a E𝔸/+𝕠d potential impulse reaction when released in a time +𝕠d.

Vectors and areas

The impulse would be represented by a vector, the work by an area. This might be in a graph where the integral area is under it, as the -𝕆D kinetic probability stretching the band and the +𝕆D potential probability reacting against this. For example the hands moving apart with the band on top would enclose an integral area.

FIGURE 5.14 A reproducible force.



Acceleration as a slope or area

The acceleration of the block can be regarded as the slope of a Pythagorean Triangle below, it can also be regarded as the integral area. With inertia and the -ⅆd and eⅴ Pythagorean Triangle this can be a -ⅅD and eⅴ Pythagorean Triangle where the spin Pythagorean Triangle side is squared. In this model that would have a square area on its side as the integral. This would apply to a single rubber band initially, the acceleration would be as seconds^2 or -ⅅD and the horizontal axis would be eⅴ meters.

Adding rubber bands

Adding more rubber bands has the same slope and would increase the area of the Pythagorean Triangle as it extends to the right. The area of the Pythagorean Triangle where the squares are equally spaced would be a double integral with respect to -ⅆd, the area of the Pythagorean Triangle would be ½×-ⅅD×eⅴ.

E𝕍 as a vector

In terms of impulse this would be a E𝕍 and -ⅆd Pythagorean Triangle where the straight Pythagorean Triangle side is squared as a vector. Its length eⅴ then is longer as e increases. The slope of the Pythagorean Triangle would be increasing with this acceleration giving a parabolic curve. If the vertical axis is drawn as squares with an equal spacing, as in the diagram, then the slope remains constant. This would be a second derivative with respect to eⅴ to give the E𝕍/-ⅆd inertial impulse.

Force and the Pythagorean Triangle area

With the E𝕍 and -𝕚d Pythagorean Triangle increasing E as e^2 will cause d to contract, but this cannot maintain the constant Pythagorean Triangle area. That only happens with the -𝕚d and e𝕧 Pythagorean Triangle where both sides are not squared as forces. This is resolved by the Pythagorean Triangles emitting or absorbing the difference between this as one of the four central Pythagorean Triangles. These can be e𝕪×-𝕘d photons for example.

Emitting forces

When a Pythagorean Triangle has an active or reactive force this is a squared Pythagorean Triangle side. It is incompatible with the constant Pythagorean Triangle area so in effect this square is expelled from it. This change is a Pythagorean Triangle itself, this can be a e𝕪 and -𝕘d Pythagorean Triangle as a photon for example. This is a record of how the -𝕠d and e𝕪 Pythagorean Triangle as the electron for example changed. It might have dropped its -𝕠d kinetic magnetic field by 1 and so -𝕘d in the photon is 1. To maintain the constant Pythagorean Triangle area e𝕪 would increase by 1 and so e𝕪 in the photon would have a value of it.

Absorbing forces

This e𝕪 and -𝕘d Pythagorean Triangle as a photon then might encounter another electron in an atom, if it does -𝔾D×e𝕪 light work then the -𝕠d kinetic magnetic field might go up 1 and the e𝕪 kinetic electric chargegoes down 1. So the photon sent a change from one electron to the other, but the -𝕠d and e𝕪 Pythagorean Triangles as electrons did not change their areas. Instead, the Pythagorean Triangle side values changed proportionally.

Collision forces

A similar process happens if the electron collides with a photon acting with a e𝕐/-𝕘d light impulse as a particle. It might increase the e𝕪 Pythagorean Triangle side by 1 which causes the -𝕠d Pythagorean Triangle side to decrease by 1 to maintain a constant Pythagorean Triangle area. In each case the change is in θ, the angle opposite the spin Pythagorean Triangle side not the area.

One side acts or reacts to a force

If a force is exerted on an electron, whether this is -𝔾D×e𝕪 light work or a e𝕐/-𝕘d light impulse from a photon, then the squared Pythagorean Triangle side is the one that causes the change. So -𝔾D×e𝕪 light work would cause the photon to be absorbed, that would do -𝕆D×e𝕪 kinetic work on the electron. This would change its -𝕠d kinetic magnetic field with a force -𝕆D where d is usually 1. If the photon collided with the electron, then the e𝕐/-𝕘d light impulse would have E𝕐 exert a force on the e𝕪 Pythagorean Triangle side making it increase by 1.

Inertia reacts against the photon

When a e𝕪×-𝕘d photon is absorbed by an electron as -𝕆D×e𝕪 kinetic work, the -𝕚d and e𝕧 Pythagorean Triangle would have an equal and opposite reaction to this as -𝕀D×e𝕧 inertial work. The +𝔾D value as a force is expended by making the -𝕚d Pythagorean Triangle side move by an amount d. The force +𝔾D has D as the square of d, it makes d in -𝕠d change by that amount.

An orbital change of 1

Often this D value is 1, the force causes the electron to move up one orbital so that its -𝕚d inertial mass increases by 1 and its -𝕠d kinetic magnetic field increases by 1. This is observed as a quantized amount of h as -𝕠d ×e𝕐/-𝕠d, d increased by 1 and e𝕪 decreased by 1. The Pythagorean Triangle area remains constant so just the angle θ has changed.

Planck's constant and h

Because this is change by constant increments of Pythagorean Triangle sides then the orbitals are quantized with regular intervals called h in quantum mechanics. The -𝕠d ×e𝕐/-𝕠d value represents the E𝕐/-𝕠d kinetic impulse as part of it, the additional -𝕠d factor is for dimensional analysis to make this compatible with conventional physics. This can also be imagined as -𝕠d×e𝕪/-𝕠d as the kinetic momentum of the electron, when observed it shows a change h where e𝕪 becomes the observable force in -𝕠d ×e𝕐/-𝕠d.

Observing the wave

In classical physics there is no difference between an observation of impulse and a measurement of work because they can occur at the same time and position. In quantum mechanics this is called the position and momentum commuting, that one can convert to the other with no uncertainty. In this model an absorption of a e𝕪×-𝕘d photon occurs as work, however electrons are not observable as waves. Instead they refer to this as a wave function, it is calculated from observing the impulse of electrons and working out this wave aspect.

Torque versus velocity

With -𝔾D×e𝕪 light work the electron might experience a -𝕀D inertial torque like a wrench turning a nut. This causes the electron to spiral up one or more orbitals, the same motion happens with a rocket as it accelerates with a torque to spiral to a higher orbit. A collision of the electron with a e𝕐/-𝕘d light impulse is not torque, it pushes the electron in a straight-line. The electron then might emit a photon after this collision but this would not be quantized, impulse then gives a different continuous spectrum while work gives a discrete or quantized spectrum. The effects of work and impulse are then very different in quantum mechanics, they can appear equivalent as a classical approximation.

Kinetic energy and mass

Its -𝕚d inertial mass does not change like from the -𝔾D×e𝕪 light work, instead its kinetic energy changed because it might move more chaotically in an elliptical orbit for example. The photon then can change the -𝕚d inertial mass or it can with its e𝕐/-𝕘d light impulse change the energy of the electron with E𝕐 as the kinetic electric force.

Conservation of matter and energy

When work and impulse are taken as being simultaneous, and in the same position, then there is no difference between changing the energy or the mass. This is equivalent to a conservation of matter and energy in classical physics, the -𝕀D×e𝕧 inertial work is proportional to the inertial mass which is matter. The E𝕍/-𝕚d inertial impulse is proportional to the kinetic energy the inertia reacts against according to Newton's first law of motion.

Commutation

The two Pythagorean Triangle sides such as e𝕧 and -𝕚d would commute with Poisson brackets, in quantum mechanics this would be equivalent to the Pythagorean Triangles having a zero area. This becomes important in quantum mechanics as one of the differences between it and classical physics.

Energy and mass equivalence

With Einstein came the conversion of mass to energy and vice versa, in this model that happens when the -𝕀D×e𝕧 inertial work for example as mass might come from absorbing a photon which increases its inertial mass. But it also might collide with a photon acting as a particle with a e𝕐/-𝕘d light impulse. That causes the electron to be observed as a particle with this change.

Energy and mass are orthogonal

This is not a change in its -𝕚d inertial mass but its E𝕍 length force. The electron then would be accelerated by this collision as a particle, it would not change as a wave in an orbital. This acceleration is equivalent to a change in energy with this model, the absorbing a photon is equivalent to a change in inertial mass. This would be a change of energy into mass or vice versa depending on whether there was an impulse observed or work measured.

Rest mass

In this model there is no rest mass, there is only the mass that is measurable. The -𝕚d inertial mass then increases in an electron with higher orbitals, it does not have a separate rest mass because the time of the orbital revolution is equivalent to the inertial mass. The proton also does not have a fixed +𝕚d gravitational mass, only the mass which is measured with +𝕀D×e𝕙 gravitational work at different heights e𝕙 above it. Because of this a mass energy equivalence is directly derived from the separate measurements of work and observations of impulse.

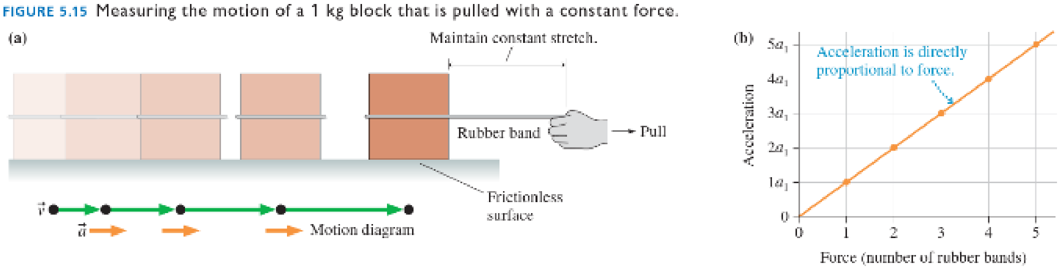
Rest mass estimates

From these measurements a rest mass for the proton and electron can be estimated classically. In this model that would be a limit which is not actually measurable. This becomes important in quantum mechanics where the masses of particles can change with their velocities, absorbing photons, and merging with other particles.

Relativity and mass

As an example, a rest mass of a planet might be estimated by a spring scale held above it at different e𝕙 heights. It could also be measured by the velocity of a satellite to maintain an orbital e𝕙 height. But the actual +𝕚d gravitational mass and -𝕚d inertial mass is relative, entirely dependent on where it is measured, this is also a tenet of both General and Special Relativity. In this model mass comes from an integral of time so the relativity of time and mass are the same thing.

FIGURE 5.15 Measuring the motion of a 1 kg block that is pulled with a constant force.



Inverse proportionality

In this model the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron are inversely proportional to each other. The straight Pythagorean Triangle side e𝕒 has e proportional to d in -𝕠d with a spherical orbital. This can be changed if there is an external force such as an absorption of a e𝕪×-𝕘d photon with -𝔾𝔻×e𝕪 light work, then there can be a time +𝕠d and position e𝕒 before this adjusts at a speed of c.

Spherical and hyperbolic geometry

The Pythagorean Triangles in circular geometry as the +𝕠d and e𝕒 Pythagorean Triangle and the +𝕚d and e𝕙 Pythagorean Triangle are inversely proportional to the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle in hyperbolic geometry. This follows from the conic sections, a hyperbola is orthogonal to the circle as a cut through a cone.

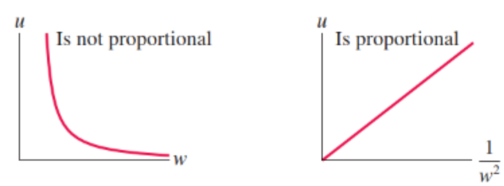
Proportionality

The -𝕠d and e𝕪 Pythagorean Triangle as the electron is directly proportional to the -𝕚d and e𝕧 Pythagorean Triangle as inertia with suitable values of d and e for the scales used such as meters, grams, seconds, etc. The +𝕠d and e𝕒 Pythagorean Triangle as the proton is directly proportional to the +𝕚d and e𝕙 Pythagorean Triangle as gravity.

Rebalancing

When these are not proportional then there is a rebalancing with the four central Pythagorean Triangles as e𝕪×-𝕘d, +𝕘d×e𝕒, -𝕘de𝕧, and +𝕘de𝕓. The negative terms as e𝕪×-𝕘d and -𝕘d×e𝕧 move forward in time, the positive terms +𝕘d×e𝕒 and +𝕘d×e𝕓 moving backwards in time so all forces are conserved.

Proportionality is not limited to being linearly proportional. The graph on the left shows that u is clearly not proportional to w. But a graph of u versus $1/w^2$ *is* a straight line passing through the origin; thus, in this case, u is proportional to $1/w^2$, or $u \propto 1/w^2$. We would say that "u is proportional to the inverse square of w."



F=ma

The Newtonian equation, as force equal mass times acceleration, would be written as -𝕚d×e𝕧/-𝕀𝔻 where -𝕚d is the inertial mass and e𝕧 is a length travelled. This is proportional to e𝕧/-𝕚d when the two -𝕚d factors cancel, this gives an infinitesimal e𝕧 length as a position divided by an instant or fluxion -𝕚d. This is not being observed because there is no force as the square has been removed, it is a first derivative with respect to e𝕧 and can also be written as ∂-𝕚d/∂e𝕧 because by convention the derivative goes in the denominator.

Newton's first law

From this comes Newton's first law that an object will move with a constant e𝕧/-𝕚d velocity unless acted upon by an external force.

Inverting velocity and acceleration

Classically the more common form is e𝕧/-𝕚d in meters/second, as a first derivative with respect to e𝕧 this is conventionally written as ∂-𝕚d/∂e𝕧 or seconds/meter. With a force there is a second derivative with respect to e𝕧 as the E𝕍/-𝕚d inertial impulse, or as ∂-𝕚d/∂E𝕍.

Partial derivatives and partial integrals

In this model only partial derivatives are used because a derivative can only act on one straight Pythagorean Triangle side in a position. An integral is also assumed to be partial because only one spin Pythagorean Triangle side can be integrated at a time.

Observing impulse as a fraction

This equation observes impulse because it is a fraction, the Pythagorean Triangle slope observes a particle while an integral area would measure a field. Because of this the -𝕀D×e𝕧 inertial work would be in meters^2/seconds which is classically equivalent to meters/second^2. By changing this to e𝕧/-𝕀D as meters/second^2 this gives the conventional acceleration form. In this model that would not be a fraction, instead as the -𝕀D×e𝕧 inertial work it would be multiplied not divided as a field.

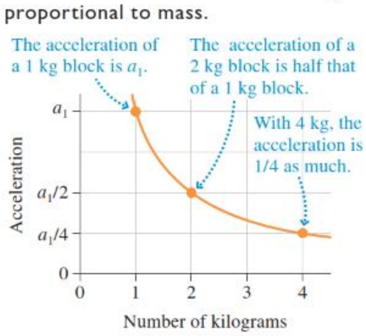
Commuting position and time

It gives the same answer because in Newtonian physics time and position commuted, that meant that they could be measured in the same position and moment. There was at that time no difference between the E𝕍/-𝕚d inertial impulse and the -𝕀D/e𝕧 inertial work, there was no uncertainty principle after an observation or measurement so the two could be exactly converted into each other.

Exponential acceleration

This also allows for an exponential curve because as the mass decreases by a constant amount the acceleration increases as a square. Taking the -𝕚d and e𝕧 Pythagorean Triangle then this is for example dividing the mass as -𝕚d by 2 and multiplying e𝕧 by 2 to maintain a constant Pythagorean Triangle area. Because this is being observed as impulse this gives -𝕚d as halved and E𝕍 as the square of e𝕧 going up by 4 times. As different values of d and E are plotted this gives an exponential curve.

FIGURE 5.16 Acceleration is inversely proportional to mass.



Forces in an instant or infinitesimal

In this model a force can act in an instant from a spin Pythagorean Triangle side with impulse. It can also work over an infinitesimal amount of the straight Pythagorean Triangle side with work.

Work, impulse and memory

The impulse in F=ma has no memory because time is acting as a scale, the position is being measured not time. This has a kind of memory of where it has been because E𝕍 is a squared vector with a magnitude of where it was an where it is on this time scale. With work there is no memory of where the iota has been, this is because e𝕧 for example in -𝕀D×e𝕧 inertial work is a scale. Here the -𝕀D inertial probability does have a memory because it creates a Gaussian with different values.

The past and uncertainty

There cannot be a memory without uncertainty, the force attempts to change the Pythagorean Triangle's area which cause it to emit or absorb a e𝕪×-𝕘d photon or +𝕘d×e𝕓 Gravi. This creates a past, in work this past is probability so independent events can fall on a normal curve. In impulse this past is a vector, so particles are observed to have moved in a straight-line.

The past and negative entropy

The negative entropy of this E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work is increasing, the particles are observed to have scattered more with impulse and become increasingly randomized with work. This also happens with the E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work, the energy is increasingly scattered in straight lines and randomized such as in heat. In this model that is referred to as negative entropy because the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle have negative spin Pythagorean Triangle sides.

Negative enthalpy and the past

The -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work can also be regarded as a negative enthalpy because heat is being lost as particles become more randomized. An example would be water losing heat as it evaporates with the water molecules becoming more randomized.

Positive entropy and the past

The past from the +𝕠d and e𝕒 Pythagorean Triangle and +𝕚d and e𝕙 Pythagorean Triangle is positive because they have positive spin Pythagorean Triangle sides. So the E𝔸/+𝕠d potential impulse and Eℍ/+𝕚d gravitational impulse tends to point to the center of circular geometry, for example asteroids might fall towards the center of a planet. Because there are fewer alternatives for the asteroids their positive entropy is increasing, and their negative entropy is decreasing.

Positive enthalpy and the past

Also their work is increasing with a positive entropy, it can also be regarded as a positive enthalpy in the sense that heat is increasing. This is because as asteroids fall onto a planet, they cause it to heat up.

We can rewrite Newton's second law in the form

$$\vec{F}_{\text{net}} = m\vec{a} \tag{5.5}$$

which is how you'll see it presented in many textbooks. Equations 5.4 and 5.5 are mathematically equivalent, but Equation 5.4 better describes the central idea of Newtonian mechanics: A force applied to an object causes the object to accelerate.

It's also worth noting that **the object responds only to the forces acting on it *at this instant*.** The object has no memory of forces that may have been exerted at earlier times. This idea is sometimes called **Newton's zeroth law.**

Active and reactive forces in the zeroth law

In this model F=ma acts with the four Pythagorean Triangles, with the +𝕠d and e𝕒 Pythagorean Triangle or proton it is the potential force or E𝔸/+𝕠d potential impulse equals a potential acceleration as E𝔸/+𝕠d and the mass acts as the +𝕠d potential magnetic field.

Force and dimensional analysis

This can also be written for dimensional analysis as +𝕠d×E𝔸/+𝕠d, in this model the integral and derivative of a Pythagorean Triangle cannot be taken at the same position and moment. Because this would imply an observance of the impulse in E𝔸/+𝕠d it cannot also measure the +𝕆D×e𝕒 potential work because there would be both Pythagorean Triangle sides squared.

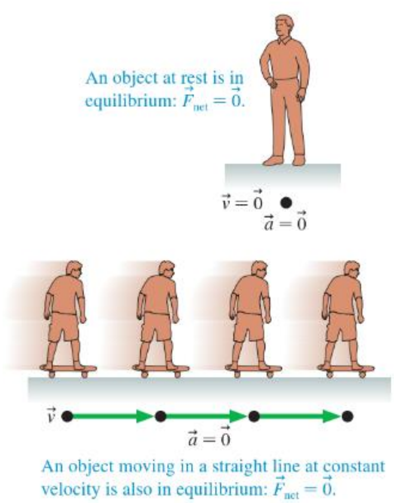
Other F=ma equations

There would also be the E𝕐/-𝕠d kinetic impulse which with dimensional analysis can be classically approximated as -𝕠d×E𝕐/-𝕠d. The E𝕍/-𝕚d inertial impulse refers to what Newton was describing, then there the is Eℍ/+𝕚d gravitational impulse or +𝕚d×Eℍ/+𝕚d.

> **Newton's first law** An object that is at rest will remain at rest, or an object that is moving will continue to move in a straight line with constant velocity, if and only if the net force acting on the object is zero.

No observations or measurement

When an object has no forces it is not observable as an object or particle, to be at rest is equivalent to saying the Pythagorean Triangle sides are not squared. When an object moves in a straight-line, such as with a kinetic velocity of e𝕪/-𝕠d or a velocity of e𝕧/-𝕚d, the Pythagorean Triangle sides are not squared and so there is no force. The values of d and e can be increased as long as the ratio between them stays constant. This is a classical approximation because they would means the -𝕚d and e𝕧 Pythagorean Triangle for example had increased in area, it would be a series of iotas with E𝕍/-𝕚d inertial impulses and -𝕀D×e𝕧 inertial work where the forces were approximately canceled out.



Reference frames

In this model there are four reference frames: the potential reference frame from the +𝕠d and e𝕒 Pythagorean Triangle or proton, the kinetic reference frame from the -𝕠d and e𝕪 Pythagorean Triangle or electron, the inertial reference frame from the -𝕚d and e𝕧 Pythagorean Triangle and the gravitational reference frame from the +𝕚d and e𝕙 Pythagorean Triangle.

Light and Gravi reference frames

There can also be a light reference frame from the e𝕪×-𝕘d Pythagorean Triangle, this would be the photon can observe an electron by colliding with it as a e𝕐/-𝕘d light impulse. There can also be -𝔾D×e𝕪 light work where from the light reference frame the electron is measured by the photon being absorbed. The +𝕘d×e𝕓 Gravi can also be the Gravi reference frame, it can observe with a -𝕘d/e𝔹 Gravi impulse or measure with a +𝔾D×e𝕙 Gravi work. With impulse both observe the collision according to a scale of time, with the photon this is -𝕘d and with the Gravi this is +𝕘d. With work they measure with a position, the photons has a scale of e𝕪 as its phasor or kinetic electric charge. The Gravi has e𝕓 as depth to act as a scale.

Einstein on traveling with a photon

Einstein referred to this photon reference frame in imagining how the world would look when traveling with a photon. This can be regarded as a rolling wheel, the -𝕘d rotational frequency acts as the axle and the e𝕪 kinetic electric chargeas the phasor. The absorption of a photon would be measured by how large the -𝕘d axle was as the light frequency force or light probability +𝔾D. This can also be measured by constructive and destructive interference in a double slit experiment.

Observing a collision with the light impulse

With a e𝕐/-𝕘d light impulse the e𝕪 kinetic electric chargecan be regarded as becoming the E𝕐 kinetic electric force, this might act like a spring as the position is compressed and rebound. This would happen because the photon can measure this impulse over a time scale -𝕘d.

Traveling with a Gravi

The Gravi can also be regarded as observing a collision with the -𝕘d/e𝔹 Gravi impulse, also as gravitational waves it is already being measured as the +𝔾D×e𝕙 Gravi work. This wave would cause the e𝕓 depth or inversely the e𝕙 height to expand and contract as it passed. In this model it would be absorbed by the proton's +𝕠d and e𝕒 Pythagorean Triangle which would react against its mass being changed.

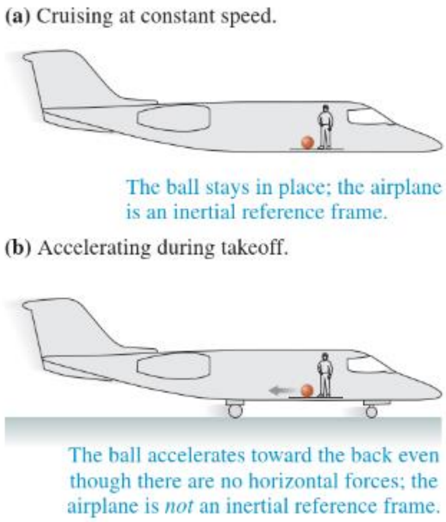
Light waves and electrons

A photon in this model would also cause an expansion and contraction of the electron's e𝕪 Pythagorean Triangle side if it passed without being absorbed. The electron would then oscillate like a ship floating on ocean waves but would not absorb the -𝔾D×e𝕪 light work. If the wave is absorbed this is like a ship absorbing the impact of an ocean wave instead of riding over it.

Resonating with ocean waves

By doing this the resonation of the ship is changed, it might be oscillating in heavy ocean waves by rising and falling with them. On absorbing the energy from a wave this would cause the ship to rise or fall more sharply, with an inertial reaction force it might then do -𝕀D×e𝕧 inertial work by regaining the original resonation and emitting the wave energy in a changed wake.

FIGURE 5.19 Reference frames.



Inertia and gravitational equivalence

In relativity inertial acceleration from the -𝕚d and e𝕧 Pythagorean Triangle is regarded as being equivalent to the gravitational acceleration from the +𝕚d and e𝕙 Pythagorean Triangle. There is a Eℍ/+𝕚d gravitational impulse acting downwards actively, this is reacted against by the E𝕍/-𝕚d inertial impulse acting upwards. As the e𝕙 height increases then the Eℍ height force increases as a square and the +𝕚d gravitational field decreases constantly.

Weightlessness versus free fall

If the elevator was shot upwards like a projectile with an initial force, then the occupant would be weightless as it went upwards and then downwards. This is because the -𝕚d and e𝕧 Pythagorean Triangle has its -𝕚d inertial mass increase inversely to the decreased +𝕚d gravitational mass at each e𝕙 height. Because they always balance in the absence of an -𝕀D×e𝕧 inertial work or +𝕀D×e𝕙 gravitational work force the occupant experiences weightlessness. Instead, the forces are of impulse, the changing e𝕙 height as a square is Eℍ in the Eℍ/+𝕚d gravitational impulse.

Free fall

The motion of e𝕧 length is also straight upwards inversely to the value of Eℍ, the elevator then decelerates as meters^2/second with both forces inverse to each other. Because of this the occupant experiences not just weightlessness from the gravitational and inertial mass, but a lack of motion in the elevator as the e𝕙 height and e𝕧 length are also inversely connected. If not then the occupant would experience a change in e𝕙 height in their cabin position and move with a length e𝕧, that would be experienced as an acceleration and an end to the weightlessness.

Vectors and free fall

In this model vectors are associated with impulse and not work, the free body diagram would then show the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse not the +𝕀D×e𝕙 gravitational work and the -𝕀D×e𝕧 inertial work. The tension in the rope would come from a E𝕐/-𝕠d kinetic impulse as the elevator was pulled upwards, for example by an electric motor as electrons are given an impulse. The rope also has a E𝔸/+𝕠d potential impulse as the protons react against the rope being pulled apart, as electrons are torn free. The E𝕍/-𝕚d inertial impulse would be proportional to the E𝕐/-𝕠d kinetic impulse if the elevator was being raised.

Stationary elevator

If the elevator was stationary, then the E𝕐/-𝕠d kinetic impulse would be classically constant in the many electron orbitals in molecular bonds. The E𝕍/-𝕚d inertial impulse would also be classically constant and react against the active Eℍ/+𝕚d gravitational impulse pulling the elevator downwards.

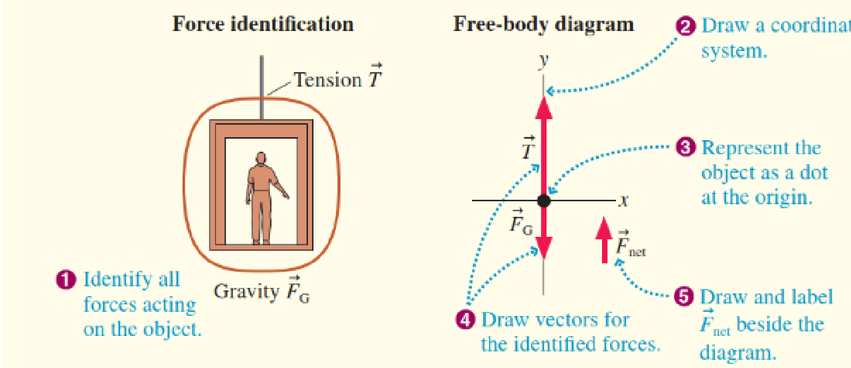


FIGURE 5.20 Free-body diagram of an elevator accelerating upward.

Potential friction

Here the -𝕚d and e𝕧 Pythagorean Triangle is at an angle to the +𝕚d and e𝕙 Pythagorean Triangle pulling downwards with gravity. The person can be moving to the right with a E𝕐/-𝕠d kinetic impulse, this is reacting against with potential friction as the E𝔸/+𝕠d potential impulse. Molecular bonds form between the skis and the snow, breaking these with the E𝕐/-𝕠d kinetic impulse is reacted against with this E𝔸/+𝕠d potential impulse.

Lenz's law and inertia

There was also an E𝕍/-𝕚d inertial impulse against the motion of the skier when they were accelerated to their current e𝕧/-𝕚d velocity. Now as in Lenz's law there is a reactive force against their being slowed down, the potential friction and inertia react against each other. With a magnetic field Lenz's law reacts against a change with electromagnetism in a circuit, this acts like inertia and comes from the +𝕠d and e𝕒 Pythagorean Triangles as protons. The -𝕠d and e𝕪 Pythagorean Triangles have active forces which may try to accelerate or decelerate a magnet, the +𝕠d and e𝕒 Pythagorean Triangles react against this like inertia from the -𝕚d and e𝕧 Pythagorean Triangle in Biv space-time.

The normal force

The normal force here is where the +𝕠d and e𝕒 Pythagorean Triangles react against the downward Eℍ/+𝕚d gravitational impulse, it tends to rebound upwards with a E𝔸/+𝕠d potential impulse.

A change in the slope as a derivative

The change in the slope also changes the angles θ in these Pythagorean Triangles. The downward Eℍ/+𝕚d gravitational impulse then decreases as the slope becomes gentler. This slope comes from the derivative of the +𝕚d and e𝕙 Pythagorean Triangle as the e𝕙/+𝕚d brevity or gravitational speed.

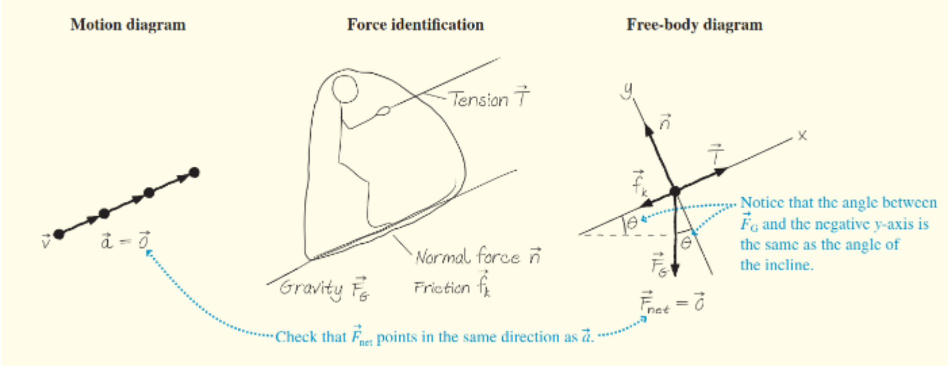
Tension changing with the slope as a derivative

The tension in the rope also changes with the angle θ, the +𝕠d and e𝕒 Pythagorean Triangles with their E𝔸/+𝕠d potential impulse experience a stronger E𝕐/-𝕠d kinetic impulse from the rope being pulled upward as the slope increases.

Work as an integral area

If the +𝕀D×e𝕙 gravitational work was being measured then under this slope there would be an integral area, this would be associated with an integral area for the -𝕀D×e𝕧 inertial work, the -𝕆D×e𝕪 kinetic work and the +𝕆D×e𝕒 potential work.

FIGURE 5.22 Pictorial representation for a skier being towed at a constant speed.



Dynamics 1: motion along a line

Orthogonal Pythagorean Triangles

Here there would be three Pythagorean Triangles orthogonal to each other, these can act in circular geometry such as in the +𝕠d and e𝕒 Pythagorean Triangle as the proton and proportionally its mass as the +𝕚d and e𝕙 Pythagorean Triangle. There can also be three orthogonal -𝕠d and e𝕪 Pythagorean Triangles associated with an electron and proportionally the -𝕚d and e𝕧 Pythagorean Triangles as their inertial mass.

Fractional charges

In the proton the three orthogonal Pythagorean Triangles can form a resonance so that there is a -1/3 and +2/3 spin value, this is because with an odd number the squared sides cannot fit in all three. This creates an asymmetry in forces, the positive 2/3 acts with +𝕆D×e𝕒 potential work and the -1/3 with -𝕆D×e𝕪 kinetic work. This would be in a neutron where there are two of the -𝕆D×e𝕪 kinetic work as 2×-1/3 and one of the +𝕆D×e𝕒 potential work as 1×+2/3 to balance as neutral.

Neutron to proton and electron

The work acts like a quantization when the quarks are measured as waves, when observed as particles they appear to move close to c as a E𝔸/+𝕠d potential impulse and a E𝕐/-𝕠d kinetic impulse. When this changes into a proton the -1/3 value as -𝕆D flips to +2/3 as +𝕆D, the difference between them is -1 which is ejected as the -𝕠d and e𝕪 Pythagorean Triangle or electron. The remaining value is +1 which acts as the +𝕠d and e𝕒 Pythagorean Triangle.

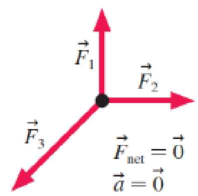
Balancing orthogonal Pythagorean Triangles

In this model three orthogonal Pythagorean Triangles with the same values is a classical approximation, each would have to be observed as impulse or measured as work. This increases uncertainty making them unequal and so there would be a force imbalance such as vibration or rotation.

Mechanical equilibrium

For objects on which the net force is zero.

- Model the object as a particle with no acceleration.
  - A particle at rest is in equilibrium.
  - A particle moving in a straight line at constant speed is also in equilibrium.
- Mathematically: $\vec{a} = \vec{0}$ in equilibrium; thus
  - **Newton's second law** is $\vec{F}_{net} = \sum_i \vec{F}_i = \vec{0}$.
  - The forces are "read" from the free-body diagram,
- Limitations: Model fails if the forces aren't balanced.



The object is at rest or moves with constant velocity.

Impulse and scales

In the diagram there is a Eℍ/+𝕚d gravitational impulse pulling straight down, when balanced there is a minimum amount of rotation with +𝕀D×e𝕙 gravitational work on the pivot. When observed over a timescale +𝕚d the particles have an Eℍ height force straight downwards. These would not be called masses in this model, except as a classical approximation, mass would refer to a measured of the gravitational torque as +𝕀D or the inertial torque as -𝕀D.

Impulse as energy, work as mass or magnetism

Instead, impulse refers to energy, mass and energy are convertible into each other because they arise from orthogonal Pythagorean Triangle sides. The e𝕙 height of the blocks and powder give the gravitational potential energy as it is referred to in conventional physics. To avoid confusion from potential energy in the +𝕠d and e𝕒 Pythagorean Triangle this would be the gravitational energy here.

A pendulum

A pendulum would do mainly +𝕀D×e𝕙 gravitational work where the rotational force varies as it swings. The e𝕧 length of the pendulum will vary the -𝕀D×e𝕧 inertial work done as a reaction to the +𝕀D×e𝕙 gravitational work, that changes the period of the pendulum as the difference of the +𝕀D-𝕀D torque at different e𝕙 heights. A pendulum works with masses being measured because of the +𝕚d×e𝕙 gravitational momentum and the -𝕚d×e𝕧 inertial momentum.

Weight scales

These work with a spring where the Eℍ/+𝕚d gravitational impulse acts downwards and the E𝔸/+𝕠d potential impulse as the normal forces reacts against this. These is no rotation to the side and so classically there is no work. The weight scale in this model observes the change in e𝕙 height as a position with respect to energy, it does not measure the +𝕚d gravitational mass. The spring flexes with a E𝔸/+𝕠d potential impulse as the downward impulse distorts is molecular bonds.

Molecular bonds react against gravity

Because the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity are proportional to each other then the increasing E𝔸/+𝕠d potential impulse against this deformation acts on a scale of time +𝕠d and +𝕚d.

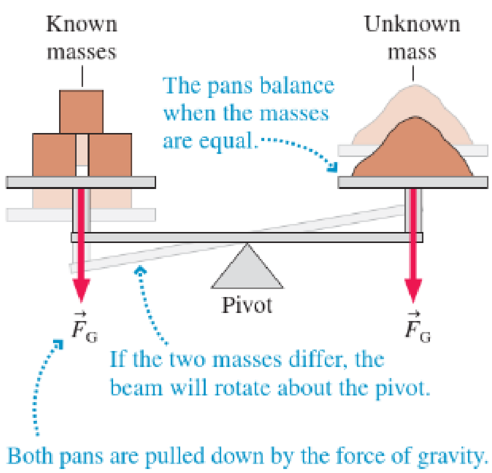
Convertible into a work measurement

This can also be regarded as the +𝕆D×e𝕒 potential work in these molecular bonds as the potential torque +𝕆D reacts against the spring being twisted. The +𝕀D×e𝕙 gravitational work as in the pendulum applies a +𝕀D gravitational torque and the two are measured over a position e𝕒 and e𝕙. The weight scale then drops on this scale according to the masses because the +𝕀D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse are inverses of each other.

Classical work and impulse

In each case there is both work and impulse, one can be used much more than the other as in these examples.

FIGURE 6.5 A pan balance measures mass.



Each planet has gravity from its +𝕚d and e𝕙 Pythagorean Triangle and inertia from its -𝕚d and e𝕧 Pythagorean Triangle, each is also the inverse of the other. The planet m_1 is smaller and so its Eℍ/+𝕚d gravitational impulse is smaller for the height e𝕙 between them. But the larger planet m_2 has a larger E𝕍/-𝕚d inertial impulse so the forces are adding two vectors, the Eℍ/+𝕚d gravitational impulse is smaller and the E𝕍/-𝕚d inertial impulse vector reacting against this is larger.

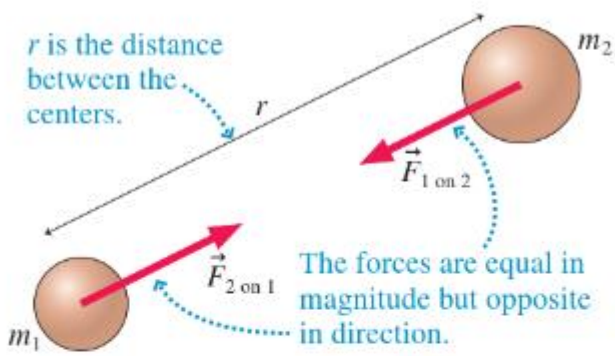
With planet 2 the m_2 Eℍ/+𝕚d gravitational impulse is larger, but the smaller planet m_1 reacts against this with a smaller E𝕍/-𝕚d inertial impulse. This adds two vectors again to give the same magnitude, so the impulse forces are equal. Because of this if the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work are measured they must also be equal as inverses.

Taking the +𝕀D×e𝕙 gravitational work this gives an inverse square law, as e𝕙 increases then +𝕀D decreases as a square with a gravitational torque. Because the forces are equal this is the same as an inverse square law of +𝕚d$_1$×+𝕚d$_2$/e𝕙 where the gravitational force from the masses drops off as the inverse square.

Taking squares in the numerator as +𝕚d$_1$×+𝕚d$_2$ and e𝕙$_1$×e𝕙$_2$ in the denominator, this is equivalent to +𝕚d/e𝕙 being a constant and that the +𝕚d and e𝕙 Pythagorean Triangle has a constant area. That connects the gravitational constant G to the +𝕚d and e𝕙 Pythagorean Triangle. This can also be written as +𝕚d$_1$×-𝕚d$_2$/e𝕙$_1$×e𝕧$_2$ which is equal to +𝕚d$_2$×-𝕚d$_1$/e𝕙$_2$×e𝕧$_1$ so that the +𝕚d and e𝕙 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle both have a constant area.

So where +𝕚d is larger in the second planet -𝕚d is smaller in the first planet, the inverse also follows exactly as -𝕚d being larger in the second planet and +𝕚d being smaller in the first planet. The Eℍ height force is stronger in the second planet and the E𝕍 length force is weaker in the first planet, as an exact inverse the Eℍ height force is weaker in the first planet and the E𝕍 length force is stronger in the second planet.

FIGURE 6.6 Newton's law of gravity.

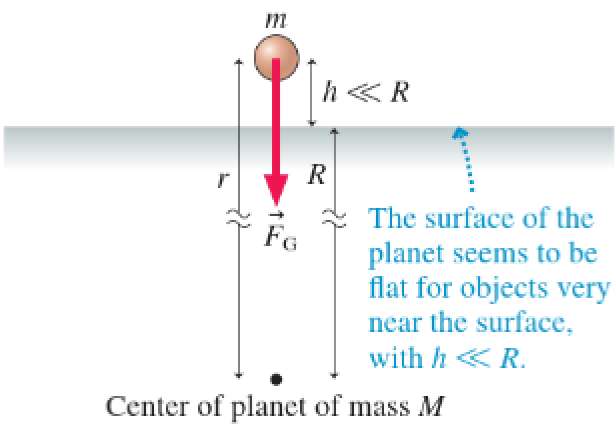


$$F_{1\text{ on }2} = F_{2\text{ on }1} = \frac{Gm_1m_2}{r^2} \qquad \text{(Newton's law of gravity)}$$

Tidal effects and gravitational torque

Here there would mainly be a Eℍ/+𝕚d gravitational impulse, the +𝕀D×e𝕙 gravitational work and the +𝕀D gravitational torque is being ignored. With a large mass this gravitational torque acts as tidal forces, a person in a rocket might experience a force pushing at them from all sides as they get closer to it. This might reach the strength needed to crush someone with this torque.

FIGURE 6.7 Gravity near the surface of a planet.



Mg from F=ma

Here mg is the gravitational mass as +𝕚d times g which is in meters/second^2 to give F=ma. In this model +𝕚d as the gravitational mass is not a fixed value, it changes according to the e𝕙 height above a planet for example.

Gravitational and inertial rest mass

If the gravitational mass was fixed as a rest mass then the +𝕚d and e𝕙 Pythagorean Triangle would have to have a fixed angle, to be equivalent the -𝕚d inertial mass would also have a fixed angle. An inertial rest mass in this model would be where the velocity e𝕧/-𝕚d was at a minimum, it could not be at rest because the -𝕚d and e𝕧 Pythagorean Triangle cannot have a zero side. A gravitational rest mass also could not exist here, instead objects weigh different amounts according to how high as e𝕙 they are.

Time and mass are relative

In this model the +𝕚d gravitational mass is different to the -𝕚d inertial mass, this gravitational mass would be regarded as a rest mass. When this is accelerated in Special Relativity then that does -𝕀d×e𝕧 inertial work in this model, the -𝕀d inertial probability is where the rocket for example is compared to where it would have been without the acceleration. This is the displacement representing the inertial mass force from a starting to a final position. Because -𝕀d is dilated then e𝕧 is contracted to maintain a constant Pythagorean Triangle area, this is measured as a e𝕧 length contraction.

Accumulating inertial mass

This makes the -𝕚d inertial mass relative to the forces that were used, with acceleration a rocket accumulates inertial mass. This makes it act like it is heavier as in General Relativity, a larger planet with more +𝕚d gravitational mass would have its clock gauges running slower at the surface. When the -𝕀d×e𝕧 inertial work is measured then this increased -𝕀d inertial probability also appears as clock gauges running more slowly.

Inertial time is slower

The rest mass then has dilated from the -𝕀d×e𝕧 inertial work of the rocket. When the e𝕍×-𝕚d inertial impulse is observed there is an increasing in velocity, e𝕧 is dilated and so -𝕚d is contracted as a slower inertial time -𝕚d on the clock gauges.

Slower gravitational time

The slower +𝕚d gravitational time contracts because the eℍ/+𝕚d gravitational impulse has a dilated eℍ displacement. This is from a higher starting e𝕙 position above the planet to the final e𝕙 position where this is observed. Because this is a fixed gravitational history it cannot be changed, that causes the +𝕚d gravitational time to run slower. This can also be compared with the +𝕀d gravitational probability, there is an increased probability that the rocket will be closer to the surface at a lower e𝕙 height. That probability acts as an attraction so objects fall towards a gravitational mass.

Gravitational time and Special Relativity

Because the +𝕚d and e𝕙 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle are inverses of each other, when -𝕀d as the inertial probability is dilated then +𝕀d as the gravitational probability is contracted. The rocket then acts more with a larger inertial mass as its velocity increases, this happens also with the gravitational mass of the protons. In this model the proton is also a mix of +𝕚d gravitational mass and -𝕚d inertial mass as will be discussed later. So this increased velocity would decrease the rocket's gravitational mass, but because of this inverse relationship it still increases its inertial mass overall.

Gravity and inertial equivalence

In relativity a person in an accelerating elevator cannot tell the difference between this and gravity. In this model that is because the -𝕀d×e𝕧 inertial work done increases their -𝕀d inertial weight as an inertial probability. They experience this inertial force because the probability of their e𝕧 position is changing. With gravity there is +𝕀d×e𝕙 gravitational work done, this has a +𝕀d gravitational weight as a gravitational probability. The gravitational force then acts on a spring scale with changes in e𝕙 height, this represents the +𝕀d gravitational probability of where the person should be as a e𝕙 position.

Inertial weight is reactive, gravitational weight is active

The difference between the two is the -𝕀d inertial weight is reactive, it only occurs because the elevator is moving. The +𝕀d gravitational weight is an active force, it acts without needing to react against a motion.

Gravitational displacement

The equation below has a force which varies as the square of the radius, in this model R is e𝕙 as the height. When squared this is eℍ as the gravitational probability. It is a displacement from an initial e𝕙 height to a final e𝕙 height. This makes GMm act as the +𝕚d gravitational time in the eℍ/+𝕚d gravitational impulse, the equation is inverted so eℍ is in the denominator.

Gravitational mass and gravitational time

Here +𝕚d can also be regarded as the gravitational mass, this depends on whether the +𝕚d and e𝕙 Pythagorean Triangle is expressed as a derivative slope e𝕙/+𝕚d or an integral as +𝕚d×e𝕙. In the former +𝕚d acts as time, in the latter it acts as mass.

Contracting gravitational time

The eℍ/+𝕚d gravitational impulse is also determined by the +𝕚d gravitational mass, when eℍ is dilated then +𝕚d as the gravitational time is contracted. This is meters^2/second so that when the seconds are contracted objects fall faster.

Combining equations

This is from the +𝕀d×e𝕙 gravitational work so that in the numerator below multiplying the masses of two planets would give +𝕀d as the gravitational probability. It is then combining the eℍ/+𝕚d gravitational impulse and the +𝕀d×e𝕙 gravitational work in one equation, this was done in classical physics because it was assumed there was no uncertainty principle. This is also done later with the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, that is a combination of the e𝕐×-𝕠d kinetic impulse and the -𝕆d×e𝕪 kinetic work.

Work and impulse acceleration

With this larger +𝕀d gravitational probability then objects would move faster towards each other, this is because the +𝕀d×e𝕙 gravitational work can be written as seconds^2/meter while the eℍ/+𝕚d gravitational impulse is the equivalent meters^2/second.

Acceleration and Pythagorean Triangles

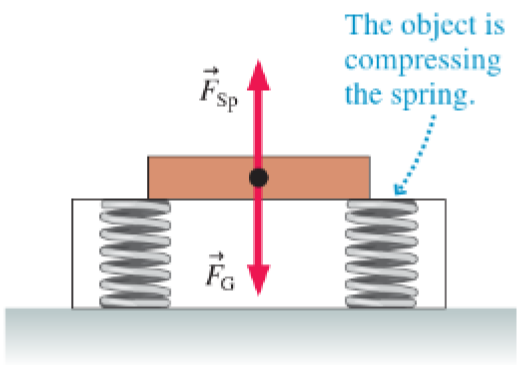
In this model an acceleration with impulse is then the straight Pythagorean Triangle side squared as a displacement divided by the spin Pythagorean Triangle side as time. To make all Pythagorean Triangles the same, the -𝕠d and e𝕪 Pythagorean Triangle as the electron would have its e𝕐×-𝕠d kinetic impulse as a displacement between kinetic positions divided by a kinetic time. There is then a position in a kinetic electric charge which is the same concept as a e𝕧 length position on a ruler in Biv space-time. The +𝕠d and e𝕒 Pythagorean Triangle as the proton would have the e𝔸×+𝕠d potential impulse as the potential displacement between two potential electric charge positions, also like a e𝕧 length position on a ruler and +𝕠d would act as potential time.

$$\vec{F}_G = \vec{F}_{\text{planet on } m} = \left(\frac{GMm}{R^2}, \text{ straight down}\right) = (mg, \text{ straight down})$$

Weight versus position

In this model the weight comes from the +𝕀D×e𝕙 gravitational work, this measures the +𝕚d gravitational mass as a +𝕀D gravitational torque on the springs. More typically this is expressed as a Eℍ/+𝕚d gravitational impulse which observes the change in e𝕙 height or position of the spring, not the probability of where the spring will depress down to. This +𝕆d×e𝕒 potential work is inversely proportional to the E𝔸/+𝕠d potential impulse where the protons have their molecular bonds twisted with this +𝕀D gravitational torque, they react against this with a +𝕆D potential torque. This reaction impulse is observed as the normal force.

FIGURE 6.9 A spring scale measures weight.



Gravitational and inertial probability

Here the man would feel heavier because the gravitational probability is higher that he would be in the lower part of the elevator. This comes from the +𝕀D×e𝕙 gravitational work because +𝕀D as the gravitational probability is higher when the e𝕙 height is smaller. Also there is -𝕀D×e𝕧 inertial work being done as the elevator moves higher on a e𝕧 length, this -𝕀D inertial probability is equal and opposite to the acceleration upwards. Again the person has a higher inertial likelihood of being found in the bottom of the elevator.

Weight and momentum

Because the -𝕚d inertial mass is inversely proportional to the +𝕚d gravitational mass this is experienced as inertial and gravitational weight, it can also be regarded as the tendency to have a +𝕚d×e𝕙 gravitational momentum and an -𝕚d×e𝕧 inertial momentum.

Impulse and scale position

If this is observed as impulse then it refers to how fast the elevator moves on a timescale +𝕚d for the Eℍ/+𝕚d gravitational impulse and -𝕚d with the E𝕍/-𝕚d inertial impulse. Then the force comes from the square of the position as a vector, this would be Eℍ as the height force vector and E𝕍 as the length force vector. The weight then is being observed as a position on the scales, the e𝕙 height of the spring decreases as does the e𝕧 length of it.

Inverse torque

With the work and impulse, they are not added because the -𝕀D×e𝕧 inertial work has the -𝕀D inertial torque increasing with a greater e𝕧 or e𝕙 while the +𝕀D gravitational torque is decreasing inversely to it. With impulse Eℍ is increase with the height and E𝕍 is decreasing inversely to it.

Kinetic probability

The rope is also being pulled up with -𝕆D×e𝕪 kinetic work so this is moving the elevator not the person directly. This would give a -𝕆D kinetic probability that the person is moving upwards as the elevator floor pushes them upwards, reacting against this is the -𝕀D inertial probability that they will stay at the bottom of the elevator.

Potential probability

The -𝕆D kinetic probability is then that the person will move upwards with the bottom of the elevator, not that they would move to the top of the elevator. There is also a +𝕆D potential probability where the rope reacts against its molecular bonds to the protons being torn apart.

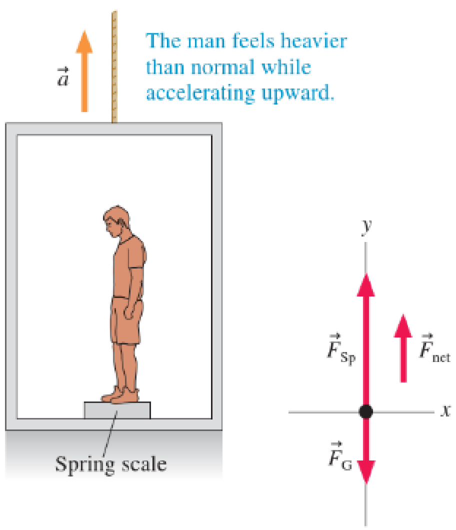
The normal force

This also creates a normal force pushing the person upwards against the -𝕆D inertial probability of their not moving upwards with the elevator. Because these are both reactive forces they do not move the person. This is a normal force because +𝕆D in the +𝕆D×e𝕒 potential work gives a Gaussian or normal curve. It reacts against a change in its position on the e𝕒 position scale, this tends to maintain it in the normal position.

The normal force and vibration

The -𝕀D inertial probability also acts like a normal force against a change in its average position. Because of this the normal force can also act as a vibration, a Gaussian or normal curve distribution with the average as its original position.

FIGURE 6.10 A man weighing himself in an accelerating elevator.



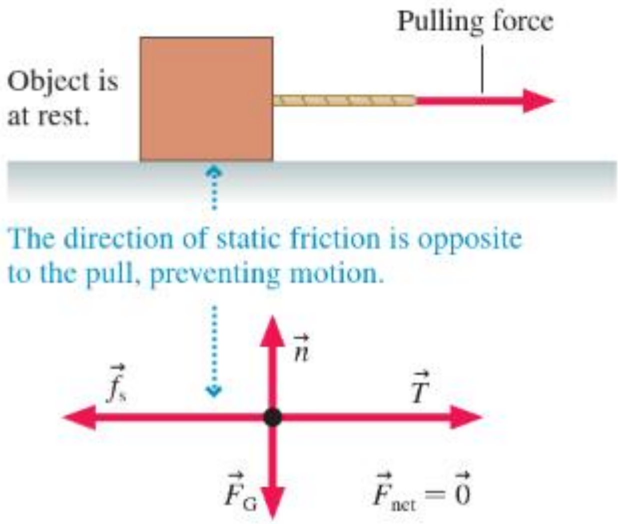
Vectors and impulse

Because this is shown as vectors these come from squaring the straight Pythagorean Triangle sides. They would then have a time scale to observe this force not a position as shown, except as a classical approximation. The static friction would come from the E𝔸/+𝕠d potential impulse which reacts against a change in its position with a squared E𝔸 potential electric force. This pulls downward on molecular bonds between the box and the ground as the motion tries to break them.

Active and reactive forces in impulse

The pulling force would come from the E𝕐/-𝕠d kinetic impulse, which here would be E𝕐 as the kinetic electric force such as from an electric motor. The Eℍ/+𝕚d gravitational impulse pulls the box downwards increasing the static friction, there is also an E𝕍/-𝕚d inertial impulse acting against the change in position of the box with an E𝕍 length force.

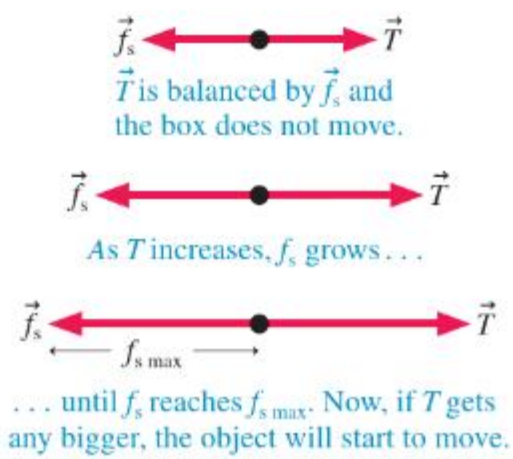
FIGURE 6.11 Static friction keeps an object from slipping.



Tipping point

The static friction has a E𝔸/+𝕠d potential impulse against the E𝕐/-𝕠d kinetic impulse, then this would start to move. Because impulse is chaotic this would reach a tipping point with a sudden movement.

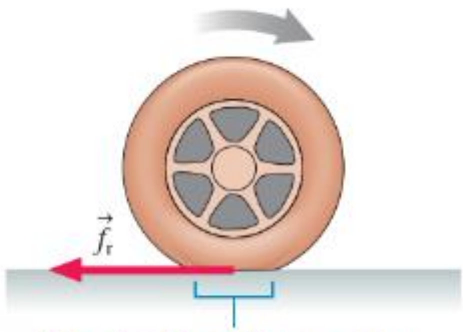
FIGURE 6.12 Static friction acts in response to an applied force.



Rolling friction

Rolling friction happens when there are molecular bonds forming between the tire and the road. These are broken by the kinetic torque -𝕆D in the -𝕆D×e𝕪 kinetic work done. Reacting against this is +𝕆D potential torque in the +𝕆D×e𝕒 potential work. These are both work because the rotational motion gives a spin force.

FIGURE 6.14 Rolling friction is also opposite the direction of motion



Static friction from reactive forces

Static friction in this model comes from reactive forces in the +𝕠d and e𝕒 Pythagorean Triangles as protons, also from the -𝕚d and e𝕧 Pythagorean Triangles as inertia. Kinetic friction can be an opposing active force, this would be kinetic from the -𝕠d and e𝕪 Pythagorean Triangles and electrons. It can also be gravitational friction from the +𝕚d and e𝕙 Pythagorean Triangle, pulling a sled up a slope might have gravity causing the sled to dig into a rough surface.

Straight friction

In this model instead of using the term static friction it would be a straight friction. This is because the friction comes from impulse in straight lines, for example a gravitational static friction is confusing because gravity is an active force in this model.

Potential rolling friction

A rolling friction comes from work as torque, this can be from all four Pythagorean Triangles. A potential rolling friction is where the protons and their molecular bonds react against a change in the orbitals of the electrons. This is different from static potential friction which is in a straight-line, hence that is the E𝔸/+𝕠d potential impulse. Here the +𝕆D×e𝕒 potential work reacts against the turning of the wheel, the molecular bonds between he tire and the road are not pulled apart like in impulse. They are instead causing these bonds to be twisted in a kinetic torque for example, this would be reacted against as the molecular bonds are being more twisted.

Kinetic rolling friction

A car engine might exert a kinetic rolling friction by using the engine, it has the tires rolling on a slope upwards against gravity. This friction would become a static friction if the tires began to move downwards without turning in a skid.

Inertial rolling friction

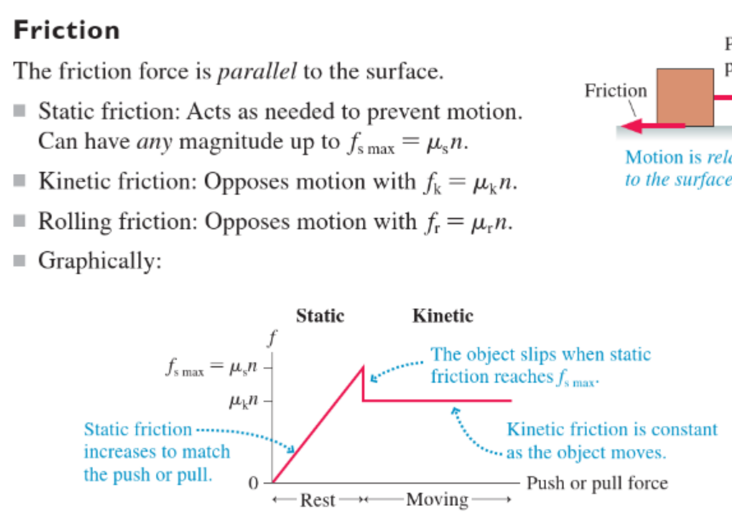
This would be where a car's tires experience an inertial torque as a reaction against the kinetic torque. A car going up a slope would have a kinetic rolling friction as it created and broke molecular bonds between the tires and the roads. It would break these by a torque as the tire rolled, it would change the angle between the tire surface and the road. This is reacted against by the -𝕚d inertial mass of the electrons against their orbitals being changed by this torque,

Gravitational rolling friction

An example would be where the +𝕚d gravitational mass of the protons strengthened the molecular bonds between the tires and the road. This strengthened the bonds, a car on a larger planet with a stronger gravity would have an increased gravitational rolling friction. The potential rolling friction from the protons would be the same.

Parallel to the surface

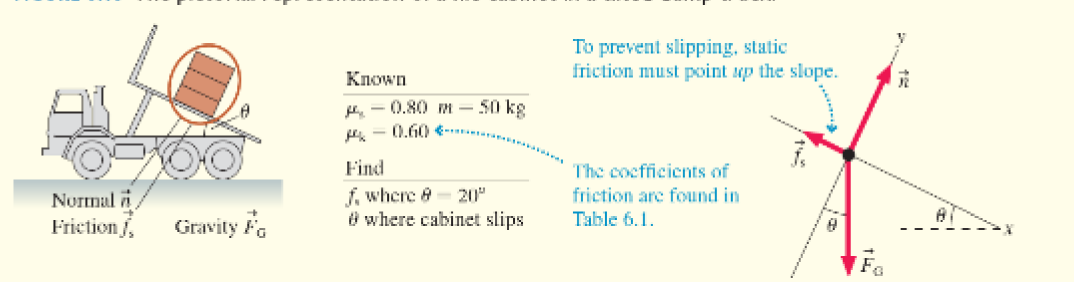
When this friction is exerted in a straight-line parallel to a surface, or orthogonal to it with molecular bonds being broken, this would be impulse. When there is rolling friction this comes from work.



Vectors as impulse

The vectors would be impulse, there would be a potential straight friction as the E𝔸/+𝕠d potential impulse reacting upwards against the gravity straight friction from the Eℍ/+𝕚d gravitational impulse. The changing angle θ would vary this impulse, a larger slope would have gravity pointing downwards more with a stronger Eℍ/+𝕚d gravitational impulse.

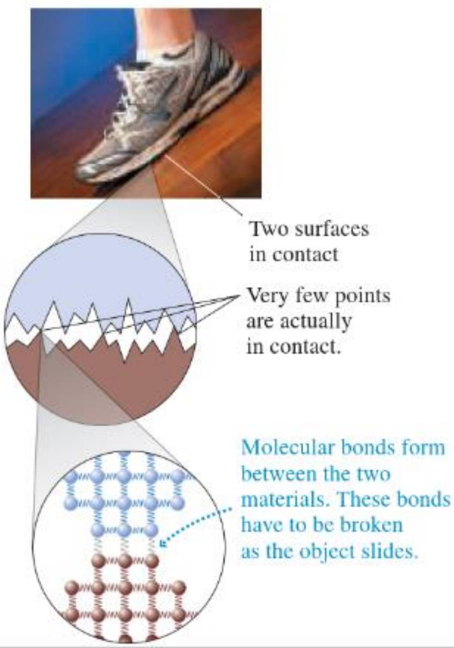
FIGURE 6.16 The pictorial representation of a file cabinet in a tilted dump truck.



Uneven surfaces and friction

There would be a motion up and down because of the uneven surface, this adds the Eℍ/+𝕚d gravitational impulse as a gravitational friction. The molecular bonds are being broken which comes from the E𝔸/+𝕠d potential impulse, there is also a E𝕐/-𝕠d kinetic impulse as the shoe is lifted to break the bonds and an E𝕍/-𝕚d inertial impulse where the inertia of the shoe must be overcome to lift it.

FIGURE 6.17 An atomic-level view of friction.



Area as work not impulse

In this model the cross-sectional area can be connected to the straight Pythagorean Triangle side squared. For example, with the E𝕍/-𝕚d inertial impulse and inertial friction the shoe might be moved along a surface, the larger the area of the shoe in contact with the surface then proportionally the inertial friction will increase. The square E𝕍 does not refer to an area except as a classical approximation, instead it would be a squared magnitude of a vector.

Inertial probability

With the -𝕀D×e𝕧 inertial work there is a squared area as -𝕀D, this would be the inertial torque or inertial probability. So with a larger shoe there inertially probability increases proportionally with this area, with double the shoe area then it is twice as likely to not move according to the inertial probability. That is, there is double the probability that the shoe is found where it was. This also acts like a force, the inertial probability reacts against an active force such as -𝕆D×e𝕪 kinetic work moving it.

Scales not vectors

Here this is being measured as work, in this model that means vectors cannot be used as they represent impulse forces. The e𝕧 lengths for example can be used as a scale similar to with vectors, but the scale is not observable in the same position or time as the -𝕀D×e𝕧 inertial work. This is because of the uncertainty principle. With work the position value of the straight Pythagorean Triangle side is a scale and the values on this would be scalars, for example e𝕧 here from the -𝕚d and e𝕧 Pythagorean Triangle. With impulse the scalar or scale value would be time as -𝕚d.

Gauge theories

Scales in this model come from one Pythagorean Triangle side when the other is squared as a force. This scale can be regarded as having an arbitrary value, for example with +𝕀D×e𝕙 gravitational work the scale value of the height as a scalar can be changed. A scale then has no definite value because it is not being observed or measured. It depends on the force being observed or measured with the other Pythagorean Triangle side.

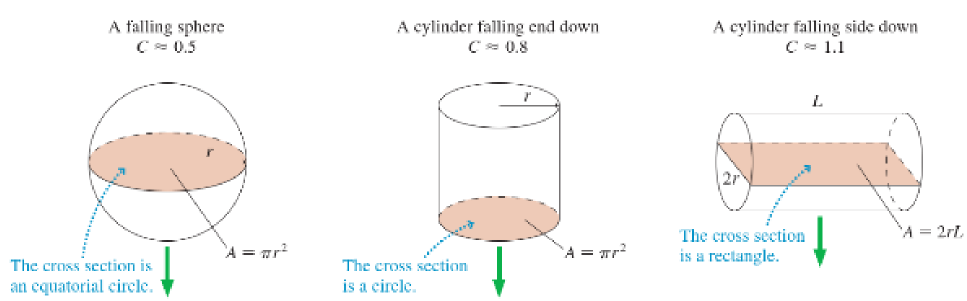
Setting a scale

The e𝕙 height then can be set from the center of a planet, its surface, or at zero. The point of the Pythagorean Triangle observation or measurement is with the force from the squared Pythagorean Triangle side, as long as the change of scale does not change the Pythagorean Triangle area it can be varied. The scale then of a Pythagorean Triangle side goes from one vertex to another, it is the difference between these two that is related to the Pythagorean Triangle area not their absolute values.

Absolute and relative gauges

There is also an absolute gauge theory in the sense that a Pythagorean Triangle has a limit, its angle θ has a minimum and maximum value. There can be relative differences such as in special relativity with the -𝕚d and e𝕧 Pythagorean Triangle. Also there are limits such as c as an angle θ, also a minimum inertial velocity above absolute zero. A gauge in this model is like a clock and refers to spin Pythagorean Triangle sides, there are also relative scales like ruler from straight Pythagorean Triangle sides with maximum and minimum limits.

FIGURE 6.19 Cross-section areas for objects of different shape.



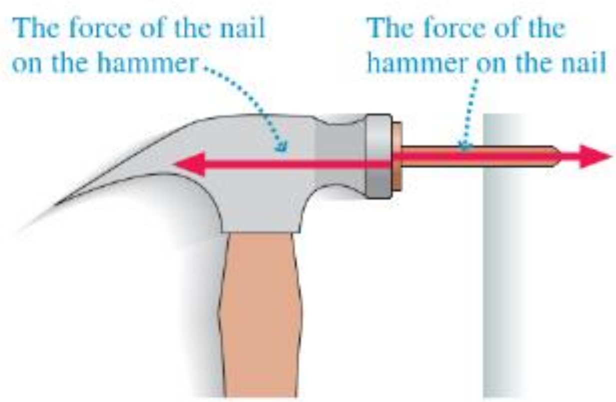
Action/reaction pairs

In this model an action/reaction pair comes from two Pythagorean Triangles, in the diagram there would be the -𝕠d and e𝕪 Pythagorean Triangle with active kinetic forces and the -𝕚d and e𝕧 Pythagorean Triangle with reactive inertial forces. An additional action/reaction pair here would be gravity from the +𝕚d and e𝕙 Pythagorean Triangle as an active force, reacting against atoms being crushed by gravity is the +𝕠d and e𝕒 Pythagorean Triangle and inertia.

Circular and hyperbolic geometry

There can also be other action/reaction pairs, this would be where one is in hyperbolic geometry and the other in circular geometry. For example, gravity has active forces from the +𝕚d and e𝕙 Pythagorean Triangle, this is reacted against by inertia from the -𝕚d and e𝕧 Pythagorean Triangle. The nucleus has reaction forces from the +𝕠d and e𝕒 Pythagorean Triangle, these are acted on by kinetic forces from the -𝕠d and e𝕪 Pythagorean Triangle. Circular geometry is often referred to as circular geometry, in this model a volume is not allowed except as a classical approximation. A circle and a hyperbola both comes from conic sections and the Pythagorean Theorem, a volume does not.

FIGURE 7.1 The hammer and nail are interacting with each other.



Reactive forces

In this model the reactive force is not actually directed opposite to the active force. Instead, the reactive force comes from the square root of -1 being positive as +𝕠d for the +𝕠d and e𝕒 Pythagorean Triangle and the proton. This is not allowed here because the square root of -1 would then have two values, one positive and one negative, that would mean there are two opposing forces when a rational number acts as a square. Instead, when the square root of -1 is negative as -𝕠d this is related to active forces, the +𝕠d value can be added to -𝕠d and then the sum can be squared to go back to a rational number.

Potential and kinetic energy

In most cases this makes little difference, it means the +𝕠d and e𝕒 Pythagorean Triangles cannot be observed or measured directly. This is why according to this model the potential acts differently from kinetic energy in conventional physics.

The square root of +1

The square root of +1 also gives rise to a conflict in this model, this is when the square root can be both positive and negative. This would mean two different values would be squared to give the same force. Instead, the +𝕚d value is the square root of +1, the other value of -𝕚d cannot be observed or measured directly. So -𝕚d can only be subtracted from +𝕚d and then the total can be squared to be observed or measured.

Compatible with conventional math

This remains largely compatible with conventional math, in both cases multiplication and division can be performed as before. When there are two roots of √-1 in conventional math they are generally kept as separate solutions or one is discarded, here they are added together. If the two roots are used it means that one becomes a classical approximation, it still works in math, but it does not describe the physics of this model in quantum mechanics, quantum field theory, and in relativity.

Rotation and torque

When ni is used as an exponent it means there is a rotation, +ni is clockwise and -ni is counterclockwise. These can be added together in conventional physics with the Euler equation, a Pythagorean Triangle is inscribed in a circle so that the two rotations can sum to a single angle. If there is a single ni value then this can be regarded as many different values of +ni and -ni that sum to it. Because this is a rotation, in this model when squared it becomes a torque.

Observable and measurable

The reason why √-1 as negative and √+1 as positive are observable and measurable is because of the form of the Pythagorean Equation, on the left-hand side two squares are subtracted and on the right-hand side two squares are added. When they are subtracted this gives the equation for a hyperbola, in this model that allows the electron to leave the atom in a hyperbolic trajectory. When the squares are added this gives a circle, that allows the proton to have a circular gravitational field around it.

The Pythagorean Equation in this model

On the left-hand side in this model that is (e𝕒 +𝕠d)(e𝕪-𝕠d) which is E-D, for example when e=2 and d=1 this gives 3 which when squared is 9. On the right-hand side there is (e𝕙+𝕚d)(e𝕧-𝕚d) which is E+D, when e=2 and d=1 then this is 5 and 5^2=25. +𝕠d×-𝕠d=-D as both are the square root of -1. +𝕚d×-𝕚d=+D as both are the square root of +1.

The center of the Pythagorean Equation

The central Pythagorean Triangles can be for Roy electromagnetism e𝕪×-𝕘d plus +𝕘d×e𝕒, these would sum to zero. With Biv space-time on the right-hand side they would be +𝕘de𝕙 and -𝕘de𝕧, these also sum to zero.

Forward or backward in time

Because the positive terms move backwards in time these can represent +2ed as +𝕘d×e𝕒 and +𝕘de𝕙. With moving forward in time these would be e𝕪×-𝕘d and -𝕘de𝕧, both of these with e=2 and d=1 would equal 2+2=4. The central terms then can represent adding them to Roy electromagnetism to give Biv space-time or subtracting them from Biv space-time to give Roy electromagnetism.

Constant Pythagorean Triangle areas

This model is consistent with the areas of the Pythagorean Triangles being constant, when the angles θ in Roy electromagnetism with the +𝕠d and e𝕒 Pythagorean Triangle and the -𝕠d and e𝕪 Pythagorean Triangle change the Pythagorean Triangle areas themselves do not change. However, the difference between the straight Pythagorean Triangle sides squared such as E𝔸 and the spin

Pythagorean Triangle sides such as +𝕆D do change, this difference is the same as in the Pythagorean Equation where d and e change values.

Conserved Pythagorean Equation solutions

For example 4-1=3, 2×2×1=4, and 4+1=5, this gives the familiar Pythagorean Equation of $3^2+4^2=5^2$. If d and e change with a change of the angle θ then this gives another Pythagorean Equation solution, in this model the Pythagorean Triangles would not have both sides becoming squares at the same time. This is because a Pythagorean Equation solution with 2 squares is static, there can only be one $3^2+4^2=5^2$ so another solution with integers squared might have to jump to for example $5^2+12^2=13^2$.

Conserved central Pythagorean Triangles

Taking the central Pythagorean Triangles as positive these would be +𝕘d×e𝕒 and +𝕘de𝕙, with a constant Pythagorean Triangle area these can have other values of d and e and remain the same as 2de. For example id e=2 then doubling this makes e=4, d then goes from 1 to ½. Then on the left-hand side this becomes other values of E-D, 16-1/4 and on the right-hand side it becomes 16+1/4. When these are all squared it is $(16-1/4)^2+(2×4×1/2)^2=(16+1/4)^2$ or 248.0625+16=264.0625.

Propagating angle changes

Maintaining a constant Pythagorean Triangle area then gives many solutions to the Pythagorean Equation which are consistent, in this model this means the changes in d and e are conserved when the Pythagorean Triangle areas are constant. This allows for changes in the angles of the Pythagorean Triangles to propagate through these Pythagorean Equations without changing the sums. It also means the e𝕪×-𝕘d photons have a conserved area as do the Gravi.

Universal constants

Because of this constant are then photons have the same energy everywhere, also Gravis with their gravitational waves are the same everywhere. It links the electromagnetic and gravitational forces to universal constants, this leads as will be shown to a constant speed of light and other constants.

Asymmetrical forces

In this model these changes are caused by forces, this is where one Pythagorean Triangle side becomes squared and the other does not. This is propagated through the system so that a squared straight Pythagorean Triangle side is observed as impulse and a particle. A squared spin Pythagorean Triangle side is measured as work and a wave. Because the sums of the Pythagorean Equation do not change, and the areas of the Pythagorean Triangles do not change, then what does change is observed as impulse and measured as work while remaining conserved overall.

Conservation of mass and energy

This for example gives a conservation of mass and energy where mass comes from +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, energy comes from the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse. The word energy here then means what is observed with a particle as it changes position over time with an impulse. The word wave or field here is associated with what is measured as it changes with a torque or probability over a position.

Destroying and creating mass or energy

The Pythagorean Triangles can also be destroyed such as with an electron as the -𝕠d and e𝕪 Pythagorean Triangle and the positron as the +𝕠d and e𝕪 Pythagorean Triangle. These can annihilate each other to leave the central Pythagorean Triangle as e𝕪×-𝕘d photons, these can also form electrons and positrons when near a gravitational field because of Gravis as +𝕘de𝕙. Because these photons have conserved Pythagorean Triangle areas they can also mediate changes between other atoms.

Impulse and work as inverses

These two forces of impulse and work can also act together. Because the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle are inverses of each other this would also give -𝕆D×e𝕪 kinetic work because -𝕆D is a square when E𝔸 is a square. When one Pythagorean Triangle has impulse being observed as a particle then the other has work being measured as a wave.

Differences in Pythagorean Equations

Often the Pythagorean Equations are not conserved in comparison to other nearby Pythagorean Equations, that happens when a change in one atom for example is different from in another atom. To balance these Pythagorean Equation changes so the overall equations are conserved then there must be an interaction between them.

Balancing work and impulse

This can be e𝕪×-𝕘d photons which are observed as e𝕐/-𝕘d light impulse particles or measured as -𝔾D×e𝕪 light work. This can also be Gravis from the +𝕘d×e𝕓 or +𝕘de𝕙 Pythagorean Triangle, the difference is whether e𝕓 depth is used in a gravitational field or its inverse for convenience as e𝕙 height. The two have the same values. The rebalancing would then have Gravi as a -𝕘d/e𝔹 Gravi impulse like gravitons or +𝔾D×e𝕙 Gravi work as gravitational waves.

Because the Pythagorean Triangles all have the same area, then they also have the same area as those Pythagorean Triangles in other atoms or even other galaxies. A change then needs to be transmitted across a position which comes from a straight Pythagorean Triangles side and over a time which comes from a spin Pythagorean Triangle side.

Single hydrogen atoms

The +𝕠d and e𝕒 Pythagorean Triangle and the -𝕠d and e𝕪 Pythagorean Triangle form Roy electromagnetism in a single hydrogen atom, the changes in this are mediated by e𝕪×-𝕘d photons and +𝕘de𝕙 Gravis to rebalance its own Biv space-time with the +𝕚d and e𝕙 Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle.

Simple Pythagorean Equation interactions

This is the simplest unit of the Pythagorean Equation, when there are other hydrogen atoms nearby then changes can be simply mediated between them as rebalancing by e𝕪×-𝕘d photons and +𝕘de𝕙 Gravis. When hydrogen becomes fused in Helium and higher elements then these rebalancing angle θ changes can occur in the same atom.

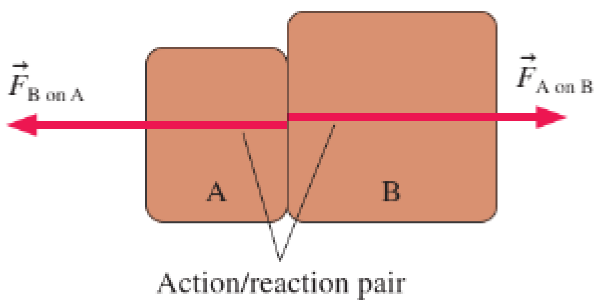
Perturbation and balancing

Because there are active forces these can perturb the Pythagorean Equations, for example with the Higgs Boson there can be a spontaneous asymmetrical change. This would then lead to a rebalancing of the Pythagorean Equations. These perturbations can arise from tipping points in chaos, this comes from impulse. The balancing tends to come from work and probability.

Conserved Pythagorean Triangle pairs

When the -𝕠d and e𝕪 Pythagorean Triangles as electrons gives a E𝕐/-𝕠d kinetic impulse to a block, this is conserved by an equal and opposite reactive E𝕍/-𝕚d inertial impulse from the -𝕚d and e𝕧 Pythagorean Triangles as inertia.

FIGURE 7.2 An action/reaction pair of forces.



Force diagrams

In this model these forces are usually vectors and so are impulse acting on particles. They can be summed up like vectors, here they have no positive or negative signs. Instead as in conventional physics vectors are summed by placing them head to tail. Only the spin Pythagorean Triangle sides have positive and negative signs.

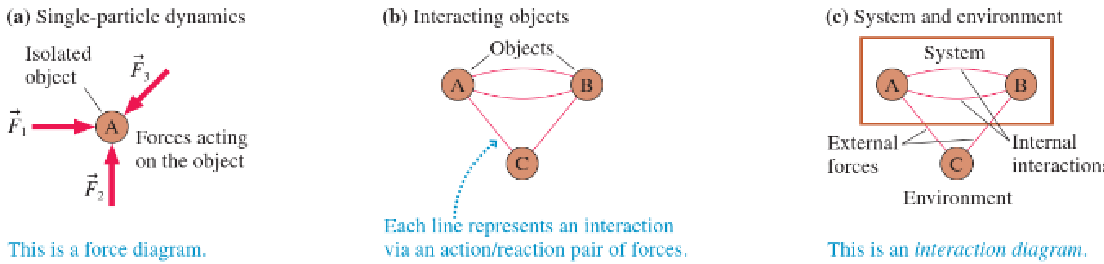
Interacting objects

Here there are two Pythagorean Triangles, such as the -𝕠d and e𝕪 Pythagorean Triangle giving a reaction force with kinetic energy, and the -𝕚d and e𝕧 Pythagorean Triangle giving a reaction force as inertia. This kinetic energy can also have the E𝔸/+𝕠d potential impulse from the proton giving an equal and opposite reactive force. It can also be the Eℍ/+𝕚d gravitational impulse as an action force against the E𝕍/-𝕚d inertial impulse or E𝔸/+𝕠d potential impulse as reaction forces.

System and environment

The two previous cases can occur in a single Pythagorean Equation with angle θ changes. With an environment energy and gravitational changes can be added to it or subtracted from it. This means that heat might be added to or taken from a system with e𝕪×-𝕘d photons, also gravity might cause a system to hit the ground affecting its internal system and Pythagorean Equations.

FIGURE 7.3 Single-particle dynamics and a model of interacting objects.



Interaction diagrams

Here gravity as an active force changes the Pythagorean Equations inside the system box. The action interaction pairs here would be the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse with kinetic energy and inertia, also the Eℍ/+𝕚d gravitational impulse pulls downwards. There is a reaction against this with the normal force, that comes from the E𝔸/+𝕠d potential impulse of the protons in their molecular bonds.

FIGURE 7.5 The interaction diagram.

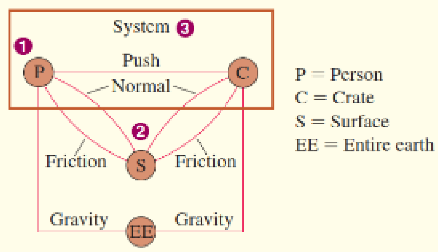
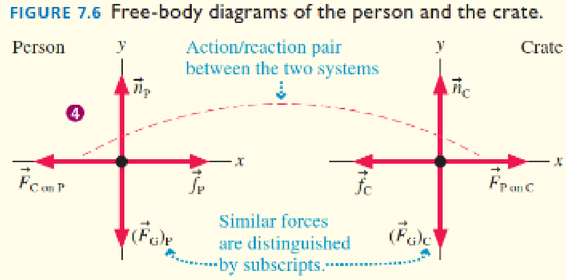


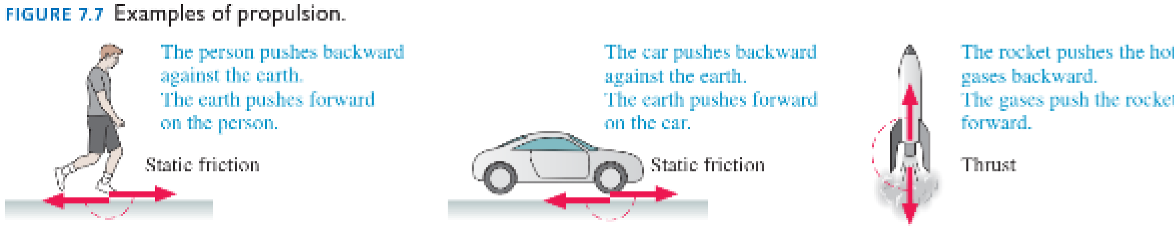
FIGURE 7.6 Free-body diagrams of the person and the crate.



Friction as a reaction force

Here the reaction force comes from the E𝔸/+𝕠d potential impulse as the protons and the molecular bonds resist a change. If the surface was covered in oil this would be reduced and the propulsion would not work as well. There is also the E𝕍/-𝕚d inertial impulse as the ground is being pushed backwards, it reacts against this with its inertia. The rocket creates thrust with a E𝕐/-𝕠d kinetic impulse, the gases expelled behind it react against being displaced with an E𝕍/-𝕚d inertial impulse.

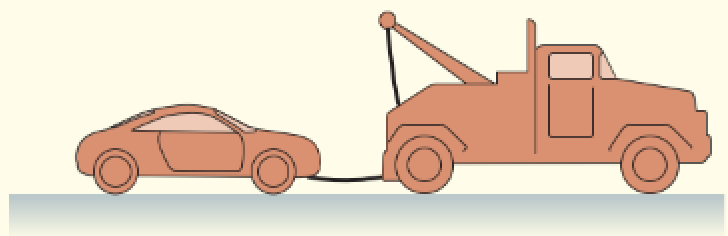
FIGURE 7.7 Examples of propulsion.



Molecular bonds in the rope

The rope also has an action/reaction pair, the E𝕐/-𝕠d kinetic impulse stretches the molecular bonds in the rope. The E𝔸/+𝕠d potential impulse reacts against this, that keeps the rope from breaking so the E𝕐/-𝕠d kinetic impulse is transmitted to the car.

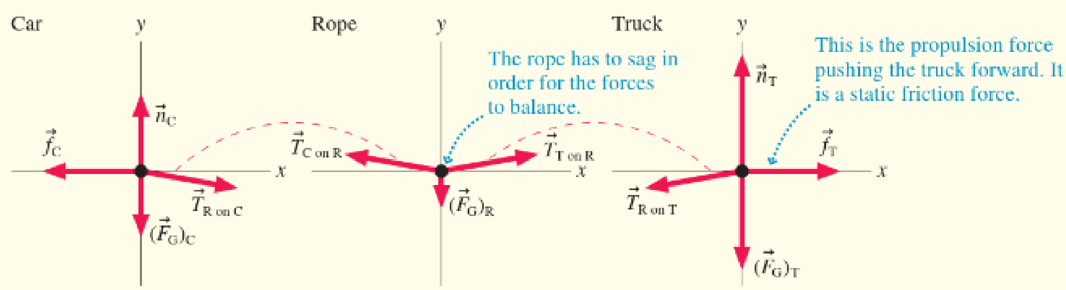
FIGURE 7.8 A truck towing a car.



Free body diagram

Here the term body refers to impulse as particles, otherwise there would be work and fields. The E𝕐/-𝕠d kinetic impulse changes chaotically as the truck pulls on the rope, then the rope sags, and then it is pulled tight.

FIGURE 7.10 Free-body diagrams of Example 7.2.



Newton's third law

In this model there can be action/action and reaction/reaction pairs. A rocket uses an active E𝕐/-𝕠d kinetic impulse to go upwards against the active Eℍ/+𝕚d gravitational impulse downwards. A spring can have the E𝔸/+𝕠d potential impulse of protons with their molecular bonds reacting against the inertia as the E𝕍/-𝕚d inertial impulse. This inertia causes the spring to overshoot in both directions, the molecular bonds react against this over and over. If the spring is instead twisted clockwise and counterclockwise then there are again two reactions forces, there is potential torque from +𝕆D×e𝕒 potential work and inertial torque from -𝕀D×e𝕧 inertial work.

Work and impulse

The reason these are equal in magnitude and opposite in direction with impulse is because magnitude is the straight Pythagorean Triangle side squared such as E𝕐 and E𝕍. The only way this can be opposed is in the opposite direction, when vectors are summed only this can cancel the first vector. With a Wilberforce pendulum a spring can be tuned to move up and down with impulse, then rotate with work over and over. Because each is a different kind of force they can operate one after another.

Newton's third law Every force occurs as one member of an action/reaction pair of forces.

- The two members of an action/reaction pair act on two *different* objects.
- The two members of an action/reaction pair are equal in magnitude but opposite in direction: $\vec{F}_{\text{A on B}} = -\vec{F}_{\text{B on A}}$.

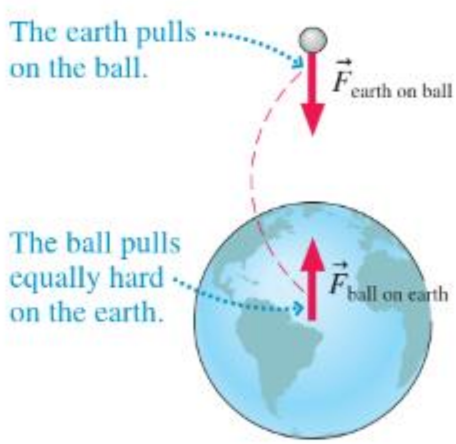
Gravity and inertia

In this model gravity has active forces from the +𝕚d and e𝕙 Pythagorean Triangle, inertia has reactive forces from the -𝕚d and e𝕧 Pythagorean Triangle. These are inverses of each other, the ball here has an E𝕍/-𝕚d inertial impulse which reacts against the Eℍ/+𝕚d gravitational impulse of the Earth. The ball also has a Eℍ/+𝕚d gravitational impulse which acts on the E𝕍/-𝕚d inertial impulse of the Earth. When the ball moves closer to the Earth the Eℍ/+𝕚d gravitational impulse has e decreasing in e𝕙 height as a square in Eℍ, inversely to this the ball has its E𝕍 length force decreasing as a square.

Inverse Pythagorean Triangles

Because each Pythagorean Triangle changes inversely in regard to the other both remain weightless in terms of +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, they also remain in free fall with the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse. This appears as if the forces are equal to each other, otherwise the ball would observe and measure impulse and work. Because the -𝕚d and e𝕧 Pythagorean Triangle only has reactive forces these are subtracted from the +𝕚d and e𝕙 Pythagorean Triangle.

FIGURE 7.11 The action/reaction forces of a ball and the earth are equal in magnitude.



Potential and kinetic pressure

In between the boxes there is a E𝔸/+𝕠d potential impulse reacting against a potential pressure. This would be compressing the molecular bonds forcing the electrons with their E𝕐/-𝕠d kinetic impulse to lower orbitals. By reacting against this the kinetic pressure from the hand and its E𝕐/-𝕠d kinetic impulse is transmitted through both blocks. There is also a E𝔸/+𝕠d potential impulse under the blocks where they tend to form molecular bonds with the surface, here this is frictionless as an example. The blocks also react against this motion with an E𝕍/-𝕚d inertial impulse towards the left as well as a Eℍ/+𝕚d gravitational impulse downwards.

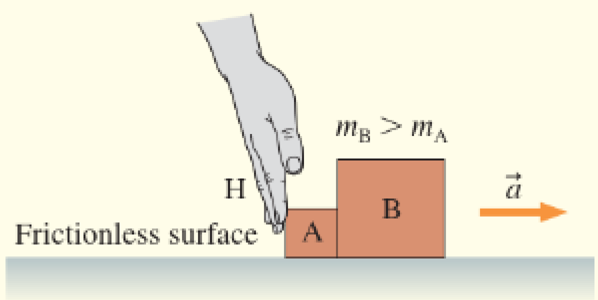
Pressure and impulse

In this model pressure is from the straight Pythagorean Triangle sides and impulse, this is because it is exerted in straight lines. Pressure is observed in Joules which in this model comes from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. A stronger pressure would lead to a faster expansion of a balloon for example, this change would be observed on a time scale as impulse.

Stress and strain

These are more related to torque and the spin Pythagorean Triangle sides, the blocks might be deformed by the hand pushing them because the smaller block A pushes in the bottom of the block B. This would be -𝕆D×e𝕪 kinetic work which would be reacted against by +𝕆D×e𝕒 potential work from the molecular bonds. This would be easier to measure if the two blocks were sponges and there was friction on the surface. The stress and strain here would be measured with the ½×-𝕆d/e𝕐 ×e𝕪 rotational kinetics and the ½×+𝕆d/E𝔸 ×e𝕒 rotational potential.

FIGURE 7.12 Hand H pushes boxes A and B.



Net forces

When there are net forces in this model, these are where a reactive force is added or subtracted from an active one. The reactive forces of inertia here cannot be observed or measured directly as impulse or work, with the E𝕐/-𝕠d kinetic impulse this is an active force pushing the blocks to the right. The active kinetic forces begin as chemical reactions in the hand's muscles.

Kinetic forces in muscles

For example energy as e𝕪×-𝕘d photons would cause the molecular bonds in the muscles to expand as electrons move outwards in their orbitals. This is reacted against by the protons as +𝕠d and e𝕒 Pythagorean Triangles in these muscle atoms, that reaction is added to the kinetic forces reducing their strength.

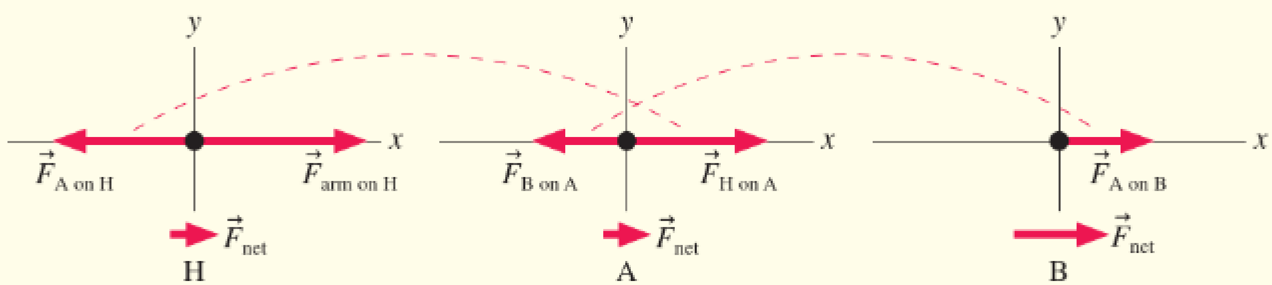
Inertia of the hand and blocks

These kinetic forces cause the hand to move to the right with an inertia from the -𝕚d and e𝕧 Pythagorean Triangles of the electrons, this is reacted against by an equal and opposite force in the blocks. As this is overcome the blocks change their inertia, with vectors here this would be a change in their E𝕍/-𝕚d inertial impulse.

Gravity restoring the electron orbitals

As these inertial changes occur the Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work done by the protons also changes, the electrons are drawn back actively to lower orbitals by gravity so there is a net force between the +𝕚d and e𝕙 Pythagorean Triangles with gravity and the -𝕚d and e𝕧 Pythagorean Triangles with inertia.

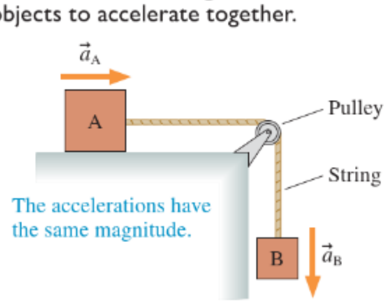
FIGURE 7.13 The free-body diagrams, showing only the horizontal forces.



Reducing gravity

Here the block A would react with inertia against being pulled by gravity, its -𝕚d inertial mass is subtracted from block B's +𝕚d gravitational mass. This slows the blocks as if the gravity has been reduced, the same happens with a satellite where its -𝕚d inertial mass appears to cancel out a planet's +𝕚d gravitational mass so it is no longer pulled downwards onto the planet.

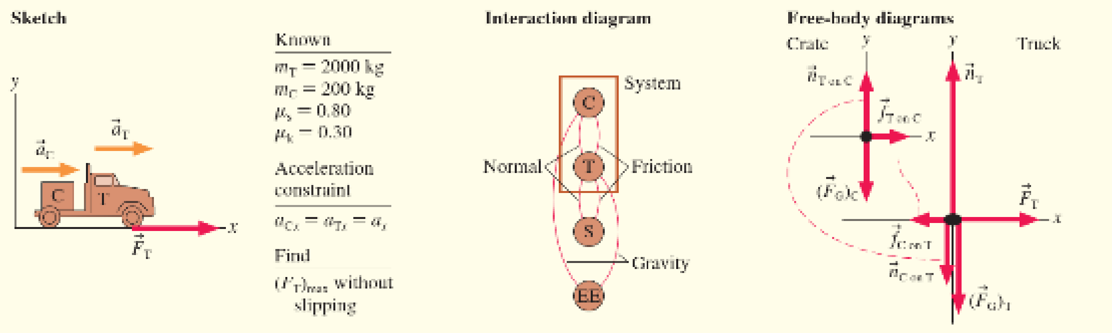
FIGURE 7.15 The string constrains the two objects to accelerate together.



Normal force and friction

The normal force is where the protons and their +𝕠d and e𝕒 Pythagorean Triangles react against the deformation of their molecular bonds. Potential friction is where molecular bonds between the tires and the road need to be broken as the truck moves. A gravitational friction is where the tire molecules move up and down against gravity like small hills.

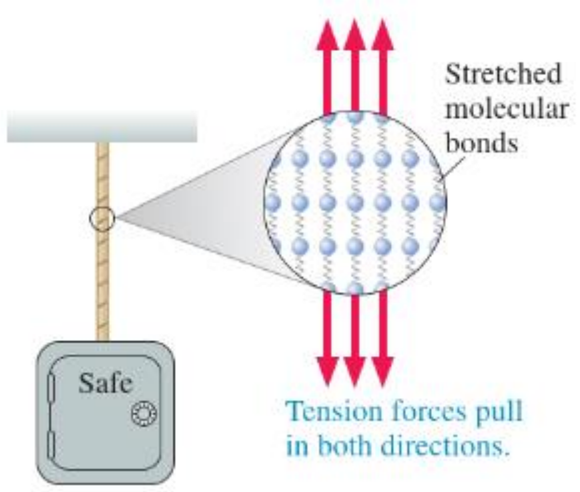
FIGURE 7.16 Pictorial representation of the crate and truck in Example 7.4.



Work and impulse on molecular bonds

The molecular bonds are stretched by an active force of gravity or kinetics. When the bonds are stretched in a straight-line this is impulse, the Eℍ/+𝕚d gravitational impulse pulls the safe downwards. If the safe was also being accelerated upwards by a rocket this would be a E𝕐/-𝕠d kinetic impulse. If the molecular bonds are twisted then this comes from work, the +𝕀D×e𝕙 gravitational work done on the rope would also tend to turn the molecules with a torque. There would be -𝕆D×e𝕪 kinetic work if the safe was being moved upwards as well.

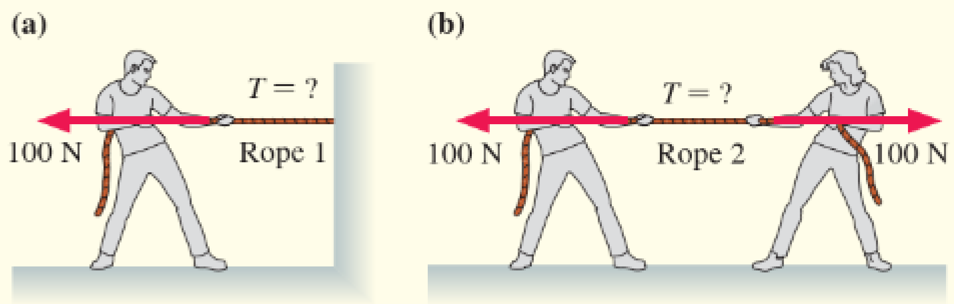
FIGURE 7.17 Tension forces within the rope are due to stretching the spring-like molecular bonds.



Rope and tension

The rope can only react against being stretched by the E𝕐/-𝕠d kinetic impulse from the boy. There is a E𝔸/+𝕠d potential impulse as the molecular bonds react against being stretched. There would also be a Eℍ/+𝕚d gravitational impulse as gravity causes the protons in each molecule to be attracted to other molecules, this also causes the rope to rebound against being stretched. There is also the E𝕍/-𝕚d inertial impulse of the rope reacting against being moved, when it begins to be stretched it tends to keep move to the left. This is reacted against by the E𝔸/+𝕠d potential impulse and actively by the Eℍ/+𝕚d gravitational impulse.

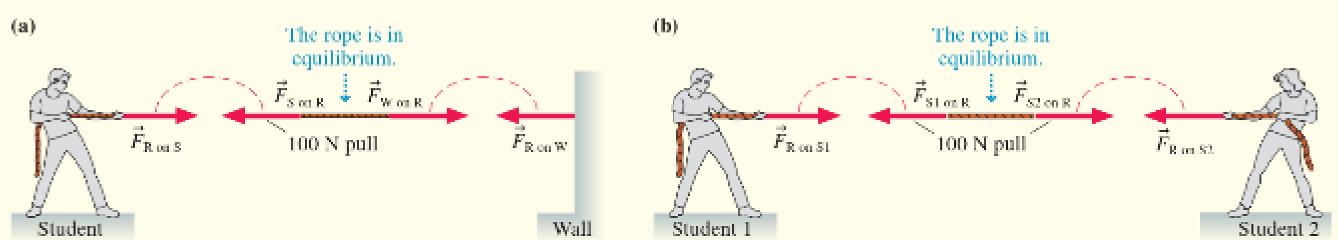
FIGURE 7.18 Which rope has a larger tension?



Molecular bonds and tension

The wall exerts a reactive E𝔸/+𝕠d potential impulse as the molecular bonds in it are stretched, also there is a Eℍ/+𝕚d gravitational impulse as the protons are attracted closer to each other. The girl exerts and active E𝕐/-𝕠d kinetic impulse on the rope, this has the same effect because the d and e values in the -𝕠d and e𝕪 Pythagorean Triangles as kinetic forces would be the inverse of the +𝕠d and e𝕒 Pythagorean Triangles with their potential forces. Also because the girl is not moving her molecular bonds are reacting against this motion with a E𝔸/+𝕠d potential impulse like the wall. Her protons would be actively attracting each other holding the molecular bonds together with a Eℍ/+𝕚d gravitational impulse.

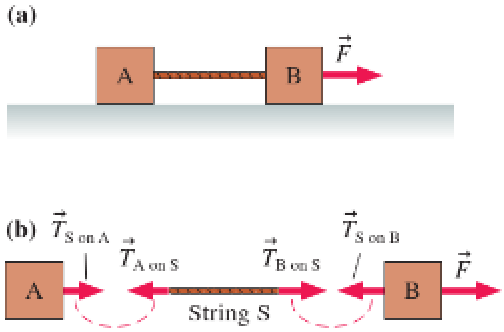
FIGURE 7.19 Analysis of tension forces.



As if

Here the mass of the string is ignored, the stretching of the string would introduce an additional impulse. The effect is similar to a tennis ball hitting a racquet, the string stretches from the E𝕐/-𝕠d kinetic impulse of the block being moved. This causes the e𝕒 altitude in the molecular bonds of the string to increase, that causes a reaction with the E𝔸/+𝕠d potential impulse against this. There is also a Eℍ/+𝕚d gravitational impulse where the molecular bonds are attracted to each other. These impulses are ignored to examine the forces on the blocks directly.

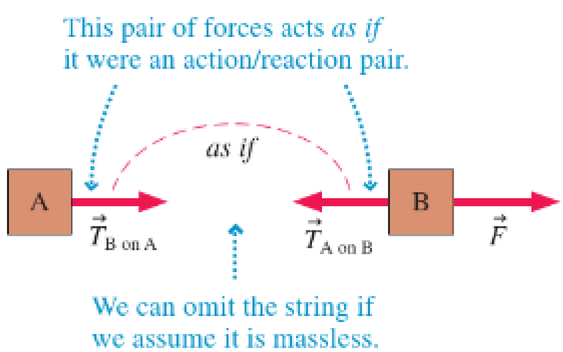
FIGURE 7.20 Tension pulls forward on block A, backward on block B.



Action/reaction pairs

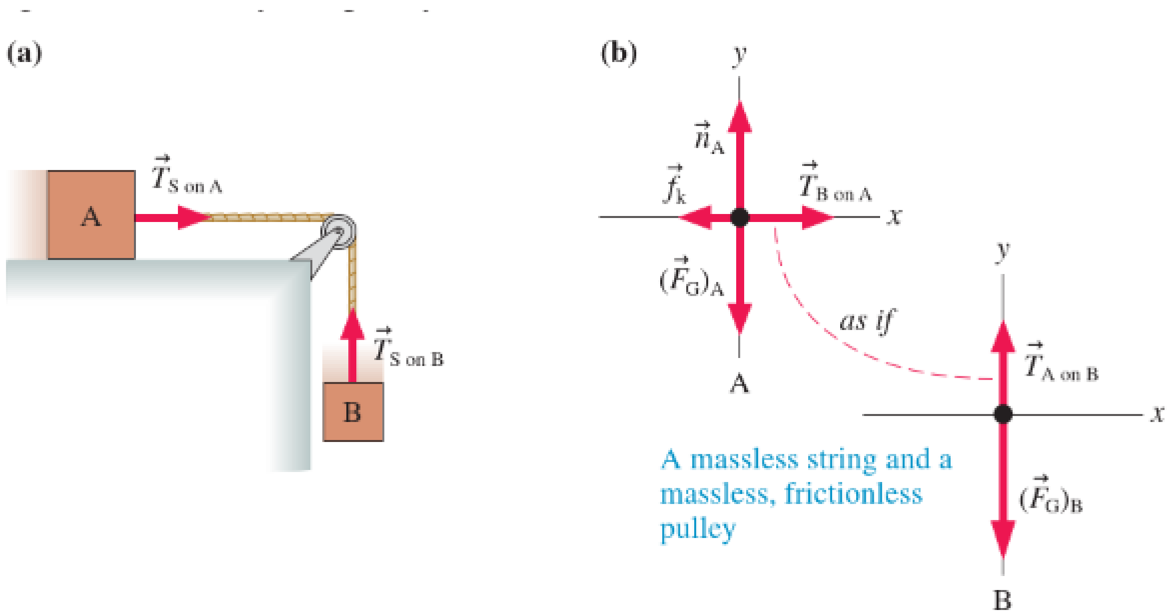
Here the action comes from the E𝕐/-𝕠d kinetic impulse in pulling one block, there is a E𝔸/+𝕠d potential impulse reaction against this giving the action/reaction pair. There is also an action reaction pair in the string as described, the E𝕐/-𝕠d kinetic impulse stretches the string and the E𝔸/+𝕠d potential impulse reactions against this.

FIGURE 7.21 The massless string approximation allows objects A and B to act *as if* they are directly interacting.



Gravity and the potential impulse

Here there is an action force from the Eℍ/+𝕚d gravitational impulse, reacting against this is the E𝔸/+𝕠d potential impulse from the protons making molecular bonds between the block and the table.



Overcoming potential friction

The molecular bonds in the leg and their E𝔸/+𝕠d potential impulse are stretched by the Eℍ/+𝕚d gravitational impulse, this causes a slippage with some molecules with their potential friction being overcome. It can allow bone segments to straighten for healing.

FIGURE 7.25 A leg in traction.

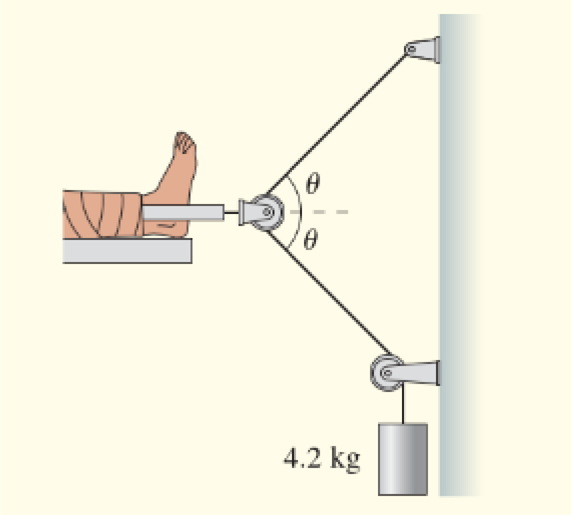
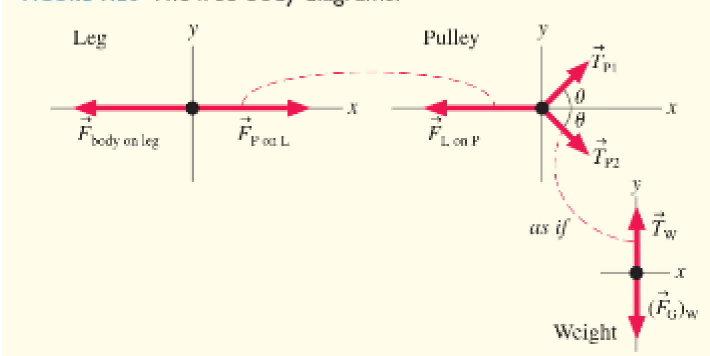


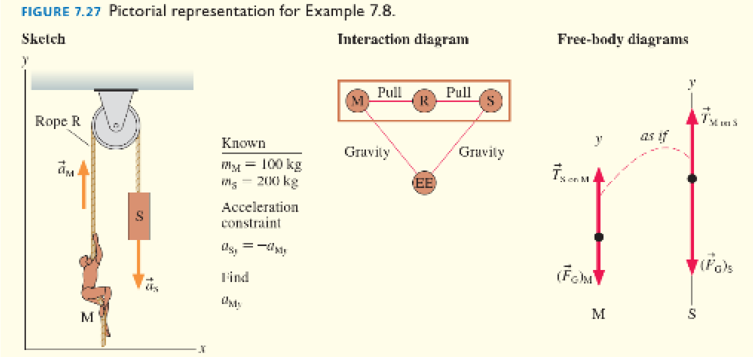
FIGURE 7.26 The free-body diagrams.



Gravitational impulse

In this diagram both active forces come from the Eℍ/+𝕚d gravitational impulse.

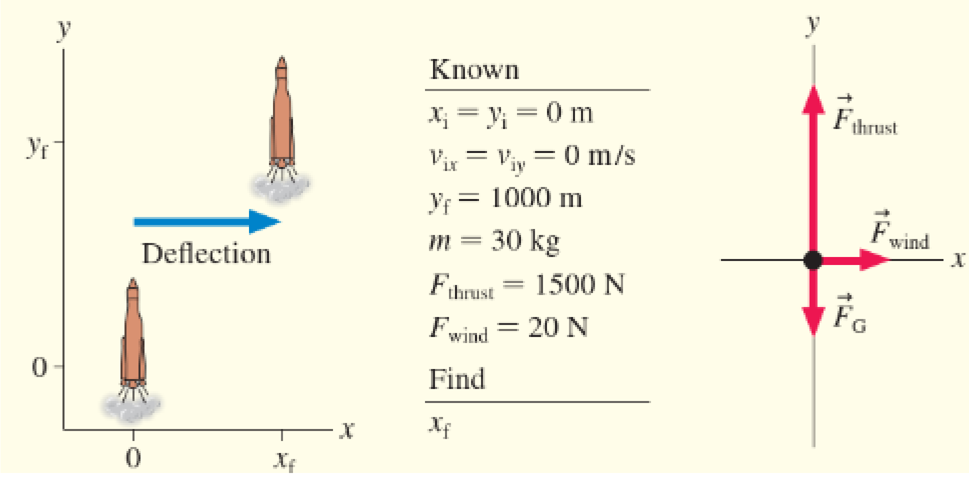
FIGURE 7.27 Pictorial representation for Example 7.8.



Dynamics 2: motion in a plane

Here the forces can be in a plane, in this model forces are squared values of square roots. With impulse there is no actual plane of force, that would come from work as a field. There is a Eℍ/+𝕚d gravitational impulse pulling the rocket down, also a E𝕐/-𝕠d kinetic impulse moving the rocket upwards by creating an E𝕍/-𝕚d inertial impulse of the burning fuel downwards. The E𝕍/-𝕚d inertial impulse of the wind would come from the E𝕐/-𝕠d kinetic impulse of it being heated by the sun, also by being pulled downwards by a Eℍ/+𝕚d gravitational impulse.

FIGURE 8.1 Pictorial representation of the rocket launch.



Banked curves

Here there is a Eℍ/+𝕚d gravitational impulse pulling downwards, the car used a E𝕐/-𝕠d kinetic impulse from burning fuel to increase its kinetic velocity. This causes a centrifugal force as the car has a tendency to move in a straight-line from impulse. Being on a circular track the impulse is changed in its direction with a E𝔸/+𝕠d potential impulse from the tires holding molecular bonds between the tires and the road.

On banked curves, the normal force of the road assists in providing the centripetal acceleration of the turn.

Roy electromagnetism and impulse

In Roy electromagnetism the force outwards is active from the E𝕐/-𝕠d kinetic impulse, this is reacted against by an inward E𝔸/+𝕠d potential impulse. When an electron is an atom there are not necessarily forces, there can be a balance between the outward squared force E𝕐 and the inward force E𝔸. That would mean there are no forces and the electron could not be observed.

Impulse is not quantized

This could not happen in a circle with this model, the forces of impulse are chaotic. They could not then create a circle as this would be a constant quantized value of the -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work. Then the forces could not be shown as vectors, they only occur with a magnitude of a straight-line force with impulse. Instead the forces are waves, there would be a wave travelling in a circle doing -𝕆D×e𝕪 kinetic work while the proton does +𝕆D×e𝕒 potential work with the are inside the circle.

Biv space-time and impulse

If this was in Biv space-time then the active force would be inwards with the Eℍ/+𝕚d gravitational impulse, the reactive passive force is outward with the E𝔸/+𝕠d potential impulse. These also could not go in a perfect circle, that would make them the +𝕀D×e𝕙 gravitational work and the -𝕀D×e𝕧 inertial work. Then the area inside the circle would be from the +𝕚d gravitational field, the inverse square law makes +𝕀D decrease as a square while the e𝕙 height increases.

Inverse square law and the parabola

With the inverse square law this is from work, when there is impulse it becomes a parabola where one axis is squared and the other changes constantly. The parabola refers to the motion of a particle with impulse, the inverse square law refers to the changes in a wave.

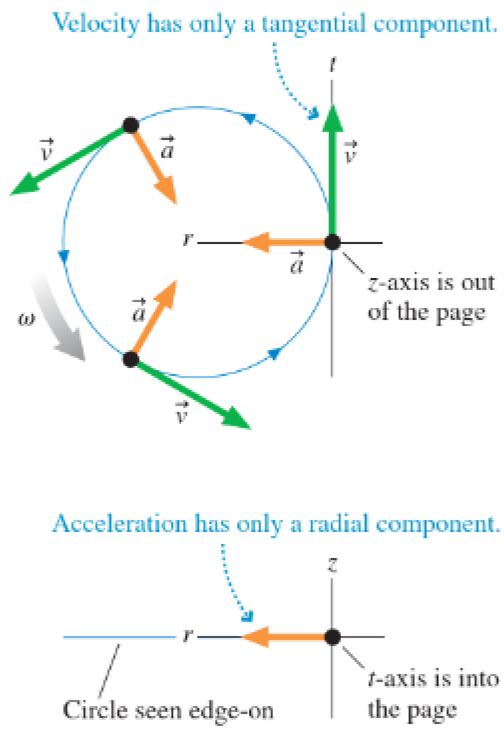
Derivatives and integrals

A derivative comes from a slope and the division of two values. This allows for a continuous spectrum with impulse, like the Compton effect of a photon colliding with an electron. It also occurs from two electrons colliding as particles because the E𝕐/-𝕠d kinetic impulse is a fraction. Work comes from a multiplication such as the -𝕆D×e𝕪 kinetic work, it can form a field as the two are multiplied together. It cannot form a fraction and so a continuous spectrum is not possible. Instead, it is quantized with a discrete spectrum, the gaps in between cannot be filled in with fractions. In this model then the concept of quantization arises naturally from an integral area.

Radial and tangential components

In this model a Pythagorean Triangle is not part of a circle and so the concepts of radius and tangent do not apply to them. The probability of where an electron is relates to its -𝕆D×e𝕪 kinetic work and the +𝕆D×e𝕒 potential work from the proton, these are the squares of square roots making them forces which can be measured.

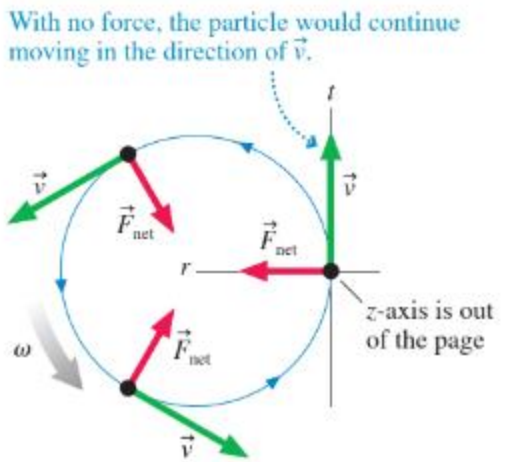
FIGURE 8.3 Uniform circular motion and the *rtz*-coordinate system.



Observing a vector

In this model the net force would only be directed inward with Biv space-time as the Eℍ/+𝕚d gravitational impulse. With Roy electromagnetism the E𝔸/+𝕠d potential impulse is reactive and cannot be observed directly. It is instead added to the E𝕐/-𝕠d kinetic impulse of the electron reducing its overall force. Showing this E𝔸/+𝕠d potential impulse as a separate vector can make it appear as if it can be observed separately.

FIGURE 8.4 The net force points in the radial direction, toward the center of the circle.



Impulse and circular motion

Here the force refers to a squared value, the unsquared value is not being measured as work or observed as an impulse. Modeling the object as a particle means only impulse can be observed, modeling it as a wave means only work can be measured. With impulse there cannot be uniform circular motion, this only happens with work such as the integer number of deBroglie waves around an orbital.

Gravito-inertial forces

This force here $F^{\rightarrow}_{net}$ is the mass as -𝕠d which is the kinetic magnetic field of the electron, that is proportional to the -𝕚d inertial mass of the electron. This is in Biv space-time, the velocity here is squared as E𝕍/-𝕀D with dimensional analysis. That is divided by the radius e𝕙 from the Eℍ/+𝕚d gravitational impulse. These forces also act proportionally on an electron in an orbital, they must be so that the electromagnetic forces and gravito-inertial force balance each other.

Proportions of Roy and Biv forces

For example, if the electron weighed more then it could not stay in its ground state in a hydrogen atom, it would have to move further out and so α would be different. In this model the values of α and c are derived, because gravity also determines the orbital radius this also leads to the derivation of the gravitational constant.

Gravito-inertial and electromagnetic forces

Here gravito-inertial is not the same as electromagnetic as a concept, electromagnetism in this model is a balance between the electrical forces from the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse along with the magnetic forces from the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. Gravito-inertia can be regarded as how the +𝕀D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse have the -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse subtracted from them to give the overall attraction of a satellite to a parent body.

Electromagnetism and stress energy

A related concept to electromagnetism would be the stress energy tensor in General Relativity, this refers to the energy of a body and its momentum. In this model the energy is related to impulse, the E𝕐/-𝕠d kinetic impulse of an electron for example leads to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy.

Impulse observes energy

Here only one side of a Pythagorean Triangle can be observed as an impulse or measured as work in a position or time, so the term E𝕐/-𝕆D is a classical approximation leading to uncertainty. Instead, impulse observes energy in this model, this can be gravitational energy with the Eℍ/+𝕚d gravitational impulse in General Relativity. That leads to the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation term used in this model, it is analogous to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy.

Inertial energy

There can also be inertial energy from the E𝕍/-𝕚d inertial impulse with a satellite orbiting a planet in General Relativity. This comes from observing the E𝕍/-𝕚d inertial impulse and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. That is proportional to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy in an electron for example, the format of the two equations is the same.

Energy and height or length contraction

The velocity of the satellite is subject to Special Relativity, its E𝕍/-𝕚d inertial impulse or inertial energy would lead to its e𝕧 length contracting as its velocity increased. With a larger planet its Eℍ/+𝕚d gravitational impulse leads to a e𝕙 height contraction of an object with General Relativity, this is observed in its gravitational well.

Stress energy and momentum

The stress energy tensor is also related to momentum, in this model a satellite might move while doing -𝕀D×e𝕧 inertial work. This relates to its inertial momentum or -𝕚d×e𝕧/-𝕚d because the force of this increases as a square if the satellite has more mass. If the satellite is heavier then its inertial momentum requires more gravitational energy from the Eℍ/+𝕚d gravitational impulse to constrain it into an orbit. It can then be said that the gravitational energy creates an inertial stress on the satellite urging it into an orbit.

Linear energy as a classical approximation

The satellite can be regarded as having an inertial energy, in this model that comes from the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. It has the same form as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and the denominator 1/-𝕆D is also squared compared to the unsquared denominator in the E𝕍/-𝕚d inertial impulse. This means the ½×e𝕍/-𝕀d ×-𝕚d linear inertia is also a classical approximation, it is observing the E𝕍/-𝕚d inertial impulse and measuring the -𝕀D×e𝕧 inertial work at the same position and time which violates the uncertainty principle.

Inertial energy and gravitational stress

With its inertial energy the satellite is subject to the +𝕀D×e𝕙 gravitational work done by the planet, this comes from its +𝕚d×e𝕙/+𝕠d inertial momentum. The gravitational field then exerts a gravitational stress on the inertial energy of the satellite, this allows for a stress energy tensor to be used in both cases. The term stress energy is not ideal for this model, but here it is used to be proportional to an electro-magnetic tensor in Roy electromagnetism.

Roy electromagnetism and Biv stress energy

In Biv space-time a satellite is rarely charged negatively and the planet positively, instead in Roy electromagnetism the electron is negatively charged and the proton is positively charged. The electron has a -𝕚d inertial mass which can act as inertial energy with an E𝕍/-𝕚d inertial impulse or an inertial stress with -𝕀D×e𝕧 inertial work. The proton has a +𝕚d gravitational mass which can act as a gravitational energy with the Eℍ/+𝕚d gravitational impulse or a gravitational stress with the +𝕀D×e𝕙 gravitational work.

A potential and gravitational tensor

With the +𝕠d potential field around a proton this is proportional to the +𝕚d gravitational field around it. That means the tensors in General Relativity are proportional to a tensor representation in Roy electromagnetism as another classical approximation, the electron would move in a potential geodesic in a +𝕠d potential field around the proton as well as a +𝕚d gravitational geodesic in this field.

The macro world and impulse

In the macro world impulse is much stronger than work, this is because the positions are larger and so being squared the forces are also larger. This creates a problem in General Relativity because it relates mainly to fields, but in this macro world particles are observed more easily. The deBroglie wave of an electron for example becomes much smaller in this macro world, it acts move like a particle.

Impulse in General Relativity

That makes the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse the dominant forces in General Relativity, but in this model the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work can also refer to the fields around particles and their impulses. In this model the particle nature with their impulses cannot be observed in the same position and time as their field nature with work. How impulse and work are separated then can lead to the removal some paradoxical aspects of General Relativity.

Quantum mechanics as Roy, Relativity as Biv

Quantum Mechanics as Roy electromagnetism is more prominent in the micro world with waves and work, in this model they are combined with the particles and impulse in General and Special Relativity. This happens as the work forces of waves and probability are associated with smaller straight Pythagorean Triangle sides, these occur because the Pythagorean Triangles have a constant area. As the spin Pythagorean Triangle sides dilate then the straight Pythagorean Triangle sides contract. Over smaller positions then the work forces much be larger, conversely over larger positions the impulse forces are larger with particles.

Time dilation and impulse

A particle then moves with an E𝕍/-𝕚d inertial impulse in a +𝕚d gravitational field, but the dominant or active force is the Eℍ/+𝕚d gravitational impulse from a planet. The use of the +𝕚d gravitational field allows for the observation of a slower inertial time on a clock gauge.

The Einstein, metric and stress energy tensors

The Einstein tensor and the metric tensor add to the Stress energy tensor in General Relativity. This uses a tensor because the volume of space around a gravitational mass is being measured. In this model only two-dimensional fields are used, this means a tensor is a classical approximation only. The Einstein tensor measures the gravitational curvature around a mass, here this curvature comes from the spin Pythagorean Triangle side. This gives the curved field or geodesic, the more a straight Pythagorean Triangle side is curved to one side the more space is curved as a classical approximation.

The metric tensor

The metric tensor gives the curvature values of this +𝕚d gravitational field around a body, this can be complicated because it is in effect bending an array of cubes into a more rounded shape around this body. Because of this each cube is deformed in ways which are described by mathematical operations. It is analogous to a stress energy tensor in other parts of physics, for example a sponge with segments of cubes might be stress into shapes like a ball which could also be described with a three-dimensional tensor.

The Cosmological Constant

The other term in the General Relativity field equations in the Cosmological Constant. This indicates that space is not flat according to an amount of e𝕙 height above a +𝕚d gravitational mass, in this model it means there is a contraction of the +𝕚d gravitational mass in any direction as the height increases because the Pythagorean Triangle area is constant. This is seen for example where the +𝕚d gravitational field decreases at a greater e𝕙 height from a planet.

A minimum cosmological constant

It also means this cosmological constant appears as a minimum value, that is as if the universe has been decelerating after the Big Bang explosion. The constant determines whether the universe would continue expanding, come to a stop, or accelerate back to another Big Bang. In this model the +𝕚d and e𝕙 Pythagorean Triangle has a large e𝕙 height that extends all the way to the CMB, locally these Pythagorean Triangles have a minimum e𝕙 height and a contracted +𝕚d gravitational mass.

A zero cosmological constant is not possible

This appears as a changing eℍ/+𝕚d gravitational impulse, as the +𝕚d gravitational time from the appearance of Big Bang dilates then eℍ as the gravitational displacement from an initial to a final e𝕙 contracts. This is observed as a slowing of this gravitational acceleration from the Big Bang, it comes close to zero because e𝕙 acts as an infinitesimal. It cannot be zero because the +𝕚d and e𝕙 Pythagorean Triangle would not exist so the cosmological constant would then be zero.

Gravitational time in reverse

In this model the +𝕚d and e𝕙 Pythagorean Triangle moves backwards in time, the Big Bang can be modeled as time in reverse, the +𝕚d gravitational time from the present gives a small initial gravitational acceleration as the cosmological constant. This increases as the e𝕙 height dilates, that acts as the eℍ gravitational displacement from an initial to a final position.

Gravitational exponential

Because this is dilating as a square then +𝕚d as the gravitational time is contracting, the two diverge as a gravitational exponential because of the constant Pythagorean Triangles area. This is a property of the Pythagorean Triangles in this model, whenever one Pythagorean Triangle side is squared then compared to the other there is an exponential or logarithmic curve.

Redshifts and the gravitational impulse

This increased gravitational acceleration towards the CMB is what is observed in reverse, it appears as if there was a large initial acceleration that slowed towards the present. Because the +𝕚d gravitational time is contracting with a dilated eℍ gravitational displacement then this appears as gravitational time slowing on a clock gauge. The e𝕪×-𝕘d photons from this Big Bang also appear to be redshifted according to this eℍ height displacement, from the initial e𝕙 height away from the observer where they are emitted to the final e𝕙 height at the observer. This gives the +𝕚d gravitational time contraction as a redshift.

A gravitational well and redshift

This is the same as e𝕪×-𝕘d photons being redshifted in climbing up a gravitational well, the eℍ gravitational displacement increases at larger distances. The -𝕘d rotational frequency of the e𝕪×-𝕘d photons is proportional to this contraction of +𝕚d gravitational time, as -𝕘d contracts the frequency of the photons redshifts. This also increases the e𝕧 wavelength of the photons inversely. The changing redshift is called the Hubble constant in this model, it acts as a square because of eℍ. The Big Bang then in this model appears as a large gravitational mass which exploded.

The maximum e𝕙 height and the CMB

As the eℍ gravitational displacement approaches a maximum the CMB is reached, this is proportional to the ground state in atoms below which no e𝕪×-𝕘d photons can be emitted. The effect is like a large gravitational well, the increased e𝕙 height is analogous to seeing photons being redshifted coming up from a large planet. The larger this e𝕙 height above the planet the greater the redshift, moving closer to the surface would reduce this redshift.

Changes in the CMB

The changes in the CMB would come from the relative motions of galaxies being observed and measured in it. These galaxies would be measured with +𝕀d×e𝕙 gravitational work, their e𝕙 height is contracted into a nearly flat plane as the CMB.

Sound waves and the galactic web

There appear to be sound waves in the CMB, these become the web of galaxies in conventional cosmology after the Big Bang explosion. In this model they are the existing galactic web which is contracted into the CMB with a minimum e𝕙 height. Instead of these exploding outwards to become the galactic web, in this model they are e𝕙 height contracted into appearing as the CMB.

Limits of the +𝕚d and e𝕙 Pythagorean Triangle

In this model the Pythagorean Triangle can have a dilated e𝕙 height allowing it to reach to the CMB, the angle θ opposite the spin Pythagorean Triangle side +𝕚d is then contracted to a minimum. This Pythagorean Triangle is defined in this model by the speed of light, reaching this maximum gravitational speed e𝕙/+𝕠d stop the angle θ from contracting.

Properties of the +𝕚d and e𝕙 Pythagorean Triangle

The properties of the +𝕚d and e𝕙 Pythagorean Triangle are derived later from math, they come from α as the fine structure constant and the relative masses of the proton and electron. This is because the +𝕚d and e𝕙 Pythagorean Triangle with its gravitational mass must be proportional to the +𝕠d potential magnetic field of the proton. If not then there would be opposing forces from the proton's gravitational attraction of the electron and the potential electric charge giving the Coulomb force.

Moving to the CMB

Moving to the CMB in this model would make it disappear, the atoms there are from galaxies at this limit of our ability to observe and measure them. When this eℍ height above the CMB is reduced from the limit by moving towards it, that would be like moving deeper into the gravitational well of the planet earlier. The redshift would decrease, the CMB would appear to be moving forward in time so that when the observer arrived there it would be like a typical galactic web.

The CMB as a black hole event horizon

The redshift would decrease, the CMB would first appear as more like a quark gluon plasma, then atoms, then forming into galaxies like those close by. The expansion and evolution of the universe from the CMB then occurs as the changing angles of the +𝕚d and eℍ Pythagorean Triangles allow for different matter to form.

Relativistic matter appears as different quarks

When these angles θ are contracted then matter cannot appear to be normal, quarks will act as if they have different properties. In this model they would appear as being in the third generation as top and bottom, then strange and charm, when closer they would appear to have decayed into top and bottom quarks with protons and neutrons.

Changing Pythagorean Triangle angles and appearence

With extreme +𝕚d mass dilation this matter cannot appear to be normal, instead it might seem compressed like neutron stars or black holes. These Pythagorean Triangles must be observed and measured to be consistent with their extreme angles θ, just as a speeding rocket appears to have a contracted e𝕧 length contraction and -𝕚d time dilation. The matter like the rocket cannot appear otherwise, atoms nearer the CMB cannot appear to be normal. Instead, because galaxies cannot form with that amount of mass and time dilation, they cannot be observed and measured there.

Traveling to mass dilated matter

If the angles θ in these Pythagorean Triangles can only allow observations and measurements of protons and neutrons then they could not be observed and measured close to the CMB, even though if we went there that elapsed +𝕚d gravitational time would mean they would be normal galaxies.

The CMB as a black hole

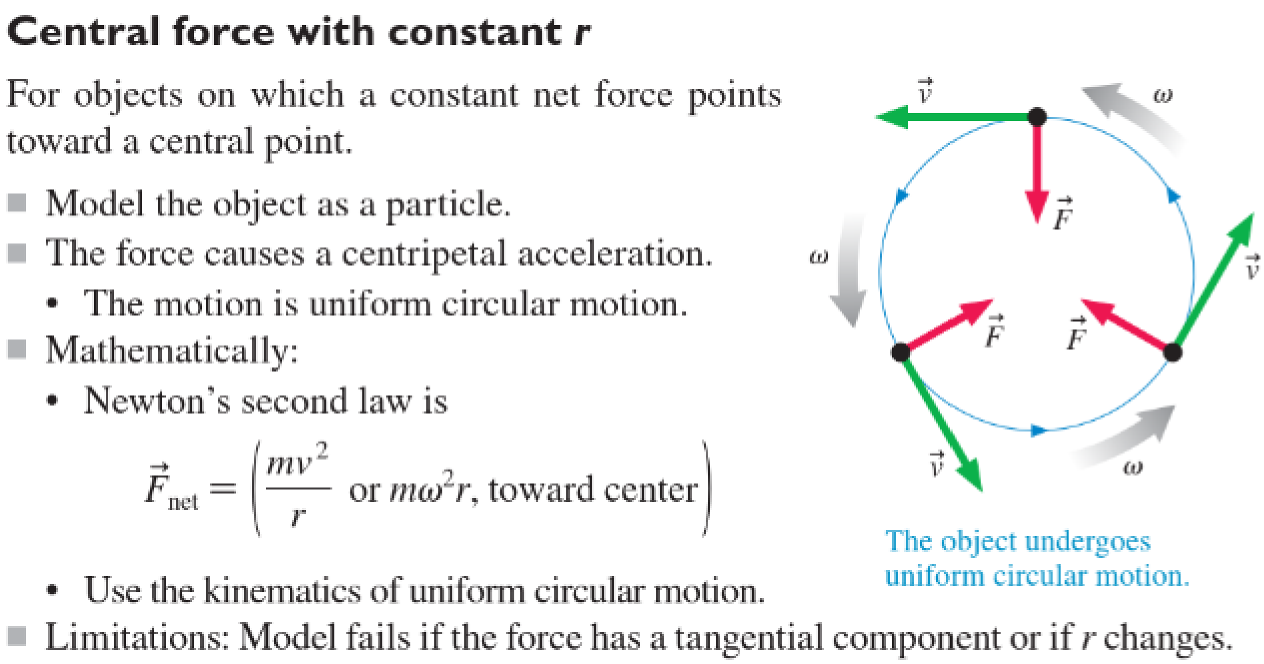
In effect the CMB appears as the event horizon of a large black hole, but passing through it would have no effect. This is also hypothesized with large black holes in conventional physics. Approaching an event horizon of a black hole would have a similar appearance, the photosphere of trapped photons would be like the CMB. Matter near the horizon would be highly compressed, a star would appear more like a neutron star with this decreased eℍ height above the event horizon. Just as a galaxy is torn apart around a black hole, one cannot form close to the CMB.

Stars evolving in reverse

Because this would appear as going backwards in +𝕚d gravitational time there would not be an observed motion as an explosion, nor would it appear to be falling into the CMB like a black hole. Instead moving closer to this matter with +𝕚d gravitational time would have its -𝕚d inertial time running forward. This would allow for atoms to be observed with a less contracted e𝕙 height, a neutron star in moving backwards in time would seem to form a conventional star. Neutron stars nearby appear to be from a collapsed conventional star, with +𝕚d gravitational time reversed they would appear like a movie of stars running backwards.

A Steady State universe appearing as a Big Bang

In this model the universe would be unending as a Steady State but appear as having this CMB as an event horizon with a maximum e𝕙 height in any direction.



Central force with constant *r*

For objects on which a constant net force points toward a central point.

- Model the object as a particle.
- The force causes a centripetal acceleration.
  - The motion is uniform circular motion.
- Mathematically:
  - Newton's second law is

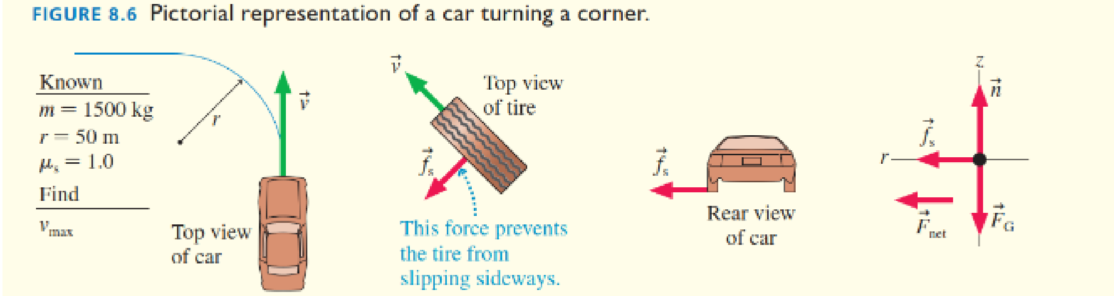
$$\vec{F}_{net} = \left(\frac{mv^2}{r} \text{ or } m\omega^2 r\text{, toward center}\right)$$

  - Use the kinematics of uniform circular motion.
- Limitations: Model fails if the force has a tangential component or if r changes.

Kinetic work and a kinetic impulse

The tire has potential friction from the road, its tire molecules connect to the road's molecules and then are broken by the rotation of the wheel. This involves -𝕆D×e𝕪 kinetic work done by the tire, a twisting breaks the bonds. There is also a E𝕐/-𝕠d kinetic impulse from the car moving forward.

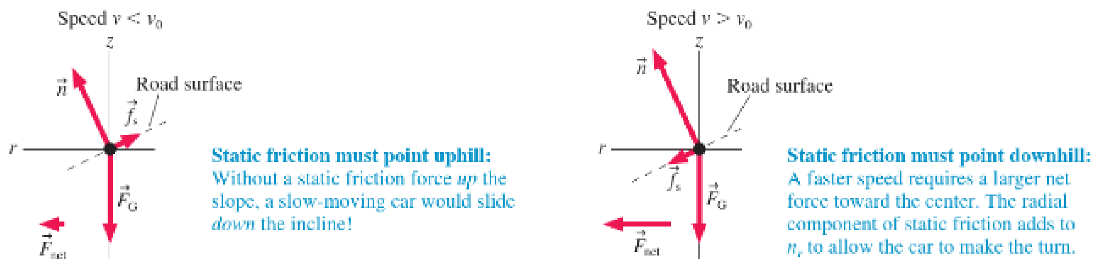
FIGURE 8.6 Pictorial representation of a car turning a corner.



Potential friction in both directions

The potential or static friction points in an opposing direction to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy of the car's motion. A banked curve then can have this potential friction pointing outwards at a slower speed, this prevents the car from sliding to the center from the Eℍ/+𝕚d gravitational impulse exerted on the car. If the speed is higher this potential friction prevents the car from sliding outwards with the E𝕐/-𝕠d kinetic impulse of the car.

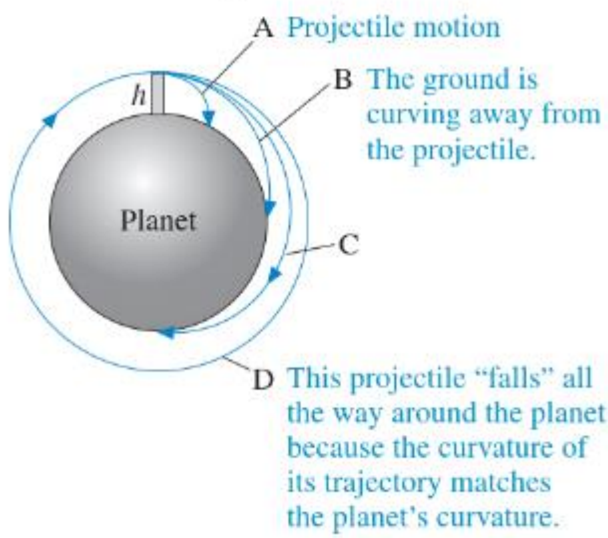
FIGURE 8.8 Free-body diagrams for a car going around a banked curve at speeds slower and faster than the friction-free speed v_0.



Impulse and work

The trajectories of the projectile are according to conic sections. With a velocity that does -𝕀D×e𝕧 inertial work equal to the +𝕀D×e𝕙 gravitational work at that e𝕙 height then the projectile moves in a circle. When the velocity is less this moves downwards in a parabola from the Eℍ/+𝕚d gravitational impulse. This is impulse because the motion is no longer quantized as an orbit. If the velocity is greater this moves outwards in a hyperbola, that is also impulse because it is not quantized.

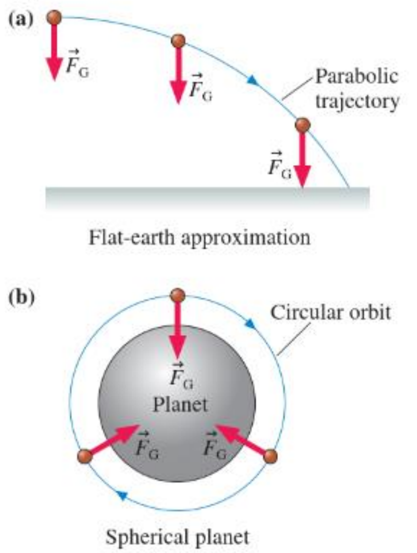
FIGURE 8.10 Projectiles being launched at increasing speeds from height h on a smooth, airless planet.



Circular geometry

The E𝕳/+𝕚d gravitational impulse is directed towards the center of a planet, this is because the forces of the +𝕚d and e𝕙 Pythagorean Triangle are in circular or circular geometry. The E𝕍/-𝕚d inertial impulse is directed orthogonally to this because the e𝕧 value from the -𝕚d and e𝕧 Pythagorean Triangle is inversely proportional to the e𝕙 value from the +𝕚d and e𝕙 Pythagorean Triangle. This can only happen if they are orthogonal. If the velocity is higher enough it approaches this right angle, then Eℍ/+𝕚d gravitational impulse approaches a minimum as the Eℍ is smaller by comparison to E𝕍.

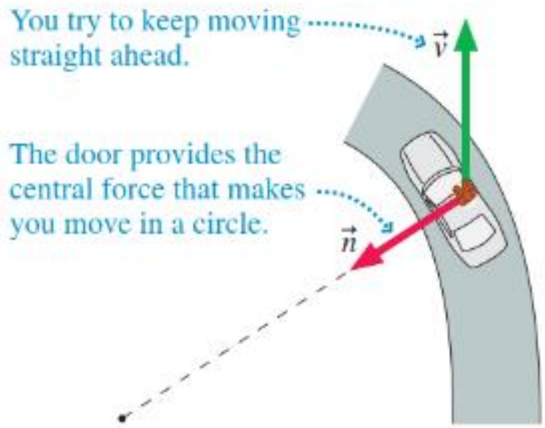
FIGURE 8.11 The "real" gravitational force is always directed toward the center of the planet.



Potential friction and chaos

The person tends to move straight ahead with their E𝕍/-𝕚d inertial impulse, the door reacts against this with its E𝔸/+𝕠d potential impulse as the potential friction causes circular motion. This circle comes from the +𝕆D×e𝕒 potential work as a potential torque, when this is represented as a potential vector this can only be impulse. This can be the potential impulse if the circle is not exact, then the car can be moving chaotically under a E𝔸/+𝕠d potential impulse of this friction.

FIGURE 8.12 Bird's-eye view of a passenger as a car turns a corner.



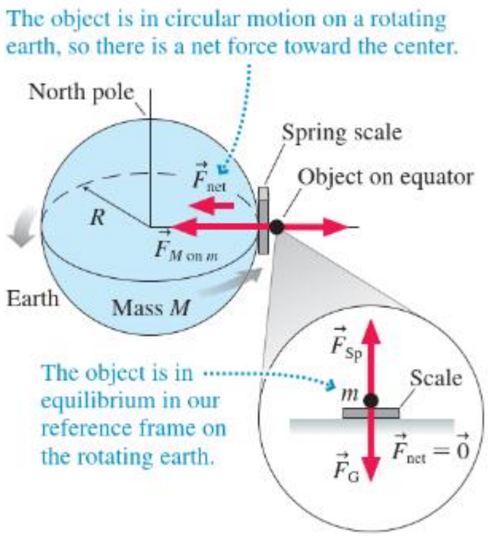
Subtracting inertia from gravity

In this model the Earth's rotation represents the -𝕀D×e𝕧 inertial work being done, this is the inertial torque in a circle. That is a reactive force, it is subtracted from the active +𝕀D×e𝕙 gravitational work inwards. The sum is then the overall force, if the +𝕀D×e𝕙 gravitational work is strong a person experiences gravity on the surface. If the -𝕀D×e𝕧 inertial work is stronger then they would feel weightless moving away with a hyperbolic trajectory.

Subtracting vectors with impulse

The forces would be orthogonal to each other, here they are as vectors which would be impulse. This is allowed here if it is not a perfect circle, the motion of the person can be chaotic with the wobbling of the planet and its imperfect spherical shape. The inertial force would point at an approximate tangent to the Earth with an E𝕍/-𝕚d inertial impulse. The two vectors are subtracted from each other according to the rules of vector addition and subtraction. This is regarded as subtraction because the reactive inertial vector reduces the force of the active gravitational vector.

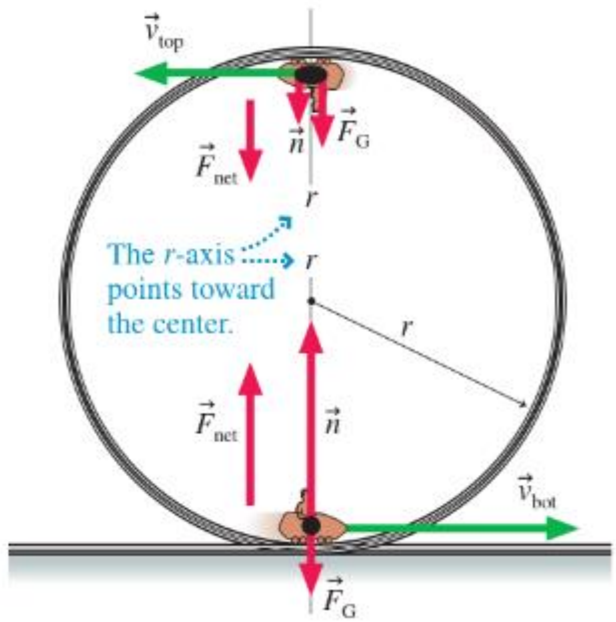
FIGURE 8.13 The earth's rotation affects the measured value of g.



Gravitational and inertial torque

Here the E𝕍/-𝕚d inertial impulse of the car at the top of the loop is stronger than the Eℍ/+𝕚d gravitational impulse pointing downwards, this prevents the car from falling. Because this is a circular track it can be presented as an inertial torque around the track, the car has a -𝕚d inertial mass from its velocity. This is affected unevenly by the +𝕀D×e𝕙 gravitational work done by the planet, the total torque is +𝕀D as the gravitational torque minus -𝕀D as the inertial torque. This also varies with the e𝕙 height of the car according to an exponential curve.

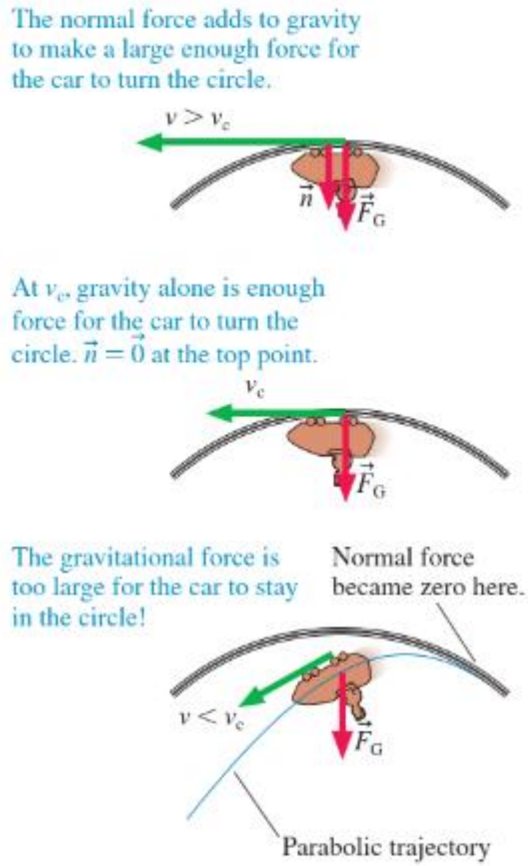
FIGURE 8.14 A roller-coaster car going around a loop-the-loop.



The normal force and potential friction

Here the normal force is the E𝔸/+𝕠d potential impulse from the molecular bonds of the track and the tires. This prevents the car from skidding on the track as it moves around it, there would be some sticking on the top with the potential friction. When the Eℍ/+𝕚d gravitational impulse is stronger than this normal force the car will fall, if this potential friction was stronger with glue then the car might stay on the track.

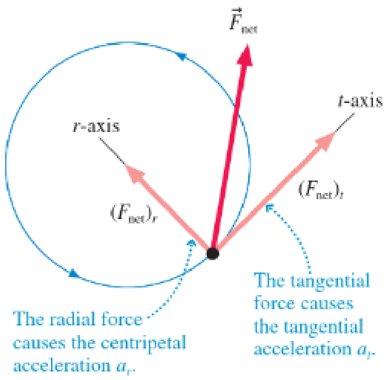
FIGURE 8.15 A roller-coaster car at the top of the loop.



Nonuniform impulse

When the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse are not balanced then the motion of the particle is chaotic, this causes it to move with an unquantized change in forces around the circle. The two forces are not orthogonal because they are chaotic in their changes. These would be reacted against by the E𝔸/+𝕠d potential impulse of molecular bonds on the circle, if this was a track it may hold the particle onto it.

FIGURE 8.16 Net force $\vec{F}_{net}$ is applied to a particle moving in a circle.



Chaotic acceleration

Because there is acceleration there is a force, because this acceleration is on a circle then it would be changing the quantized value of an orbit. For example deBroglie waves would have an integer number -𝕆D in their -𝕆D×e𝕪 kinetic work around a circle. If this changed then the wave value would have a different -𝕆D kinetic probability, the electron would jump to a higher wave number in a higher orbital. When this is a particle observed with vectors then its motion must be chaotic in its changes. The E𝔸/+𝕠d potential impulse would change with the potential friction in a chaotic way.

Newtons as impulse or work

This chaotic change is shown in Newtons, with this model Newtons are a classical approximation of work. This is because the force comes from seconds squared which with an acceleration car would be meters/second^2. Here dividing the two is only with impulse, it would be represented by the -𝕀D×e𝕧 inertial work. This would be the seconds squared as -𝕀D times the position e𝕧. Because work is a force times a position that would have the time squared as the force.

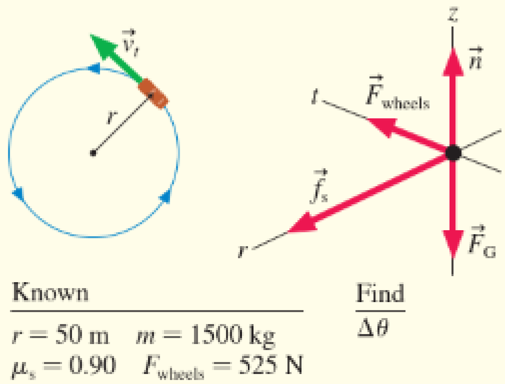
Newtons as impulse

This is multiplied as a classical approximation by the -𝕚d inertial mass in kilograms to give mass×length/seconds^2 as Newtons. In this model the standard Newton definition can be changed to the E𝕍/-𝕚d inertial impulse by making meters/second^2 an equivalent meters^2/second, that gives -𝕚d×E𝕍/-𝕚d. This gives a length force E𝕍 from the inertial momentum -𝕚d×e𝕧/-𝕚d. Here this is a classical approximation because the -𝕚d inertial mass is in the equation, but in the denominator there is -𝕚d as time which represents a derivative slope.

Time in impulse acts as mass in work

Time then acts with a derivative, mass with an integral. With a classical approximation this gives the same answers, for example if the mass is doubled the acceleration would halve with the same value in Newtons. That is because it is like the seconds value doubling. Time is a scale in impulse because it is not itself a force there, the impulse of a ball hitting a racquet assumes linear or constant time values. Work assumes a constant scale of position such as e𝕧 length, if time was also constant then this would be a constant velocity with no force. So in this model time acts as the -𝕚d inertial mass changing with an -𝕀D×e𝕧 inertial work force.

FIGURE 8.17 Pictorial representation of a car speeding up around a circle.



9 Impulse and Momentum

Energy mass equivalence

In this model energy refers to forces from the straight Pythagorean Triangle sides. A particle is changed by a force with impulse. A field is associated with work, this is referred to as mass leading to a mass energy equivalence.

Changing energy into mass

When energy is changed into mass, this is where the straight Pythagorean Triangle sides contract and the spin Pythagorean Triangle sides dilate. For example, particles close to c have their E𝕐/-ⓓd kinetic impulse converted into -𝔻D×e𝕪 kinetic work as an increased -𝕚d inertial mass when this velocity is slowed in a collision.

Changing mass into energy

The reverse is where the spin Pythagorean Triangle sides contract and the straight Pythagorean Triangle sides dilate, this is where mass turns into energy. For example, the mass in a Uranium atom might be partially converted into a ½×e𝕐/-𝔻d ×-ⓓd linear kinetic energy as the E𝕐/-ⓓd kinetic impulse increases its velocity. This can lead to an exponential chain reaction where the mass is converted into fast moving particles that break up other atoms.

Work gives a torque, a probability, or a mass

With work the spin Pythagorean Triangle side is squared, this gives a torque, a probability, or a mass. In this model the magnetic field acts like a mass, for example it might attract some atoms like a +𝕚d gravitational mass does.

Torque

A torque comes from working turning particles, for example -𝕀D×e𝕧 inertial work is where a nut reacts against its current position changing when it is turned by a wrench. A kinetic torque comes the -𝕆D×e𝕪 kinetic work done in turning the nut as an active force. A gravitational torque would be where the trajectory of a satellite is curved, from a straight-line path towards or into an orbit. A potential torque is where protons do +𝕆D×e𝕒 potential work on electrons to keep them spinning in an orbital.

Probabilities

These can also be regarded as probabilities, an inertial probability is where the nut is more likely to not move. A kinetic torque is where the work is likely to turn the nut. A gravitational probability is where a planet is likely to turn the satellite towards it. A potential probability is where the electron is more likely to be in an orbital.

Active and reactive mass

In this model mass is divided into two types, an active +𝕚d gravitational mass and a -𝕚d inertial mass. The magnetic field of the electron is -𝕠d, this is proportional to the -𝕚d electron inertial mass.

Magnetism as a kind of mass

Magnetism here acts like a mass, the -𝕆D×e𝕪 kinetic work done by a magnet attracts iron filings like gravity does to objects. The potential magnetism of the proton does +𝕆D×e𝕒 potential work, this reacts against a change in it as a kind of repulsion. This is also seen in Lenz's Law where a change in motion is resisted by a potential magnetic field.

Ferromagnetism and interference

In this model ferromagnetism is caused by the electrons all spinning in the same orientation. As they do -𝕆D×e𝕪 kinetic work this torque can add together with a constructive interference. That is where another magnet approaches it with the spin in the same direction, for example clockwise.

Magnetic attraction

When the magnets come together they join so that all the electrons in each now spin clockwise in the same direction. Because the -𝕆D kinetic probabilities are interfering constructively, they are more likely to be near each other. This is measured as an attraction.

Magnetic repulsion

If the spins of the magnets are opposed, so that one is clockwise and the other counterclockwise, then this is destructive interference. The kinetic probabilities of the -𝕆D×e𝕪 kinetic work is reduced and the magnets are less likely to be near each other. This is measured as a repulsion. This attraction and repulsion helps to form molecular bonds, some are more probable than others and this acts like an attraction or repulsion between atoms.

Gravitational mass attracting or repelling

A +𝕚d gravitational mass always attracts, but its spin causes a satellite to spin into orbit around it not to move towards a planet. The Eℍ/+𝕚d gravitational impulse is a separate force which can move a satellite directly towards a planet, but a gravitational torque cannot.

Gravitational repulsion

Just as with a magnet this gravitational spin can interfere constructively as an attraction or destructively as a repulsion. For example two stars might have planets orbiting near each other in the same plane. If they are both spinning clockwise then their spins oppose each other in between with a destructive interference. This would cause the planets to slow their velocities and be found less often in between the stars and more closer into the stars, that would push the stars apart as a repulsion. In molecular bonds this causes atoms to not connect to each other.

Gravitational attraction

If one gravitational torque is clockwise and the other counterclockwise then their spins are added together in between, this increases the velocities of the planets so they are found in between the stars more often. The planets are attracting each other and pulling the stars closer as an attraction like magnetism, a similar process creates covalent molecular bonds.

Kinetic energy

In this model that is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, this is the same as in conventional physics in terms of dimensional analysis. Here it would be more precisely written as the ½×-𝕠d× e𝕐/-𝕠d linear kinetic energy, the denominator has -𝕠d instead of -𝕆D. This can cancel out with the -𝕠d in the numerator, that is proportional to the -𝕚d inertial mass. That leaves E𝕐 as the kinetic electric force which provides the kinetic energy, the -𝕠d value acts as a scale of time with impulse.

Potential energy

Here there is the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy which is in the same form as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, the difference is the +𝕠d and e𝕒 Pythagorean Triangle from the proton is used instead of the -𝕠d and e𝕪 Pythagorean Triangle as the electron. This can be written more precisely as the ½×-𝕠d×+E𝔸/+𝕠d linear potential energy where the E𝔸/+𝕠d potential impulse is part of the formula. There is still some uncertainty from the +𝕠d term appearing in the numerator as well as in the denominator, this implies two separate observations in one energy.

A precise formula

Most precise in this model would be to use the E𝕐/-𝕠d kinetic impulse for the electron and the E𝔸/+𝕠d potential impulse for the proton or nucleus, each Pythagorean Triangle is then only observed with one force at a time. Otherwise, there is an increased uncertainty as two observations or measurements are made together. Because of this it is not necessary to use h as a term in this model to represent uncertainty, it becomes part of the Pythagorean Triangles themselves.

Thermal energy

In conventional physics thermal energy is in relation to Boltzmann's constant k times a temperature T. In this model these are multiplied together in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. Generally in this model the term thermal energy is not used, this is because it is wave like here. Heat moves deterministically so this is differentiated from heat as a thermal wave or thermal probability.

Boltzmann’s and Planck’s constant

Boltzmann’s constant is ½×e𝕪/-𝕆D ×-𝕠d which is multiplied by the temperature e𝕪. This operates in relation to the -𝕆D×e𝕪 kinetic work because -𝕆D is used as the kinetic probability, it also refers to the amount of kinetic torque the electrons experience moving them up into higher orbitals. It is similar to another constant in this model called h or Planck’s constant. This is -𝕠d ×e𝕐/-𝕠d where now the E𝕐 term is squared as a force, with k this was the -𝕆D term.

Joules from k and h

Joules are from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, so Planck’s constant is sometimes referred to as Joule seconds where the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is multiplied by a time -𝕠d to give -𝕠d ×e𝕐/-𝕠d. So just as kT refers to the Boltzmann constant times a straight Pythagorean Triangle side e𝕪, h/t is h divided by a spin Pythagorean Triangle side where t is time. Both of these refer to the same ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, k then refers to probability and waves while h refers to particles and deterministic behavior.

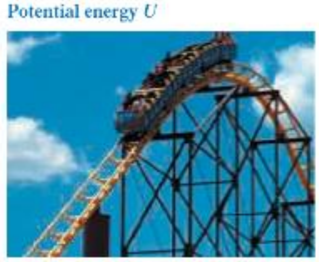
Work and impulse

This allows for two constants to be used, k is associated with -𝕆D×e𝕪 kinetic work and h with the E𝕐/-𝕠d kinetic impulse. Here k is statistical in nature because the -𝕆D×e𝕪 kinetic work gives a kinetic probability of where electrons are. In this model h is not statistical, instead it refers to a jump in between quantized energy levels. Both constants can be derived from the Pythagorean Triangles having a constant area.

Kinetic energy K

Kinetic energy is the energy of motion. All moving objects have kinetic energy. The more massive an object or the faster it moves, the larger its kinetic energy.

Potential energy U



Potential energy is stored energy associated with an object’s position. The roller coaster’s gravitational potential energy depends on its height above the ground.

Thermal energy E_{th}

Thermal energy is the sum of the microscopic kinetic and potential energies of all the atoms and bonds that make up the object. An object has more thermal energy when hot than when cold.

Heat as impulse, work as thermal waves

In this model heat comes from the E𝕐/-𝕠d kinetic impulse, it is a transfer of temperature. Work then would be from the -𝕆D×e𝕪 kinetic work electrons do, also from the +𝕆D×e𝕒 potential work of protons. Instead of thermal energy which would be energy as particles, thermal waves or thermal work is used here.

The potential as work or impulse

The potential energy comes from the E𝔸/+𝕠d potential impulse, this can also be +𝕆D×e𝕒 potential work. When it is referred to as energy this is the E𝔸/+𝕠d potential impulse, in this model energy is impulse but this distinction is not always used in conventional physics. Often the difference is not important, here energy is associated with the straight Pythagorean Triangle side forces.

Schrodinger's equation

This is deterministic, for example in Schrodinger's equation the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is used. Then this is converted into a wave function which is probabilistic, in this model that would come from the ½×-𝕆d/e𝕐 ×e𝕪 rotational kinetics. The difference is when the Pythagorean Triangles are used, Schrodinger's equation is working with the E𝕐/-𝕠d kinetic impulse and then the potential energy as the E𝔸/+𝕠d potential impulse is subtracted from it. Here the E𝕐/-𝕠d kinetic impulse is negative and the E𝔸/+𝕠d potential impulse is positive but the answer is the same.

A wave function from work

Then this is converted into a wave function, in this model that becomes the +𝕆D×e𝕒 potential work minus the -𝕆D×e𝕪 kinetic work. Because +𝕆D is the potential probability and -𝕆D is the kinetic probability, this gives a squared probability as $+\psi^2-\psi^2$. Because of the distinction of energy and a wave function this model separates work and impulse even in macro world physical phenomena. That makes it easier to show their differences in quantum mechanics later.

Thermal work as a Gaussian

Thermal work, called thermal energy in conventional physics, moves with a Gaussian according to k as -𝕠d ×e𝕪/-𝕆d. It is then related to -𝕆D×e𝕪 kinetic work. This is because -𝕆D is the square of a negative value, in this model +𝕠d and -𝕠d are the positive and negative square roots of -1 respectively. When these values are an exponent to base e they can be squared, in conventional math negative squares as exponents give a Gaussian distribution. Because e𝕪 is not a square root of -1 in the exponent its values do not give a Gaussian. Because of this it is deterministic such as in heat transfer.

Chemical energy

Chemical energy comes from the molecular bonds, these can be where electrons do -𝕆D×e𝕪 kinetic work which has a constructive or destructive interference. That causes atoms to be attracted or repelled like with magnetic fields. It can also be from the E𝔸/+𝕠d potential impulse such as a positive ion attracting a negative one, for example Sodium as positive and Chlorine as negative.

Positive and negative

In this model positive and negative refer to the +𝕠d potential magnetic field and the -𝕠d kinetic magnetic field, the e𝕒 potential electric charge and e𝕪 kinetic electric chargeare not themselves positive and negative. Instead, they add and subtract like vectors. An element might be positive in this case because it has a nearly complete shell of electrons, that allows for another element with a small number of electrons in an outer shell to share electrons.

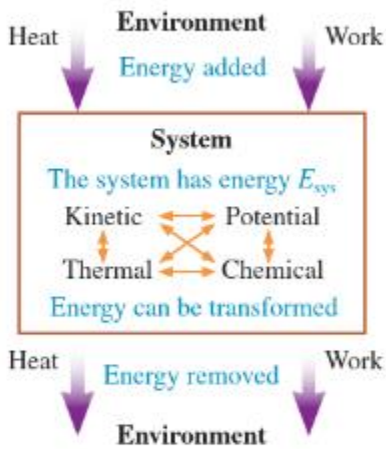
Ions

A positive ion would be where an element has lost some electrons, the +𝕠d potential magnetic field of the nucleus is not balanced by the same number of -𝕠d kinetic electric charge s from electrons.

Electromagnetism

An -𝕠d and e𝕪 Pythagorean Triangle has electromagnetism because it can have an electric charge with the E𝕐/-𝕠d kinetic impulse, it can do -𝕆D×e𝕪 kinetic work. The negative sign then has some association with its negative electric charge but not with the force, the E𝕐 kinetic electric force is observed on a scale -𝕠d which is negative. The proton also has electromagnetism from its E𝔸/+𝕠d potential impulse which has the potential electric force on a positive scale +𝕠d. The actual force is not positive, instead these forces are added as vectors.

FIGURE 9.1 A system-environment perspective on energy.



Putting a shot

In this model there is -𝕆D×e𝕪 kinetic work done over a position e𝕪, this is reacted against by the -𝕀D×e𝕧 inertial work of the shotput. That is because the shotput resists a change in its position, also as it accelerates it reacts against a change in its velocity at each point. This can then be observed as its ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, but that is an observation while the work done is a measurement.

Work and impulse together

The work and impulse appear together in the macro world, this is because the Pythagorean Triangles can be observed and measured close to the same times and positions. In this model measuring work and then observing impulse leads to an uncertainty. This is because work is probabilistic in nature as a wave, it is then uncertain how the impulse will be observed exactly.

A falling diver

The diver is in free fall according to the Eℍ/+𝕚d gravitational impulse pulling them down, they are weightless because of the +𝕀D×e𝕙 gravitational work being done on them. In this model then free fall is associated with the Eℍ/+𝕚d gravitational impulse because it is in a straight-line. Weightlessness refers to the +𝕀D×e𝕙 gravitational work because +𝕚d is the gravitational mass. The Eℍ/+𝕚d gravitational impulse is referred to as the Gravitational Potential Energy in conventional physics, because this is energy it would refer to the Eℍ/+𝕚d gravitational impulse.

Gravitational impulse and potential energy

From a particular e𝕙 height the Eℍ/+𝕚d gravitational impulse has a set value with some uncertainty, this means that there would be a set amount of impulse in falling from that height to the surface. From a smaller height the Eℍ/+𝕚d gravitational impulse would be smaller, also the Gravitational Potential Energy would also be smaller. When the diver falls his inertia from the -𝕚d and e𝕧 Pythagorean Triangle is reactive, it is subtracted from the +𝕚d and e𝕙 Pythagorean Triangle as gravity.

Inertia is reactive

So inertia cannot act as a force itself, it can also go against a force. Because the two Pythagorean Triangles are inverses in Biv space-time the inertia is being subtracted at each height from gravity. That makes the diver feel weightless with work and in free fall with impulse. For example as the +𝕚d gravitational field increases with a lower height the -𝕚d inertial mass decreases at the same rate.

Gravity and inertia cancel

Neither then produces a force on the diver with +𝕀D×e𝕙 gravitational work minus -𝕀D×e𝕧 inertial work. Also as the height decreases as a square with the Eℍ/+𝕚d gravitational impulse the length increases as a square with the E𝕍/-𝕚d inertial impulse, these forces also balance and so free fall occurs with no observation of a force. If they changed at different rates then overall there would be a measured or observed force the diver would experience.

Gaining kinetic energy

In this model he would gain ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy from this dive while the ½×eℍ/+𝕀d × +𝕚d linear gravitation decreased, he gains a kinetic impulse and loses the Eℍ/+𝕚d gravitational impulse. The Eℍ/+𝕚d gravitational impulse decreases because Eℍ is a square, it decreases more than the increase in the strength of the +𝕚d gravitational field at a lower height. This gives an exponential decay curve because Eℍ is decreasing as a square and +𝕚d is increasing linearly.

Kinetic and inertial energy

The E𝕐/-𝕠d kinetic impulse is proportional to the E𝕍/-𝕚d inertial impulse of the diver, so the E𝕍/-𝕚d inertial impulse can be used instead here. This is instead of using the E𝕐/-𝕠d kinetic impulse in Roy electromagnetism and the Eℍ/+𝕚d gravitational impulse in Biv space-time. That is common in conventional physics, most of the previous examples used inertia instead of kinetic energy.

Kinetic energy and gravity

In this section kinetic energy is being combined with the effects of gravity, but in this model they have some differences which need to be explained. Kinetic energy relates to electrons and is quantum mechanical in nature, gravity relates to General Relativity. The two do not connect together in conventional physics. In this model then they are defined in ways which will make this connection clearer later.

Impulse versus work

Gravity can be either a Eℍ/+𝕚d gravitational impulse or +𝕀D×e𝕙 gravitational work, a rocket near a planet can have an E𝕍/-𝕚d inertial impulse or do -𝕀D×e𝕧 inertial work. This can illustrate the diver and his change in height. A rocket might be in a circular orbit around the planet, it has a Eℍ/+𝕚d gravitational impulse pulling it straight down. If it was not in orbit, but hanging in midair, then the Eℍ/+𝕚d gravitational impulse would make it fall.

A changing impulse as a square

As it fell its E𝕐/-𝕠d kinetic impulse would increase, proportionally its E𝕍/-𝕚d inertial impulse would increase inversely to how its Eℍ/+𝕚d gravitational impulse decreased also increasing its velocity. If the eh height halved then Eℍ would decrease to ¼ because it is a square of the height. The E𝕍/-𝕚d inertial impulse would increase by 4 times because E𝕍 is a square, the +𝕚d and eh Pythagorean Triangle then has its angle θ opposite the spin Pythagorean Triangle side changing with the height.

A change in Pythagorean Triangle angle

The -𝕚d and e𝕧 Pythagorean Triangle has a change in its angle θ of 90° minus that θ. This is because the two Pythagorean Triangles change inversely to each other. Because of this the diver has his velocity increasing as e𝕧/-𝕚d in meters/second. The -𝕚d and e𝕧 Pythagorean Triangle with inertia then also has its angle θ change. Because e𝕧/-𝕚d is meters/second as velocity, this means the e𝕧 length side is dilating and the -𝕚d time side is contracting while the Pythagorean Triangle area is maintained.

Returning to the previous height

To get back to his original eh height he would have to expend a E𝕐/-𝕠d kinetic impulse, such as in climbing the cliff or using a rocket. This would also exert an E𝕍/-𝕚d inertial impulse against the Eℍ/+𝕚d gravitational impulse pulling him down.

Balancing impulse

The rocket hanging in mid air then is like the diver. It might fall, it might maintain a constant eh height by burning fuel with a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. The E𝕐/-𝕠d kinetic impulse of this fuel would exert an E𝕍/-𝕚d inertial impulse causing the rocket to move upwards. This is because the E𝕍/-𝕚d inertial impulse is canceling out the Eℍ/+𝕚d gravitational impulse pulling the rocket downwards. If the Eℍ height force is the same as the E𝕍 length force, then the rocket would not move.

Impulse and chaos

If the rocket moved upwards with a constant larger E𝕐/-𝕠d kinetic impulse then it would accelerate upwards, this is because the E𝕐/-𝕠d kinetic impulse would be greater than the Eℍ/+𝕚d gravitational impulse at that height. Balancing impulse with impulse is chaotic in this model, this is because there is no work done and so there is no probability. With no tendency words an average value, like the center of a Gaussian, impulse moves towards one or the other being stronger. Conversely if the E𝕐/-𝕠d kinetic impulse was weaker than the Eℍ/+𝕚d gravitational impulse at a height then the rocket would fall downwards.

Moving upwards through work and torque

If the rocket was in a circular orbit, then it might move upwards by using a E𝕐/-𝕠d kinetic impulse in burning fuel. It might also do -𝕆D×e𝕪 kinetic work by creating a kinetic torque. This is where it increases its orbital velocity at a tangent to the Eℍ/+𝕚d gravitational impulse, that causes it to rise upwards in a spiral.

Work and torque are not chaotic

At no time is the rocket pointing downwards so this is not the same as the E𝕐/-𝕠d kinetic impulse from before, instead it creates this -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work by spinning around the planet more. If the rocket stopped then it would maintain the orbit it had, its -𝕀D×e𝕧 inertial work is balanced by the +𝕀D×e𝕙 gravitational work from the planet. Before if it stopped it would fall because its E𝕐/-𝕠d kinetic impulse was balanced by the Eℍ/+𝕚d gravitational impulse. This is because of the Gaussian or normal curve of the +𝕀D gravitational probability minus the -𝕀D inertial probability, it tends towards and average and a balance not chaos like with impulse.

Pulling a slingshot

There is -𝕆D×e𝕪 kinetic work done by burning food, the molecular bonds in the muscles use this to create a kinetic torque in twisting the joints to pull back the slingshot. It can also be regarded as a E𝕐/-𝕠d kinetic impulse from food changing molecular bonds with their E𝔸/+𝕠d potential impulse. That would be consistent with it producing a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. In this model if there is -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work then this produces ½×-𝕆d/e𝕐 ×e𝕪 rotational kinetics. This is not called rotational kinetic energy because the force come from a torque and waves, in conventional physics energy is associated with particles.

Stretching molecular bonds

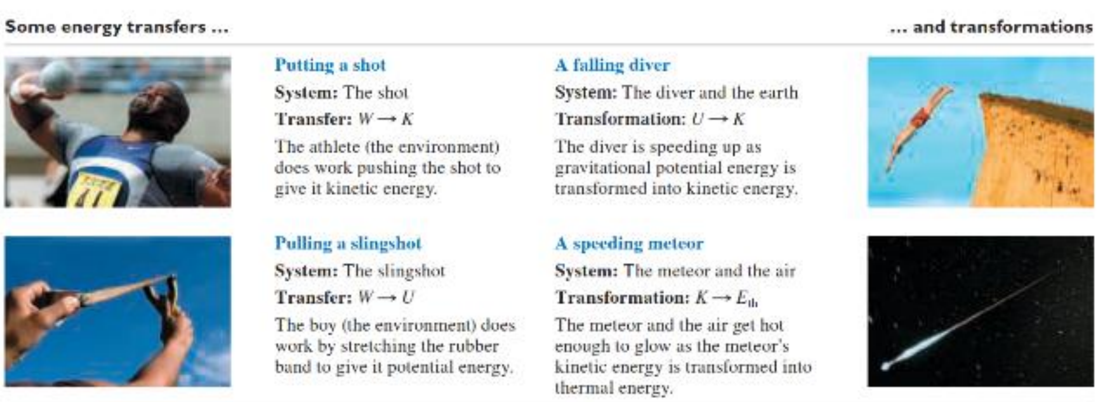
In this model pulling the elastic band would tend to stretch the molecular bonds, this would increase the E𝔸/+𝕠d potential impulse because e𝕒 as the altitude or radius of electrons above the protons is increased. This is similar to the Eℍ/+𝕚d gravitational impulse, the e𝕙 height means the electrons have a greater potential to move back downwards. The E𝕐/-𝕠d kinetic impulse is like the diver or the rocket hanging in midair. The electrons are moved further out in the molecular bonds, but this is not from -𝕆D×e𝕪 kinetic work and an increased spin.

Molecular bonds rebounding

They can then snap back into their previous positions quickly, that causes the elastic to rebound. When the elastic is released then the electrons will move downwards again, the E𝔸/+𝕠d potential impulse is reduced and the E𝕐/-𝕠d kinetic impulse increases. This can release a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy that moves the ball forward.

A speeding meteor

The meteor creates thermal work, called thermal energy below, by doing -𝕆D×e𝕪 kinetic work on the air around it. The motion of the air molecules is random to some degree, this also does +𝕆D×e𝕒 potential work on the nuclei twisting their molecular bonds. There is also some turbulence which is chaotic, in this model that comes from the E𝕐/-𝕠d kinetic impulse of the meteor and a heat transfer.



Work from a squared spin Pythagorean Triangle side

In this model work exerts a force of the spin Pythagorean Triangle side squared, this is times a position which is the straight Pythagorean Triangle side. This position is electrical in Roy electromagnetism like a dimension, e𝕣 is from a proton and represents an altitude or radius. e𝕪 is from an electron and is generally orthogonal to e𝕒. In Biv space-time e𝕙 height is like e𝕒 as an altitude, it is in circular geometry. The e𝕧 Pythagorean Triangle side is called length which is proportional to the e𝕪 kinetic electric chargeof the electron.

Magnetism and mass

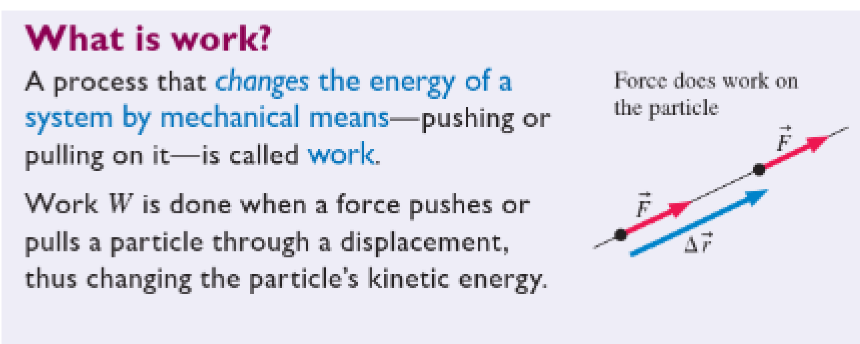
The force here is the spin Pythagorean Triangle side squared, this acts like a mass. In Roy electromagnetism +𝕆D is the potential magnetic force which is proportional to and similar to +𝕀D as the gravitational field force. -𝕆D is the kinetic magnetic force which is proportional to -𝕀D as the inertial mass force.

Work and particles

Here this does not do work on a particle because of the uncertainty principle, work acts like a wave and so it cannot also be a particle. While the difference is small in classical physics, this is pointed out so that there is no conflict in quantum mechanics later. Also work is not represented by a vector, this is because a squared straight Pythagorean Triangle side is a vector. Instead it would be represented by an integral area such as a rectangle or triangle which can point in the direction of the position.

Impulse

In this model impulse is shown by a vector, but this is over a spin Pythagorean Triangle side scale as time. Impulse is related to energy, the E𝕐/-𝕠d kinetic impulse is associated with the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. Work does not change energy, it can change the probability of where a particle might be observed with its impulse.



Power

In this model the joule is from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, so power here would be dividing this by a second or 1/-𝕠d. Because the -𝕠d and e𝕪 Pythagorean Triangle has a constant area then 1/-𝕠d is the same as e𝕪× a constant, this means e𝕪×-𝕠d=constant. Power can then be written as ½×e𝕪 -𝕆d ×-𝕠d × a constant. This is like k as -𝕠d ×e𝕪/-𝕆d so times a constant implies this is quantized.

Quantized power

Power then as a transfer of the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy into thermal work, previously called thermal energy, would be in quantized amounts as e𝕪×-𝕘d photons. Taking ½×e𝕪 /-𝕆d ×e𝕪/-𝕘d is the linear kinetic energy times the slope of the photon, that converts k back into ½×e𝕐/-𝕆d ×-𝕠d times 1/-𝕘d which is the frequency of the photon.

A photon as the e𝕪 and -𝕘d Pythagorean Triangle

A photon can be regarded as a particle where this is the slope of the e𝕪 and -𝕘d Pythagorean Triangle, it can then have a e𝕐/-𝕘d light impulse where the kinetic electric force acts like a particle. It can also be written as an integral e𝕪×-𝕘d, with the same e𝕪 and -𝕘d Pythagorean Triangle this can do -𝔾D×e𝕪 light work. Representing the photon as a slope then is consistent with light as energy.

The Boltzmann constant and thermal work

The Boltzmann constant k as -𝕠d ×e𝕪/-𝕆d gives the constant value of the -𝕠d and e𝕪 Pythagorean Triangle, it then transfers heat from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy in quantized amounts of photons. This power then would be 1 watt where the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy dissipated heat randomly as waves with quantized photons.

Planck's constant and heat

Instead of using k as -𝕠d ×e𝕪/-𝕆d Planck's constant or h as -𝕠d ×e𝕐/-𝕠d can be used. The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is a joule so h as a joule second has -𝕠d in the denominator instead of -𝕆D because it is multiplied by -𝕠d as time. The ½ factor comes from how kinetic energy is calculated between two velocities as the average, hence it is halfway between them. The increments of k or h are not averages, so there is no ½ factor. The difference between the two is 1/-𝕆D as 1/seconds^2.

The kinetic difference

This represents the kinetic probability 1/-𝕆D, the probability that electrons will emit a e𝕪×-𝕘d photon as they drop in a quantized orbital. When D is large the probability is low because this is in the denominator, the power then drops. This is also because -𝕆D is the kinetic difference in voltage, so reducing this voltage would reduce the power output and the photons emitted. The power and voltage are then related to each other, when the voltage as a force drops as a square then the power decreases linearly. Doubling the current per second is double the power, this happens by increasing the voltage by 4 times as a force.

Using h or k

Taking the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy as the current flow then it might vary by h as -𝕠d ×e𝕐/-𝕠d, this acts as increments of the E𝕐/-𝕠d kinetic impulse jumping to higher energy levels. This is where the electron is observed at different energy levels. Using k as -𝕠d ×e𝕪/-𝕆d this is measuring the -𝕆D×e𝕪 kinetic work of the electrons which will form a Gaussian pro probability distribution.

Classical approximations

In this model a squared Pythagorean Triangle side in both the numerator and the denominator is not allowed, except as a classical approximation. This introduces uncertainty because the Pythagorean Triangle cannot be measured as a wave and observed as a particle at the same position and moment.

Schrodinger’s equation

In Schrodinger’s equation h is used as -𝕠d ×e𝕐/-𝕠d, these are increments of energy from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy used there in the form $p^2/2m$. This is the kinetic momentum squared divided by 2 times the mass, as (-𝕠d×e𝕪/-𝕠d) (-𝕠d×e𝕪/-𝕠d)/2×-𝕠d, which equals the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy.

Power from the voltage

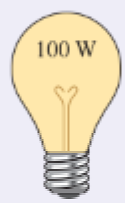
When using the Pythagorean Triangles only, the power can come from the -𝕆D×e𝕪 kinetic work done in the electric current, this is from +𝕆D as the potential difference and -𝕆D as the kinetic difference. Between the two is the voltage. Increasing this voltage will increase the heat, more e𝕪×-𝕘d photons are emitted as electrons are pushed by the voltage to move in the electric current.

Power from the current

If this is observed as a E𝕐/-𝕠d kinetic impulse then that would be related to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. That causes electrons to move in this current e𝕪/-𝕠d towards a positive terminal e𝕒/+𝕠d assuming DC current and a battery. The collisions of electrons in this current as particles would cause a more continuous spectrum emission of e𝕪/-𝕘d photons also as particles. The spectrum of the light is usually a mixture of a continuous spectrum from photons as particles, also with a discrete spectrum of quantized photons as waves.

What is power?

Power is the rate at which energy is transferred or transformed. For machines, power is the rate at which they do work. For electricity, power is the rate at which electric energy is transformed into heat, sound, or light. Power is measured in watts, where 1 watt is a rate of 1 joule per second.



Quantum field theory

In this model the concepts of work and energy can go from one to another. This also happens in Quantum Field Theory, there are fields which here would do work. They have probabilities when they are squared as forces. From these probabilities particles appear which would be observed as energy and impulse.

Energy needs a particle to be observed

For energy to be observed then there needs to be a particle, if not then it is indistinguishable from a wave. A particle has a definite position with some uncertainty, this means it is not probabilistic. This uncertainty means that once there is an observation then the particle might be in different positions, that is because of its wave nature and also because work is done on a scale of positions as positions. So once the position needs to be determined exactly this becomes uncertain, it becomes more like a scale of where it probably is as a wave.

A wave has a probability of where a particle will be at a time

A wave has no definite position, only the probability that a particle with some energy will appear later somewhere. The wave is measured with the work it does over a position, for example an ocean wave might be measured by how far it pushes a boat up and down. When this position needs to be observed then it requires a particle, that only occurs on a time scale of when the observation was made. In this case it must be after the wave moved the boat and perhaps before it moves the boat again.

Quantum mechanics

In quantum mechanics it proceeds in the opposite way, Schrodinger's equation is based on the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy minus the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. With dimensional analysis it can be showed that these are the same in this model as in conventional physics, one difference is here the kinetic energy is negative and the potential energy is positive.

Wave functions

These are then particles with an observed energy, from these a wave function is calculated which is a probability or wave. For example quantum mechanics might have an uncertain observation of an electron's energy, it constructs a wave equation to estimate where it might appear. Using the word "where" here means it is only a position scale such as in meters. It is not trying to observe when it appears.

General relativity and geodesics

This also happens in General Relativity, there is a gravitational field which in this model does +𝕀D×e𝕙 gravitational work. That field exerts a force because it is a square as +𝕀D, the gravitational field force. This affects how particles move in this field as a geodesic, the particles are assumed to have no forces but are guided in free fall by the forces of this geodesic field.

A gravitational field and a quantum field

This is similar to the concept in quantum field theory where the fields cause particles to appear in difference places, one difference is there the particle might be created or destroyed not necessarily moved.

Special relativity

In Special Relativity a higher velocity causes a rocket, as an example of a particle, to experience time dilation. It could be said the rocket is in a geodesic field as +𝕀d that causes it to appear to slow down, also to make its e𝕧 length contract. As the +𝕀d gravitational probability dilates then the +𝕚d gravitational time contracts. The ratio between these gives the gravitational exponential curve.

Simultaneous work and energy or impulse

In classical physics instead of work following impulse, a field following a particle, a measurement following an observation, or vice versa, these were assumed to happen simultaneously and in the same position. The two often alternate, the measurement of a +𝕚d gravitational field might be done by observing how particles fall. That would first be +𝕀D×e𝕙 gravitational work followed by the Eℍ/+𝕚d gravitational impulse as an observation.

Observer measurement problem

In this model that relates to the observer measurement problem in quantum mechanics, this is about what constitutes an observation and an observer. An iota would be regarded as being a probability in a wave function, that would be the -𝕆d×e𝕪 kinetic work of an electron. Then a period of time elapses, this can be the temporal duration of -𝕆D from an initial kinetic moment to a final kinetic moment.

Decoherence

This is called decoherence in quantum mechanics, the electron would then be observed as a particle. Its position was constrained by its -𝕆D kinetic probability as a wave, then it is observed with its E𝕐×-𝕠d where -𝕠d as the kinetic time means this observation happens after it was a probability wave.

Before and after

The concept of before and after on a kinetic timeline mean there is a E𝕐/-𝕠d kinetic impulse. The observer than comes after the probability wave on this kinetic timeline, the position of the particle has an E𝕐 kinetic displacement as a kinetic history.

The particle's history

This is proportional to the -𝕚d and e𝕧 Pythagorean Triangle and so E𝕍 is a displacement range or history the particle is found at the end of. That history is then what the particle did, for example it might have been observed at an initial position. Then after some uncertainty from its -𝕆D kinetic probability its history displacement causes it to be observed at a final position e𝕪 or e𝕧.

Quantum eraser

As will be covered later, the concept of a particle's history is important in quantum mechanics. Sometimes it appears as if its history has been erased or altered with a different observation. This concept of history then is an important aspect even in classical physics.

Transformations and transferals

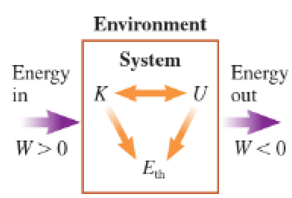
A transformation in this model refers to impulse, energy can be regarded as changing on a timeline. A transferal refers to work, this happens across a distance as a scale.

MODEL 9.1

Basic energy model

Energy is a property of the system.

- Energy is *transformed* within the system without loss.
- Energy is *transferred* to and from the system by forces from the environment.
  - The forces do *work* on the system.
  - $W > 0$ for energy added.
  - $W < 0$ for energy removed.
- The energy of an *isolated system*—one that doesn't interact with its environment—does not change. We say it is *conserved*.
- The energy principle is $\Delta E_{sys} = W_{ext}$.
- Limitations: Model fails if there is energy transfer via thermal processes (heat).



A certainty of the impulse and position

In this diagram vectors represent the change so this is impulse. For example a E𝕐/-𝕠d kinetic impulse from a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, as a particle, might exert a force on this particle by colliding with it. The particle would react against this force with an E𝕍/-𝕚d inertial impulse in meters^2/second. The position of the particle before and after this collision is assumed to be definite, but this is known to not be true because of the Uncertainty Principle.

One squared Pythagorean Triangle side

When a force from a squared straight Pythagorean Triangle side is used, this leaves the other Pythagorean Triangle side to be linear as a scale. That creates a conflict between the two because the area of the Pythagorean Triangle cannot change. This is resolved by a change in the angle θ opposite the spin Pythagorean Triangle side changing. If this is the -𝕠d and e𝕪 Pythagorean Triangle as an electron then this change of angle θ is emitted or absorbed as a e𝕪×-𝕘d photon.

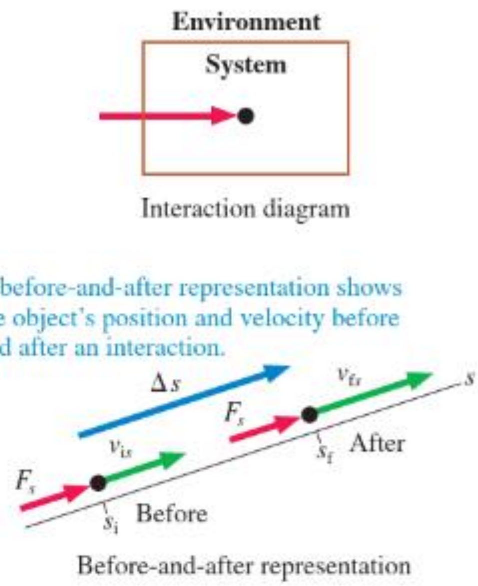
A conserved Pythagorean Triangle area

Because the straight Pythagorean Triangle side is squared then this is observable, the other spin Pythagorean Triangle side is not squared. That means it cannot be measured at the same position and moment, otherwise both Pythagorean Triangle sides would be squared together. If that happened then the area of the Pythagorean Triangle would have to change but in this model that area is conserved.

Conserved constants

If it was not longer conserved then all other constants would also change such as c, the ratio of the electron mass to the proton, α, etc. Because of this inability to square two sides, after squaring the straight Pythagorean Triangle side the momentum from the -𝕆D×e𝕪 kinetic work is not measurable. This is why the uncertainty principle allows for the observation of a position with impulse or a momentum with work but not both together.

FIGURE 9.2 The interaction diagram and before-and-after representation for a one-particle system.



The Joule

In this model the joule is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, the same format also gives the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. In Biv space-time the same formula structure gives the ½×e𝕍/-𝕀d ×-𝕚d linear inertia and the ½×+𝕚d ×eℍ/+𝕀d linear gravitation.

Subtracting kinetic energy from potential energy

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is subtracted from the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy in Schrodinger's equation, in this model the signs are reversed.

Biv spacetime

The ½×+𝕚d ×eℍ/+𝕀d rotational gravitation has the ½×e𝕍/-𝕀d ×-𝕚d linear inertia subtracted from it in Biv space-time, that leads to the Hamiltonian or the LaGrangian depending on how this is observed.

Schrodinger's equation

In Schrodinger's equation Roy electromagnetism and Biv space-time are combined, this allows for the electron's motion to be adjusted with Special Relativity in Dirac's equation. In this model the Pythagorean Triangles here are also relativistic because the sides can contract and dilate by changing the angle θ.

The unit of kinetic energy is mass multiplied by velocity squared. In SI units, this is $kg\,m^2/s^2$. Because energy is so important, the unit of energy is given its own name, the **joule.** We define

$$1 \text{ joule} = 1 \text{ J} = 1 \text{ kg}\,\text{m}^2/\text{s}^2$$

All other forms of energy are also measured in joules.

To give you an idea about the size of a joule, consider a 0.5 kg mass (≈ 1 lb on earth) moving at 4 m/s (≈ 10 mph). Its kinetic energy is

$$K = \tfrac{1}{2}mv^2 = \tfrac{1}{2}(0.5 \text{ kg})(4 \text{ m/s})^2 = 4 \text{ J}$$

Integration and work

In this model integration is only associated with work and fields. An integral is an area, so this represents a field. Derivatives are only associated with impulse and particles, this is because a slope of a Pythagorean Triangle has no area. A derivative can define a point on a slope, in calculus a Pythagorean Triangle on a tangent to a curve is used. Then the slope of the Pythagorean Triangle gives information about it.

First integral

With the -𝕚d and e𝕧 Pythagorean Triangle for example a first integral with respect to -𝕚d as the inertial mass gives -𝕚d×e𝕧. This acts as a kind of area with one side the inertial mass and the other side a e𝕧 length, it represents the inertial momentum in this model. Because there is no derivative there is no particle, so it acts like a wave.

Second integral

To do work a second integral is taken with respect to the -𝕚d inertial mass, this would be ∫-𝕚d×e𝕧 d -𝕚d. That gives the ½×-𝕀D×e𝕧 inertial work. In this model the ½ represents half of the -𝕀D and e𝕧 Pythagorean Triangle where one side is squared, there would be a square area on the -𝕚d Pythagorean Triangle side. This process shows that this model is consistent with the rules of calculus.

First derivative

A derivative works with the slope of the Pythagorean Triangle, for example here as the -𝕚d and e𝕧 Pythagorean Triangle the first derivative with respect to e𝕧 would be -𝕚d/e𝕧. Because the derivative is with respect to e𝕧 the denominator has the straight Pythagorean Triangle side, the numerator has the -𝕚d time. With a derivative -𝕚d acts as time because the slope defines a point in space and time.

Time is not in an integral

In an integral the time is not defined as a point but as part of a field, here it would be part of Biv space-time. Because of this an integral is only used for work and fields, a derivative only for impulse and particles, except as classical approximations. To have a change over time this requires a fraction like meters/second so that at a different second the meters value changed.

A point in time as a particle

For example a person might walk 10 meters in 5 seconds. This represents a change in position over time as a denominator. Assuming the velocity is constant at a point in time the position of the person would be known.

A field of space-time has no point

To say a person walked 10 meters times 5 seconds does not give a change over time, it indicates a ratio between e𝕧 length and -𝕚d time but this could mean they moved along a 5 meter line in various directions for 5 seconds. The position is no longer known and so this acts as a field.

A field of space

With e𝕧×e𝕧 this might be like a field 10 meters long times 20 meters wide. As a field it does not define a position, a person might be anywhere in that field.

A field of time

Taking -𝕚d×-𝕚d as seconds times seconds this represents a kind of time field. It also does not define a point in time, the field e𝕧×e𝕧 might be measured as a velocity in the time it takes to walk around the boundaries. In that field where a person is at a point in time is not definable, it could only be said where they were with different degrees of probability. A field then as an area is fundamentally different from a fraction, a point cannot be represented by it.

A second derivative as an impulse

The second derivative with respect to e𝕧 gives a force, ∂^2-𝕚d/∂^2e𝕧 would be -𝕚d/E𝕍 here as seconds/meter^2. As a classical approximation seconds/meters^2 can be converted into meters/second^2, but in this model they are fundamentally different forces. Meters/second^2 is not used except as this classical approximation because squaring time only refers to a field. A force as seconds^{2}meters here is the -𝕀D×e𝕧 inertial work.

Partial derivatives and integrals

The form ∂^2-𝕚d/∂^2e𝕧 as -𝕚d/E𝕍 is a partial derivative because one Pythagorean Triangle side is kept as a constant, both cannot be observed in one position. Integrals also keep on Pythagorean Triangle side a constant while the other is integrated. This is also from the uncertainty principle where only one value can be observed at a time or place, but in this model that is a consequence of the Pythagorean Triangles.

F=ma

This impulse can be written as F=ma where the acceleration is -𝕚d/E𝕍. The -𝕚d term can act as the inertial mass for this force or as time, the answer is the same so in this model they are equivalent. For example, if the -𝕚d inertial mass doubles then so does the force. If the time the force is applied doubles, then again the force doubles. Here then it is not necessary to write the inertial mass and time together, instead depending on which is being measured or observed it can be either.

Kinetic energy as a construct

This integration and derivative can be used in classical physics as below, but it does break some of the rules of this model. The calculations end up the same, but here there becomes something called kinetic energy which does not exist in the model. Instead, the Pythagorean Triangles give the same answers which can be converted into a kinetic energy formula. But that does not mean kinetic energy exists as a fundamental force.

Problems with kinetic energy

It also leads to some contradictions later when kinetic energy is used in Schrodinger's equation with quantum mechanics. Then the wave function needs to be derived from it, that seems to imply a problem with the kinetic energy concept.

The definite integral

In (9.6) there is a definite integral as ∫-𝕚d×e𝕧 d -𝕚d. Here the integral is taken with respect to -𝕚d, the -𝕚d and e𝕧 Pythagorean Triangle has a constant area so the e𝕧 Pythagorean Triangle side can be converted into -𝕚d. The term mv is the inertial momentum -𝕚d×e𝕧/-𝕚d where the -𝕚d term is used twice as a superposition. In conventional physics the two are assumed to occur together, the inertial momentum comes from the field -𝕚d×e𝕧. Then a position is a e𝕧 length at a time -𝕚d.

Space mass

In this model these two are separated, the -𝕚d inertial mass times a e𝕧 length acts like a field as space mass instead of space time. This means that drawing a 3d model as a classical approximation some areas would have a mass of different strengths. An example of this would be a geodesic around a planet in General Relativity.

Space time

With the derivative this is e𝕧/-𝕚d which would be space time because the e𝕧 length can change with respect to -𝕚d time. The space mass as -𝕚d×e𝕧 is not changing in time because the mass is a field.

A geodesic of space mass

Here the mass is measured as work, for example the +𝕀D×e𝕙 gravitational work in General Relativity would be the probability of where +𝕚d gravitational field strength is at a given e𝕙 height from a planet. The geodesic is presumed to be static around this planet, a satellite might move in free fall around the geodesic without the field strength changing in time.

Space time not space mass

The Eℍ/+𝕚d gravitational impulse is measuring the time in an acceleration as a second derivative with respect to the e𝕙 height. Now the changing time is in regard to acceleration, mass is not being measured. The uncertainty principle extends to here, the mass cannot be measured together with time. Only one or the other can be measured as work or observed in impulse.

Linear kinetic energy and linear inertia

In (9.7) below the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is in the same form, here with inertia the ½×e𝕍/-𝕀d ×-𝕚d linear inertia is used. This has E𝕍/-𝕀D as meters^2/seconds^2 the same as in (9.7), -𝕚d also acts as the inertial mass m. It is the same as with the process of integrating the -𝕀D×e𝕧 inertial work, first there is -𝕚d×e𝕧 as the first integral with respect to -𝕚d. Then e𝕧 can be taken as a e𝕧 length or time is included in the denominator to give -𝕚d×e𝕧/-𝕚d.

An integral with two variables

In the conventional integral below the second integral with respect to e𝕧/-𝕚d is taken to give -𝕚d× ½×E𝕍/-𝕀D. The difference then it is assumed it is possible to treat the velocity e𝕧/-𝕚d as a single variable, in this model that is not allowed. If this is done then it is like measuring the position and momentum of a particle together, that violates the uncertainty principle. It assumes then that two forces as E𝕍 and -𝕀D can be in one formula to give a precise answer, but in this model that is not used.

Kinetic energy leads to h and the uncertainty principle

Here the integral is only used for work and fields, the derivatives for impulse and particles. In conventional physics both are used interchangeably, in this model that leads to the need to use h as a quantized value and to the uncertainty principle. The same calculations can be done here as in conventional physics but by using the Pythagorean Triangles with work and impulse.

A disconnect between fields and particles

In quantum mechanics and quantum field theory there is a disconnect between fields and particles, one becomes the other. In this model they are separated even in classical physics. Kinetic energy is regarded as being associated with particles in conventional physics, here the integral is only used with a field that has a probability like a wave function. In Schrodinger's equation this kinetic energy is converted into the wave function as a probability.

Avoiding paradoxes later

Separating the two at this early state avoids some paradoxes in quantum mechanics and quantum field theory later. The important point here is that particles are being measured and observed, they have something called energy and do something called work.

$$mv_s\,dv_s = F_s\,ds \tag{9.5}$$

Now we can integrate. This is going to be a definite integral over just the motion shown in the before-and-after representation. That is, the right side will be an integral over position s from the initial position s_i to the final position s_f. The left side will be an integral over velocity v_s, and its limits have to match the limits of the right-hand integral: from v_{is} at s_i to v_{fs} at s_f. Thus we have

$$\int_{v_{is}}^{v_{fs}} mv_s\,dv_s = \int_{s_i}^{s_f} F_s\,ds \tag{9.6}$$

We have two integrals to examine, and we'll do them one by one. We can start with the integral on the left, which is of the form $\int x\,dx$. Factoring out m, which is a constant, we find

$$m\int_{v_{is}}^{v_{fs}} v_s\,dv_s = m\left[\tfrac{1}{2}v_s^2\right]_{v_{is}}^{v_{fs}} = \tfrac{1}{2}mv_{fs}^{\,2} - \tfrac{1}{2}mv_{is}^{\,2} = \Delta\left(\tfrac{1}{2}mv^2\right) = \Delta K \tag{9.7}$$

You'll notice that we dropped the subscript s in the next-to-last step. v_s is a vector component, with a sign to indicate direction, but the sign makes no difference after v_s is squared. All that matters is the particle's *speed* v.

The last step in Equation 9.7 introduces a new quantity

$$K = \tfrac{1}{2}mv^2 \qquad \text{(kinetic energy)} \tag{9.8}$$

Kinetic energy approximately equivalent to work

Here ΔK as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy has a initial and final state, this is regarded as being equal to work. In this model the E𝕐/-𝕠d kinetic impulse can be converted to the -𝕆D×e𝕪 kinetic work, one Pythagorean Triangle side is taken as a square root then the other is squared. The E𝕍/-𝕚d inertial impulse is in $meters^2$/second and the -𝕀D×e𝕧 inertial work is in meters/$second^2$ these can like ΔK and W be regarded as equivalent to each other as a classical approximation.

Cause and effect or probability

In this model the -𝕀D×e𝕧 inertial work does not work with cause and effect, only with probability. The E𝕍/-𝕚d inertial impulse is deterministic and changes chaotically, this means it is cause and effect only and not probabilistic.

The quantum world

The difference is not visible in the macro world, this is because impulse dominates over work. When positions are very small then the -𝕀D×e𝕧 inertial work for example would be much larger, e𝕧 is small so with a constant Pythagorean Triangle area then -𝕚d is dilated. Then when this is squared as an inertial probability the quantum world appears dominated by waves and probability.

Some waves are still seen

When positions are large then e𝕧 is large, that makes -𝕚d contract and so the wave nature is largely invisible. We still see probabilities when some work is done, for example throwing dice over a e𝕧 length give random outcomes. Ocean waves move by a +𝕀D gravitational torque which allows them to pass through each other so particles are not a barrier.

The macro world is mainly impulse

Most of the macro world is dominated by impulse, the E𝕍 length force is dilated and the times are contracted. We see particles moving and if we look at shorter time intervals they remain like particles.

Newtonian physics

This created the Newtonian physics idea of particles being accelerated only, the idea of fields was little explored except for gravity and magnetism. Probability was also a long time in evolving because of the apparent chaotic nature of reality. Work was still done as a force applied over a distance, but this could also be described as a force over a time period and they seemed to be the same.

The work integral

Here the s axis is a position like e𝕧 as a length, the F_s force in this model is -𝕀D as the inertial torque in relation to the -𝕚d and e𝕧 Pythagorean Triangle. Work can also occur in each Pythagorean Triangle such as the +𝕆D×e𝕒 potential work, the -𝕆D×e𝕪 kinetic work, the +𝕀D×e𝕙 gravitational work, -𝔾D×e𝕪 light work and +𝔾D×e𝕙 Gravi work.

Photons and Gravis

The last two are from photons and Gravis, photons can act as particles with a e𝕐/-𝕘d light impulse or as waves with -𝔾D×e𝕪 light work. Gravis can act as waves, e𝕓 represents the depth of the gravitational well and is the inverse of e𝕙 height. Gravis can also act as a e𝔹/+𝕘d Gravi impulse similar to a graviton as a concept.

Change in the system's kinetic energy → ΔK; Final kinetic energy → K_f; Initial kinetic energy → K_i; Amount of work done by an external force → W

$$\Delta K = K_f - K_i = W \tag{9.9}$$

(Energy principle for a one-particle system)

This is our first version of the energy principle. Notice that it's a cause-and-effect statement: **The work done on a one-particle system causes the system's kinetic energy to change.**

We'll study work thoroughly in the next section, but for now we're considering only the simplest case of a constant force parallel to the direction of motion (the s-axis). A constant force can be factored out of the integral, giving

$$\begin{aligned} W &= \int_{s_i}^{s_f} F_s\, ds = F_s \int_{s_i}^{s_f} ds = F_s s \Big|_{s_i}^{s_f} = F_s(s_f - s_i) \\ &= F_s\, \Delta s \end{aligned} \tag{9.10}$$

Work does not change sign

In this model work does not change sign according to whether the force is in the direction of the position or opposing it. This is to avoid confusion because the +𝕀D×e𝕙 gravitational work is positive and the -𝕀D×e𝕧 inertial work is negative. These can be added together to give the total work, for example a satellite orbiting a planet has a +𝕀D gravitational torque making it orbit and a -𝕀D inertia torque reacting against this.

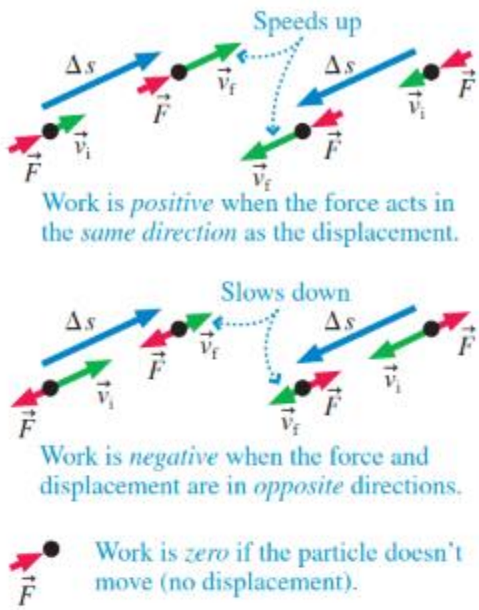
Adding the gravitational and inertial torque

The overall torque then might be in the same direction as the satellite is moving, then it would be accelerating upwards in a spiral. The e𝕙 height is increasing because the -𝕀D inertial torque is stronger, for example it might be burning fuel with a negative -𝕆D×e𝕪 kinetic work so the reaction thrust as -𝕀D×e𝕧 inertial work is also negative. This would be negative work overall because at that e𝕧 position the force causes the satellite to move outwards.

Adding the potential and kinetic work

With -𝕆D×e𝕪 kinetic work a block might be pushed on a surface, this could be reacted against by the +𝕆D×e𝕒 potential work of molecular bonds forming and breaking between it and the surface. That would appear as if the force was reducing as the block slowed, but the force was in the direction of the motion. Here the overall work would be positive because the +𝕆D×e𝕒 potential work is stronger than the -𝕆D×e𝕪 kinetic work pushing the block.

FIGURE 9.4 How to determine the sign of W.



Electron capture

An atom might capture an electron because it has an insufficient E𝕐/-𝕠d kinetic impulse or ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. That would cause it to move downwards, with work it would be decelerating to an orbital. This would be positive work overall because the +𝕆D×e𝕒 potential work is stronger than the -𝕆D×e𝕪 kinetic work.

Acceleration and probability

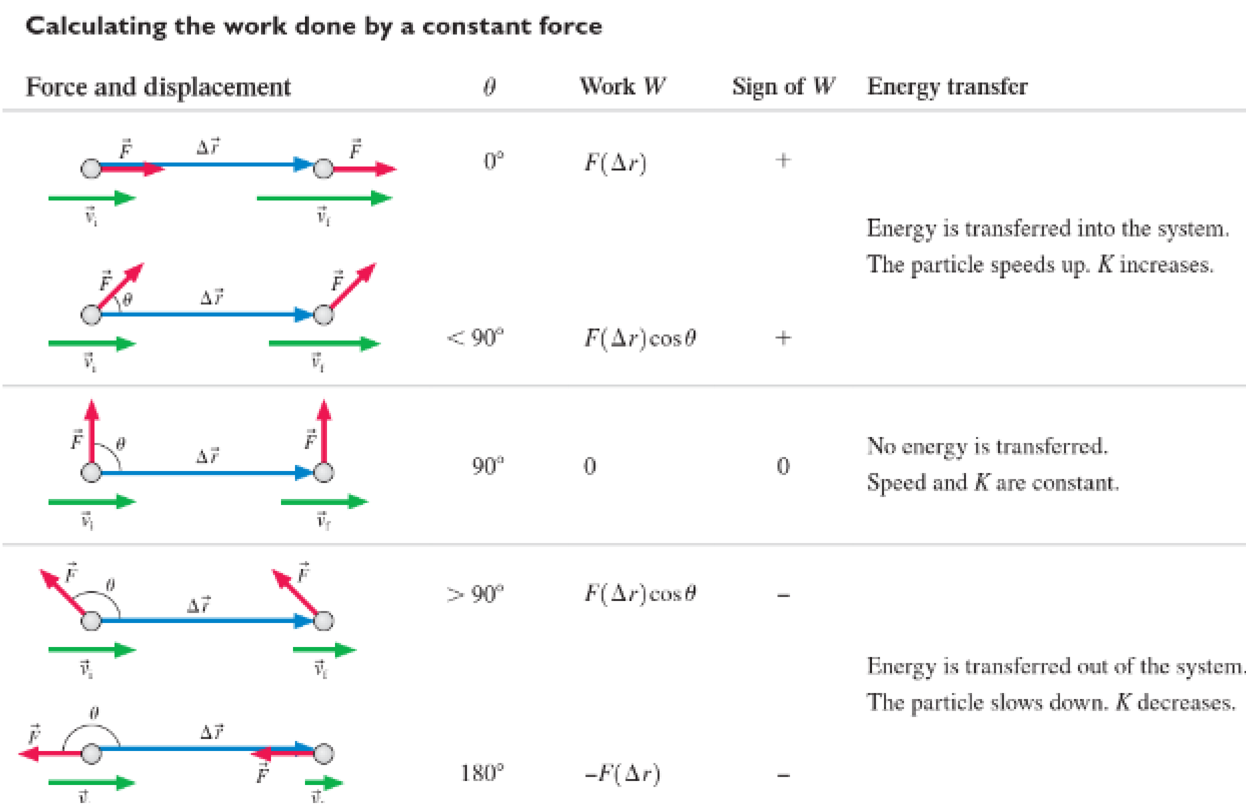
The concept of the particle accelerating or decelerating only applies to work as a classical approximation, here the electron would be acting like a wave moving to become like a standing wave in an orbital. The concept of force here occurs as a torque or probability, it could be said the electron has an increasing probability of entering an orbital or a decreasing probability of leaving the atom.

Work cannot cancel out

The +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work cannot exactly cancel out to leave a zero, this is a potential probability minus the kinetic probability. Two random values cannot add to zero. In some cases work can cancel out, when there are two electrons in an orbital of Helium then they have opposing spins.

Electrons as bosons or fermions

Their -𝕆D×e𝕪 kinetic work is in opposing directions as so their -𝕆D kinetic torque sums to zero. This makes them act as bosons able to coexist in a single orbital. It is not the same as summing the +𝕆D potential torque and -𝕆D kinetic torque because these still have different e𝕒 and e𝕪 Pythagorean Triangle side values. When there is a single electron in an orbital it can do -𝕆D×e𝕪 kinetic work as well, because there is no other electron with an opposing spin it cannot be canceled out like the boson pair.



Calculating the work done by a constant force

Force and displacement	θ	Work W	Sign of W	Energy transfer
	0°	$F(\Delta r)$	+	Energy is transferred into the system. The particle speeds up. K increases.
	$< 90^\circ$	$F(\Delta r)\cos\theta$	+	
	90°	0	0	No energy is transferred. Speed and K are constant.
	$> 90^\circ$	$F(\Delta r)\cos\theta$	–	Energy is transferred out of the system. The particle slows down. K decreases.
	180°	$-F(\Delta r)$	–	

Dot and cross products

In this model vector addition occurs between straight Pythagorean Triangles sides only, this is calculated with the dot product. The cross product has a different kind of vector in conventional physics, it represents a spin according to its size. This spin vector is the same as the spin Pythagorean Triangle side here.

Dot product for square roots and squares

When these vectors are not squared then they represent constant motion, a particle can be moving with a constant velocity for example and collide with other particles. Except for the forces of the collision these e𝕧 lengths between them can all be calculated with the dot product.

Positive and negative not needed for the dot product

That means the positive and negative signs are not needed for impulse, the position between these collisions is on a scale of time such as e𝕧/-𝕚d. This acts as the slope of the -𝕚d and e𝕧 Pythagorean Triangles, the -𝕚d Pythagorean Triangle side is not included in the dot product calculations. Because the dot product uses cosθ between different straight Pythagorean Triangle sides, this works with derivatives as slopes. There are no integrals so no work is measured.

Clockwork universe

A Newtonian universe model can be created this way that is deterministic, it is sometimes referred to as a clockwork universe. There is no need to use fields with impulse, the particles take a period of time as a scale to move between collisions. Inertia can also be represented with F=ma as Newton discovered, the particles with the E𝕍/-𝕚d inertial impulse react against a change in motion.

Square roots of +1

There is an equal and opposite reaction because -𝕚d is the negative square root of +1 in this model. That gives a conflict between +𝕚d as the square root of +1 because with a square as a force there are two values. Both cannot be used as each particle would move in two directions at once. With waves the work would come from opposing probabilities.

-𝕚d is not observable or measurable

In this model that is resolved by the -𝕚d negative square root of +1 not being usable as a number by itself. It can only be subtracted from +𝕚d, so +𝕚d-𝕚d can be used as a time scale or be squared as a probability. Because -𝕚d as the inertial mass cannot be observed or measured directly, inertia only reacts by reducing the amount of any force that acts on it.

Inertial time

This inertial time as -𝕚d in e𝕧/-𝕚d then is only observed or measured, an object then continues along a path unless another force acts on it as Newton's first law. Its E𝕍/-𝕚d inertial impulse cannot change in this -𝕚d inertial time, its -𝕀D×e𝕧 inertial work cannot change its -𝕀D inertial probability except with an active force. Because -𝕚d is negative this inertial time moves forwards towards a future, -𝕠d as the kinetic magnetic field is active and so we can observe and measure a motion towards this future.

Gravitational time

We cannot observe and measure inertial time moving towards a future, instead this is subtracted from +𝕚d which is moving backwards in time. We can then observe and measure gravity reversing time, for example a meteor might be exploded in space and the fragments could come back into approximately the original position. The concept of a Big Crunch is where the universe would reverse back to a singularity, like its gravity reversing time. The Big Bang came from kinetic energy as -𝕠d which made time move forward.

The beginning of time

The concept of a Big Bang then has the active forces from the -𝕠d and e𝕪 Pythagorean Triangles moving time forward, this is why there is no time before then. If there was a Big Crunch then time would be reversing as +𝕚d, in this model that is why there would be no time after then. In the first case time only moved forward with +𝕠d, there was no way to go backwards to before the Big Bang. With the Big Crunch time only moved backwards with +𝕚d, there would be no way for time to move forward with -𝕠d after that.

Cyclical universe

In some hypotheses this is resolved by a series of Big Bangs and Crunches. In this model neither happen, instead the Big Bang is an illusion caused by +𝕚d time dilation at the maximum e𝕙 height from us. That is because the constant area of the +𝕚d and e𝕙 Pythagorean Triangle is much larger than the +𝕠d and e𝕒 Pythagorean Triangle, the +𝕚d time value can be around 14 billion years before e𝕙 contracts towards a minimum,.

The proton as +𝕠d

The +𝕠d and e𝕒 Pythagorean Triangle is the proton in this model, this is +𝕚d as the potential magnetic field. This is also the positive square root of -1 which is not allowed to be observed or measured directly either, that is because -𝕠d as the negative square root of -1 would be a second solution to every force equation. Then objects would be observed in two directions at once, torque would twist in both directions when measured.

+𝕠d is not observable or measurable

As with -𝕚d the +𝕠d square root cannot be observed or measured directly, instead it is added to -𝕠d and the result can be squared in work or used as a scale in impulse. Because +𝕠d is potential time this also cannot be directly observed as this timescale, that is why we can observe time passing actively forward in time with -𝕠d but the past is fixed as +𝕠d. There are ways for the proton to change forwards in time, such as in becoming a neutron. This is because it is partly made up of -𝕠d, d=1/3 as the down quark.

F=ma

This refers to the E𝕍/-𝕚d inertial impulse in this model, the -𝕚d spin Pythagorean Triangle side acts as an inertial mass and as time. It could then be written as -𝕚d×E𝕍/-𝕚d to be the same as F=ma in dimensional analysis, but the mass and time cannot be measured and observed together. So only one is needed with this model, if the mass is to be calculated then the -𝕀D×e𝕧 inertial work is used.

F=ma and the inverse square law

With gravity Newton had another insight, the force acts as an inverse square between two masses. This is the same formula F=ma except here the +𝕀D×e𝕙 gravitational work is used. This gives a field not particles, F=ma can only refer to a particle changing with a force. A field refers to the gap between the Earth and Moon that Newton hypothesized caused their mutual attraction. This acts as an inverse square law because as the e𝕙 height increases between the two masses the +𝕀D gravitational field force decreases as a square.

Fields in a clockwork universe

This allowed for an active force of gravity in this clockwork universe, it acts as a clock because -𝕚d and +𝕚d represent spin like the spinning hands of a clock. Because they are not being measured they act as a constant scale, the timing of this deterministic motion is exact and not probabilistic. Newton also discovered chaos in trying to work out how three masses interact with gravity.

The three body problem

These become chaotic in this model because two of the spins cancel out to some degree when their +𝕀D×e𝕙 gravitational work is calculated. That means that +𝕀D×e𝕙 gravitational work cannot occur where this spin is cancelled, the orbits then cannot resonate with each other with whole number values as the planets do.

Chaos and randomness

In this model 1/2π is the limit β^2 approaches, this is the second Fiegenbaum constant. because of this the three body problem has spins that are opposed, but not exactly. Instead of +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work being done with quantization this results in a chaotic motion. If they reach this ½π ratio then they can move randomly or in orbits for a time, then this becomes chaotic again when it moves away from this ratio. That is why turbulence can become periodic or random at times, then become chaotic again.

Bosons and opposed spin

In an atom a boson pair of electrons also has opposed spin, when in a quantized orbital this is β^2 and so their -𝕆D kinetic probabilities are periodic and random. It may be interactions with other electrons can cause some chaotic motion, this would create an electron cloud around an orbital.

The clockwork universe and impulse

With the active Eℍ/+𝕚d gravitational impulse then masses are attracted to each other with a squared force, with the E𝕍/-𝕚d inertial impulse they react against a change in their motion with a squared force. Together they give the clockwork universe, it was not known then how electromagnetism would factor into this.

Electromagnetism and the clockwork universe

With this model Roy electromagnetism can also be part of a clockwork universe, as was originally thought in classical physics. An electron can move with a E𝕐/-𝕠d kinetic impulse which is proportional to the E𝕍/-𝕚d inertial impulse it has. A proton moves with a E𝔸/+𝕠d potential impulse that is proportional to the Eℍ/+𝕚d gravitational impulse it has. Light can be added to this as particles that have a e𝕐/-𝕘d light impulse, this allows light to bounce off particles such as with Compton scattering.

The dot product universe

Using the dot product could describe all of this, the universe was regarded as being composed of straight lines as Euclid described. This appeared to work because in this model impulse dominates the macro world, positions are large so that with the -𝕀D×e𝕧 inertial work for example the probabilities and wave natures are contracted to retain the constant Pythagorean Triangle areas.

Smaller positions and waves

As smaller phenomena were examined the influence of work and the spin Pythagorean Triangle sides became clearer, these conflicted with the impulse model of the macro world. Light had been shown to act like waves through smaller apertures, Einstein proposed that straight lines could not account for gravity.

The clock of the universe slows down

Time was no longer like clockwork, he found that sometimes it dilates or slows down. Masses appeared to be surrounded by curved space-time he called a geodesic, it was only straight directly outwards from a mass like with the straight Pythagorean Triangle side e𝕙 height.

F=ma and slower time

Time was also found to slow down with faster moving particles, this contradicted the inertial F=ma of the clockwork universe. If they moved fast enough then their -𝕚d inertial masses were larger, that affected how they collided. In some cases particles even acted like waves and passed through each other.

Max Planck

Planck found that the light from a blackbody, a kind of glowing box with a small hole in the top, had a frequency distribution that could not be accounted for by the straight Pythagorean Triangle sides and their frequency predictions. A clockwork universe relied on time being infinitely divisible, if the second hands on a clock sometimes moved with a jump then some observations would not be conserved. For example if one observation occurred just before the universe's clock ticked, then no matter what the position was it would occur in the same amount of time when the next tick happened.

Impulse conserving momentum and energy

If particles are bouncing off each other with impulse only, then faster ones have more inertial momentum and energy is conserved. It implied that there was no division of time, it could be divided to infinitely small amounts Newton described as fluxions in his calculus. In this model the time scale -𝕚d, for example in the -𝕚d and e𝕧 Pythagorean Triangle, can be divided to a small limit but it does not have separate moments of time like the tick of a clock.

Work as the ticks of a quantized clock

In the -𝕀D×e𝕧 inertial work however the squared -𝕀D becomes quantized because it is only measurable as an integer. That means only some values of -𝕚d as time can be squared to give a probability. With work these act like probability as the ticks of the clock, the position of the second hand is uncertain because of the Uncertainty Principle. There is only a probability of where it is.

A continuous spectrum

Impulse and a continuous timescale implied light would have infinitely many frequencies or colors when emitted from glowing materials in a black box or blackbody. When there were more possible frequencies there should have been an increase in its brightness, this is because each frequency would be associated with an emission of photons. Instead, it was found the light brightness went down.

Quantized frequencies

This happens because there is a limit to the difference between one frequency and the next in a discrete spectrum of an atom. That happens because the light is quantized, the -𝕆D×e𝕪 kinetic work of electrons emit -𝔾D×e𝕪 light work. There are no emissions of -𝔾D×e𝕪 light work in between these, there can be a continuous spectrum from e𝕐/-𝕘d light impulse where photons collide as particles. The clockwork universe could not account for quantization, it seemed the frequencies of light could act like the ticks of a clock rather than a continuously spinning second hand.

Planck's constant

Max Planck resolved some of this by proposing light was quantized with a set value that was called Planck's constant, that its frequency was not infinitely divisible but changed in a linear number sequence 1,2,3,… In this model that happens from work, the time or spin Pythagorean Triangle side is squared as a force into whole numbers.

Particles and probabilities are discrete

This creates separate values of time just as squaring a Pythagorean Triangle side as E𝕍 for example creates separate prices of material called particles. In this model then particles represent a quantization of straight Pythagorean Triangle sides, they can be separate from other particles. With work then time also becomes quantized, then a probability can be a separate value from another probability.

Waves need quantization to exist

These quantized pieces also acted in different ways to a continuous timescale they were like segments of waves where one wave had to be distinct from the oscillation of another wave. If not then waves themselves could not exist. As well as a clockwork universe here there was a dice throwing universe, a wave had an uncertain shape not definable like a particle.

Waves have no straight sides

That is because a particle is defined by observing the squared straight Pythagorean Triangle sides, waves have no straight sides except that they move on a straight-line as a position scale. Instead, different parts of a wave have a different spin, that represents a different torque and a different probability of where the wave will be measured. Because waves are not deterministic as with impulse, that only leaves probability.

Impulse and rotation as time

If the velocity was 6 meters/second with impulse this implied a motion of 1 meter in 1/6 of a second, because this was spin on a clock it referred to 1/360 of the rotation of the second hand.

Time versus "of the time"

But in work the fraction 1/6 meant a probability, that something would happen 1/6 "of the time" such as a dice thrown giving a 1. This was not deterministic like the $E\mathbb{V}/\text{-}\mathbb{i}d$ inertial impulse in throwing a dice, it was assumed in classical physics that everything could be predicted by calculating all particle collisions.

Laplace's demon

This concept was illustrated by Laplace, that there could be Laplace's Demon calculating all particle motions and predicting the future from this. With probability that could not happen, the dice could come up with any nondeterministic number as long as it occurred 1/6 of the time in the long run.

Waves and small positions

Quantum mechanics, quantum field theory, general relativity and special relativity are associated with this wave like nature of reality in the micro world of small positions. In this model impulse largely describes the macro world of large positions, then the straight Pythagorean Triangle sides are large then work and the wavelike probabilities are very small. In the micro world this is reversed, work and probability are dilated and impulse with its deterministic particles are contracted.

Classical physics is mainly impulse

In describing the macro world impulse is used with classical physics, when some phenomena would be better described with work and waves this is left out of the classical explanations here. Because of this the differences are pointed out for clarity because they will be used more later.

Electromagnetism and impulse

With early experiments on electricity this was also consistent with impulse, static electricity seemed to attract charged rods with an inverse squared force like gravity. It could also repel two rods with an inverse square law, magnets had a similar squared force which could attract or repel. Because of this gravity was regarded as different, it only seemed to attract. While this electromagnetic field was puzzling, like with gravity, classical physics assumed the clockwork universe applied with these forces as well.

Electromagnetism led to smaller positions

This squared electromagnetic force implied impulse, particles, collisions, and the clockwork universe would explain inside the atom as well. The Coulomb force formula had the same structure as with gravitation, there was a E𝕐/-𝕠d kinetic impulse from the negative charge and a E𝔸/+𝕠d potential impulse from the positive charge.

Positive and negative electric charges

This was before the proton was discovered, it was known experimentally that there were two forces of which one was designated to be positive and the other negative. In this model the positive value actually comes from the +𝕠d potential magnetic field of the proton and the negative from the -𝕠d kinetic magnetic field of the electron.

Deterministic work

Work was also regarded as being deterministic like impulse, it seemed to be that the same particles could be measured over a position or observed over a time period. This is now understood to violate the uncertainty principle, it implied there is no limit to how small an observation can be made and how short the timescale it.

Quantized particles and time

Instead it was found that matter was not infinitely divisible, particles such as the electron seem to have no component particles inside them. Time also has a minimum called Planck Time.

The uncertainty principle

When a position becomes small enough the probability of where a particle is becomes uncertain as the probabilistic aspects of waves become stronger, this is because the -𝕠d and e𝕪 Pythagorean Triangle as the electron for example has a constant area. When the e𝕪 and proportionally e𝕧 length decreases enough then -𝕠d must dilate. Measuring a small position then gives the -𝕆D×e𝕪 kinetic work where the -𝕆D kinetic probability is larger and more uncertain.

The unpredictability principle

Conversely observing smaller time scales makes the E𝕐/-𝕠d kinetic impulse of an electron more unpredictable, its probability contracts and it cannot be estimated as accurately. This is seen with photons where their -𝕘d rotational frequency is very small, then their e𝕪 kinetic electric chargeand e𝕧 wavelengths dilate. They can collide with electrons as particles, the scattering is less predictable because more improbable outcomes occur.

Positive and negative time with impulse

It is not necessary to use positive and negative with impulse, the dot product gives the correct answers with these signs. Instead +𝕚d and -𝕚d can be used to move these collisions forwards and backwards in time, the clockwork universe looks like a movie that is deterministic. It can be run either way though it appears different according to the direction of time.

The dot product and two vectors

In calculating the dot product with the diagram below, a Pythagorean Triangle side can be added to the end of the $B^{\rightarrow}$ at right angles to it so it drops onto $A^{\rightarrow}$. This new part of the $A^{\rightarrow}$ is the dot product answer. When there are many straight Pythagorean Triangles sides these can connect together deterministically and calculated only with the dot product, there is no probability because no work is done. In the diagram work is calculated as a classical approximation only. In this model work uses the cross product and sinθ, which is convertible from the dot product that uses cosθ.

The dot product and Pythagorean Triangles

To convert the dot product to the -𝕚d and e𝕧 Pythagorean Triangle, for example, the vector $\vec{B}$ represents the e𝕧 length of the Pythagorean Triangle. The $\vec{A}$ vector is ζ or zeta, that is used in this model to represent the hypotenuse. It is rarely used here because the forces comes from the Pythagorean Triangle sides not the hypotenuse.

Starting from Pythagorean Triangles

The dot product then multiplies the two vectors $\vec{A}$ or ζ and $\vec{B}$, these would be e𝕧 or E𝕍 with the -𝕚d and e𝕧 Pythagorean Triangle according to if they are forces or not. This gives e𝕧×ζ×cosθ, in this model θ is used as a convention to be the angle opposite the spin Pythagorean Triangle side. Here cosθ is e𝕧/ζ, so that gives e𝕧×ζ/ζ=e𝕧. So the dot product here is e𝕧 when ζ is used, this is the same for any angle $\theta < 90°$. Because $\vec{A}$ is longer than ζ in this case, that can be multiplied by a value to give the correct answer of the dot product.

Cosθ and sinθ

The use of cosθ here implies a sinθ, that would use the spin Pythagorean Triangle side divided by the hypotenuse ζ. If particles are represented as colliding with each other then the angle of collision is determined by θ and the dot products give the e𝕧 lengths of the vectors according to their velocities e𝕧/-𝕚d.

Conservation of inertial momentum and velocity

The change in their inertial momentum -𝕚d×e𝕧/-𝕚d occurs from F=ma or -𝕚d×E𝕍/-𝕚d, here e𝕧 is squared as the force E𝕍. The conservation laws in this model are derived from the constant Pythagorean Triangle areas, the interactions of different -𝕚d inertial masses in the numerators lead to an inverse change in the times in the denominators with velocity changes. For example in a particle collision, if the mass is doubled then the velocity is halved.

Conservation of mass

This gives the conservation of mass, when time as a scale is infinitely divisible as square roots then it was supposed that masses would also be infinitely divisible. If mass was not conserved in the numerator, then time would not be conserved in the denominator.

Conservation of mass and energy

Quantum physics showed neither was conserved, that mass and energy could be converted into each other. In this model that means the Pythagorean Triangles can be created and destroyed in increments of e𝕪×-𝕘d photons, in the case of electrons. A collision then might change the masses that come out of it in a particle accelerator, this also causes time dilation.

Work as a Dot Product of Two Vectors

There's something different about the quantity $F(\Delta r)\cos\theta$ in Equation 9.17. We've spent many chapters adding vectors, but this is the first time we've *multiplied* two vectors. Multiplying vectors is not like multiplying scalars. In fact, there is more than one way to multiply vectors. We will introduce one way now, the *dot product*.

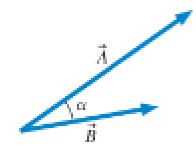
FIGURE 9.8 shows two vectors, $\vec{A}$ and $\vec{B}$, with angle α between them. We define the **dot product** of $\vec{A}$ and $\vec{B}$ as

$$\vec{A}\cdot\vec{B} = AB\cos\alpha \tag{9.18}$$

A dot product *must have* the dot symbol $\cdot$ between the vectors. The notation $\vec{A}\vec{B}$, without the dot, is *not* the same thing as $\vec{A}\cdot\vec{B}$. The dot product is also called the **scalar product** because the value is a scalar. Later, when we need it, we'll introduce a different way to multiply vectors called the *cross product*.

The dot product of two vectors depends on the orientation of the vectors. FIGURE 9.9 shows five different situations, including the three "special cases" where $\alpha = 0°$, $90°$, and $180°$.

FIGURE 9.8 Vectors $\vec{A}$ and $\vec{B}$, with angle α between them.



Dot product of e𝕙 and e𝕧

Here this could be represented in Biv space-time, a Eℍ/+𝕚d gravitational impulse pulls a particle in orbit downwards. The E𝕍/-𝕚d inertial impulse of the particle keeps it in orbit, with this model it could not be perfectly circular because they would be the same as a quantized orbit. The balance of the Eℍ/+𝕚d gravitational impulse and the E𝕍/-𝕚d inertial impulse can be represented by a dot product of two vectors, the e𝕙 height above a planet and the e𝕧 length in the velocity of the particle.

deBroglie waves

In this interpretation there is no work done because the particle returns to its original position. In this model the particle would also do -𝕀D×e𝕧 inertial work around the orbit, this can act like deBroglie waves with an electron around an orbital. In Roy electromagnetism with Hydrogen this would be doing -𝕆D×e𝕪 kinetic work, D would be an integer. That would mean d in -𝕠d would be the square root of an integer. This must be because D is a square, it cannot be a fraction because then it would be a derivative or slope not an integral.

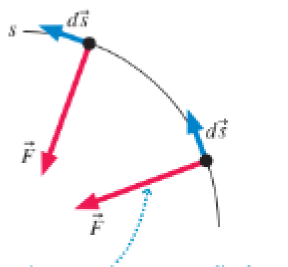
Potential work and the potential

The +𝕆D×e𝕒 potential work is larger as +𝕆D than the -𝕆D×e𝕪 kinetic work and -𝕆D, otherwise the electron would have enough active force to leave the atom. The +𝕆D×e𝕒 potential work overall then cannot be measured, it acts as the potential.

Standing wave

This is like a standing wave with an integer number of oscillations around the orbital the electron does not move like a particle in that case. In this case the dot product would not be used, instead the cross product using sinθ would measure the +𝕆D potential torque or the -𝕆D kinetic torque. The overall +𝕆D-𝕆D probability would be the electron is in the circular orbital.

FIGURE 9.14 A perpendicular force does no work.



Kinetic impulse and a spring

Here a spring is observed to change with a E𝕐/-𝕠d kinetic impulse pushing it down, when released the end can rebound with a E𝔸/+𝕠d potential impulse. In this model the E𝔸/+𝕠d potential impulse is a reaction by the proton in molecular bonds against being changed, this cannot be an active force. The active impulse comes from the -𝕠d and e𝕪 Pythagorean Triangle as the E𝕐/-𝕠d kinetic impulse, this is a squared force according to Hooke's Law.

Gravitational impulse and a spring

If the spring was hanging down with a weight on it, then gravity would pull it down actively with a Eℍ/+𝕚d gravitational impulse. Because vectors are used these can be added with the dot product without using positive and negative signs.

Kinetic work and a spring

There is also -𝕆D×e𝕪 kinetic work being done in pushing the spring down a position e𝕪. This exerts a -𝕆D kinetic torque twisting the spring. That is reacted against by +𝕆D×e𝕒 potential work with a +𝕆D potential torque.

Electric charge from straight Pythagorean Triangle sides.

The electric charge works in straight lines, in this model the e𝕒 potential electric charge reacts against the e𝕪 kinetic electric charge. When a spring is compressed the electrons are being moved closer to the protons, this is from the E𝕐/-𝕠d kinetic impulse and E𝔸/+𝕠d potential impulse. If there was no -𝕠d kinetic magnetic field the electron could fall straight downwards, but that would mean the -𝕠d and e𝕪 Pythagorean Triangle had a zero area as -𝕠d would also be zero.

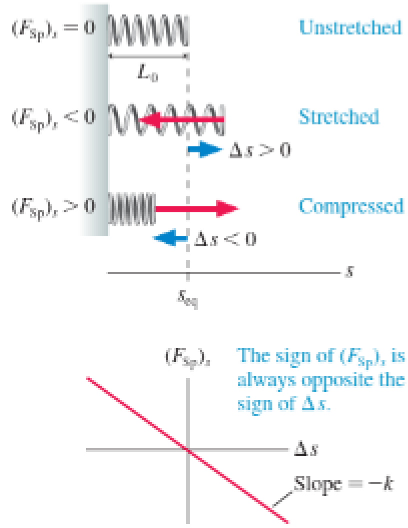
The ground state

The electron then has a minimum -𝕠d kinetic magnetic field so it moves to the ground state where its e𝕧/-𝕚d velocity is referred to as α. If it is moving with a E𝕐/-𝕠d kinetic impulse, it can go below the ground state and through the nucleus. This ground state is also in Biv space-time, the velocity of the electron is from its -𝕚d inertial mass as a ratio to the +𝕚d gravitational mass of the proton.

The ground state of a planet

This ground state functions like the ground of a planet, a falling ball cannot penetrate the surface of a planet easily because this would compress the atoms in the ground. These react against that force because the ground's electrons react against being pushed down into lower orbitals. They also react against being pushed under this ground state, a neutron star is where gravity can force electrons past the ground state to recombine with protons to make neutrons. A spring then reacts against the electrons in its atoms being compressed into lower orbitals, but also from being broken out of molecular bonds holding the spring together.

FIGURE 9.17 Properties of a spring.



Hooke's law

Here the position of the spring comes from the -𝕆D×e𝕪 kinetic work and the +𝕆D×e𝕒 potential work, with vectors being used that could also be described as a classical approximation by the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse. Then it is observed how long the spring takes to be compressed as a period of time not position. Because this is from a velocity that automatically gives the position e𝕧. With an acceleration that would be work in meters/second^2, this would be converted into meters^2/second to give impulse.

FIGURE 9.17 shows a spring along a generic s-axis exerting force $\vec{F}_{Sp}$. Notice that s_{eq} is the position, or coordinate, of the free end of the spring, *not* the spring's equilibrium length L_0. When the spring is stretched, the **spring displacement** $\Delta s = s - s_{eq}$ is positive while $(F_{Sp})_s$, the s-component of the restoring force, is negative. Similarly, compressing the spring makes $\Delta s < 0$ and $(F_{Sp})_s > 0$. The graph of force versus displacement is a straight line with negative slope, showing that the spring force is proportional to but *opposite* the displacement.

The equation of the straight-line graph passing through the origin is

$$(F_{Sp})_s = -k\,\Delta s \qquad \text{(Hooke's law)} \qquad (9.22)$$

Zeno and motion

The problem of motion and position was discussed by Zeno in Ancient Greece as a series of paradoxes. Some of these ideas led to the uncertainty principle, the concepts that arise from the spin are not just in the subatomic world but around us in the macro world. This is because the spin Pythagorean Triangle sides with waves and probabilities are still measurable, we see ocean waves and probability with dice and even with opinion surveys.

An arrow cannot move

Zeno discussed the problem of what position as e𝕧 meant, an arrow could be regarded as taking up a position with a e𝕧 length that starts at the tip and ends at the tail. But then Zeno said the arrow must be stationary because it is not moving past these boundaries. This would be the same with a moving arrow, so all motion is impossible.

The arrow's probable position

This is recognized with the uncertainty principle, that defining a particle to have a particular stationary position e𝕧 is impossible. That introduces some wave like nature making its position increasingly probabilistic. In that sense the arrow cannot be stationary, its atoms are all moving.

Vectors cannot move

This leads to the problem of defining the clockwork universe as a series of particles colliding with each other, if each vector is like an arrow then it implies that the particles cannot move. Often this is modeled with a series of stationary arrow vectors, the tip of the arrow is on the next particle and the tail is on the previous particle. That can illustrate the collisions of the clockwork universe but there is no motion as Zeno said.

Velocity as a fraction

In this model the particles can move because the velocity is a fraction, the e𝕧 length is straight while the -𝕚d time spins like a clock. Time can then pass without it needing to move forward. The photon in this model moves like a rolling ball, the axle is the -𝕘d rotational frequency and the phasor or a spoke is the e𝕪 kinetic electric charge.

The arrow vector rotates

The arrow vector then is rotated around the axle but does not change its position in relation to the -𝕘d spin Pythagorean Triangle side. The -𝕘d axle can pass time as a denominator with -𝕘d/e𝕪, d and e change inversely to each other as in the other Pythagorean Triangles while d×e is a constant. The e𝕪×-𝕘d photon can then move at a constant velocity by this rotation, the speed of c is not affected by changes in the angle θ in the e𝕪 and -𝕘d Pythagorean Triangle.

The wheel has a constant velocity

If the -𝕘d rotational frequency doubles then the e𝕪 phasor or spoke halves in position. This becomes like a wheel that halves in its radius but doubles its spin, it moves at the same speed as before. This is because the e𝕪×-𝕘d photon only transmits the changes in the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle.

A stationary particle is not allowed

When a particle slows, the e𝕧/-𝕚d velocity has -𝕚d is dilating and e𝕧 contracting to maintain a constant Pythagorean Triangle area. The time is then increasing to move the particle a position, for example a wheel moving at 1meters/1second changes to .5 meters/2 seconds.

A Pythagorean Triangle with a zero area is not allowed

The area of the Pythagorean Triangle cannot change as this would change the conservation laws, so a stationary particle would have a straight Pythagorean Triangle side of zero and a spin Pythagorean Triangle side infinitely large. That is not allowed with a constant Pythagorean Triangle area. In this model there is another limit as to why a Pythagorean Triangle cannot reach beyond a maximum or minimum angle θ. This occurs because c is defined by the velocity e𝕧/-𝕚d and the kinetic velocity e𝕪/-𝕠d of an electron in the ground state by α. With this ratio defined, the velocity is ≈ 1/137 of c. If this is a constant then c must also be a constant.

α, ϵ_0 and μ_0

In this model 1/α is a cosine of the -𝕠d and e𝕪 Pythagorean Triangle, that gives the angle θ of the ground state. This is approximately equal to e^{-1} and so it represents the beginning of a number series starting from 1. This exponent is represented by $e^{-𝕠d}$ or $e^{-𝕚d}$ with d=1. Because Roy electromagnetism has the +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the -𝕠d and e𝕪 Pythagorean Triangle as the electron, these two are connected with a ratio of their e𝕒 and e𝕪 electric charges. This gives values of ϵ_0 and μ_0 which also combine as square roots to give c as does α here.

The proton and electron mass

This is also proportional to the +𝕚d and e𝕙 Pythagorean Triangle as the gravitational mass of the proton, and the -𝕚d and e𝕧 Pythagorean Triangle giving the -𝕚d inertial mass of the electron. This ground state defined by 1 then can only exist with a certain ratio of the +𝕚d gravitational mass of the proton and the -𝕚d inertial mass of the electron, if the ratio was different then the electron would not stay at the ground state with this velocity.

The electron as a rolling wheel

At this ground state then the electron also moves like a rolling wheel, its e𝕪 kinetic electric charge acts like the phasor or spoke of the wheel like the e𝕪×-𝕘d photon. The axle is -𝕠d as the kinetic magnetic field, it is similar to the rotation of an electric motor with its electromagnetism. Zeno’s arrow then is spinning but not itself moving as with the e𝕪×-𝕘d photon.

Measuring and observing the electron wheel

The wheel is not actually observable or measurable as such, in this model it is the -𝕠d and e𝕪 Pythagorean Triangle. When the derivative is taken as e𝕪/-𝕚d that allows for the spin Pythagorean Triangle to spin as an axle. The straight Pythagorean Triangle side then can only be a spoke or phasor. If the integral is taken as e𝕪×-𝕚d this is a field not a wheel, but it can also describe the area between the -𝕠d axle and the e𝕪 phasor of a wheel.

The electron and photon wheel is not a disc

In this model the electron and photon’s measurements and observations are explained by the wheel model, but this is from taking the Pythagorean Triangle where one side spins as an axle. It is not an actual wheel as a disc.

Measuring and observing the wheel

When this is measured for -𝕆D×e𝕪 kinetic work the -𝕆D kinetic torque oscillates like a wave, that makes electrons appear as deBroglie waves. When this is observed as a particle the e𝕪 phasor acts as an electric field around the electron as a point particle. This is because the electron has no e𝕙 height like a proton, the e𝕧 length can define a position around it. This is not the same as a radius and so it appears as a point.

Renormalization

Because the -𝕠d and e𝕪 Pythagorean Triangle has a constant area, observing the electron with a smaller e𝕧 positions leads to a dilation of the -𝕆D kinetic probability and the -𝕀D inertial probability. The electron then appears to have more energy blowing up to infinity the smaller the position becomes. In conventional physics renormalization stops this process at a position so the -𝕠d kinetic magnetic field and -𝕚d inertial mass are measurable.

The proton as a spinning wheel

The +𝕠d and e𝕒 Pythagorean Triangle, as the proton, is also spinning with its e𝕒 potential electric charge as the phasor or spoke of the wheel. This arrow then is also not moving but is rotating. Together these orthogonal spin directions can recombine with the electron neutrino, as the third orthogonal spin direction, to become the neutron.

A wheel resolves Zeno's paradox

In relation to itself then Zeno's arrow does not move in a straight-line from one position to another, instead it spins around and this allows for a wheel to resolve Zeno's paradox in this model. A wheel can move while Zeno's arrow inside the wheel has not in relation to the wheel's boundary.

Impulse and Zeno's paradox

With impulse the wheel changes, the e𝕪 phasor of the electron becomes E𝕐 as the kinetic electric force. This is observed as a particle but the -𝕠d rotating axle is not being also measured. The wave nature is not observed because the -𝕠d spin Pythagorean Triangle side would also need to be squared to give -𝕆D as the wave torque. This allows the E𝕐 kinetic electric force to move with impulse without oscillating and without a -𝕆D kinetic probability.

A wave size is not observed

The wheel has its axle measured as -𝕆D but the e𝕪 kinetic electric charge is not observed. Because of this a wave can have a torque or probability, but its position or size is not well defined. This is seen with ocean waves for example where the boundaries of its shape are not clear like a particle.

Impulse observed over time not position

The arrow here would be moving with respect to time as -𝕠d but the actual position is not being measured. The change in the arrow's position then is not in regard to a change in its position, or a change in where its e𝕧 length is, but with respect to time as -𝕠d only. The wheel has its E𝕐 phasor observed but a change in its orientation from spin cannot be measured as well.

No oscillation in time

There is no oscillation in the spin Pythagorean Triangle side called time and so the kinetic electric force does not oscillate in strength. The E𝕐 kinetic electric force would remain constant until an observation changes it, or a collision occurs which also acts as an observation.

Relativity and rolling wheels

This also leads to relativity. A rotating electron wheel might move with a velocity approaching c, when it is measured its deBroglie waves have contracted. This is because -𝕠d has also contracted as e𝕪 dilates in e𝕪/-𝕠d proportionally to e𝕧/-𝕚d.

Relativity and length contraction

In this model there is a time dilation with the electron as its -𝕠d spin Pythagorean Triangle side contracts, that acts like a clock spinning more slowly. With measuring -𝕀D×e𝕧 inertial work this is not from the velocity, that is because an integral is not dividing a straight Pythagorean Triangle side by a spin Pythagorean Triangle side like e𝕧/-𝕚d. Instead, it is multiplying them. Measuring the e𝕧 length contraction then refers to the length of the electron, also of a rocket approaching c.

Electron and photon rolling wheels

When e𝕪×-𝕘d photons move they are like rolling wheels, similar to the electron except they move at c. When they are absorbed by the electron, with -𝔾D×e𝕪 light work, their -𝔾D light torque acts to spin the electron faster with a constructive interference. Conversely, when an electron in an atom emits a e𝕪×-𝕘d photon with -𝔾D×e𝕪 light work it loses some of its -𝕆D kinetic torque and drops down an orbital.

Work contracts length

When e𝕪×-𝕘d photons do -𝔾D×e𝕪 light work on the electrons then they increase its -𝕚d inertial mass, an electron has a higher -𝕚d inertial mass in higher orbitals. When the photons do enough -𝔾D×e𝕪 light work on the electron then it reaches the ionization level and leaves the atom, this -𝕚d inertial mass keeps increasing as the electron is accelerated. When this -𝕆D×e𝕪 kinetic work of the electron is measured, and proportionally its -𝕀D×e𝕧 inertial work, then -𝕆D and -𝕀D are larger. That means e𝕪 and e𝕧 are contracted and so a rocket would appear contracted in e𝕧 length. The electron itself has no e𝕙 height but only a e𝕧 length, being a point particle this e𝕧 length contraction doesn't make it appear contracted.

Absorbing photons

When e𝕪×-𝕘d photons do -𝔾D×e𝕪 light work on the electron it absorbs them, the equal and opposite reaction occurs by having absorbed the photon so it no longer exists. The photon has become a change in the angle θ of the electron and its rotational frequency. Here the inertial mass increased as a reaction to the photons and their -𝔾D×e𝕪 light work so the overall amount of work is conserved.

A rotating wheel approaches c

With the properties of the -𝕚d and e𝕧 Pythagorean Triangle this model works in Special Relativity. When the maximum velocity is c is approached then e𝕧/-𝕚d, as the electron velocity, has e𝕧 dilated towards a maximum and -𝕚d towards a minimum. This is the opposite of the uncertainty principle where e𝕧 is contracted towards a minimum and -𝕚d towards a maximum. Zeno's arrow is rotating slower, -𝕚d is contracted and the arrow like the clock hands are spinning more slowly.

Work and impulse from fuel

The rocket appears both with a e𝕧 length contraction and with a -𝕚d inertial time being slowed. This is because the rocket fuel gives both an increased E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work to the rocket. An electron or photon cannot do both of these, it must be one or the other. Overall, both measurements and observations are occurring. The increased -𝕀D×e𝕧 inertial work has dilated the -𝕚d inertial mass which contracts the rocket's e𝕧 length. The increased E𝕍/-𝕚d inertial impulse increased the rocket's velocity so that e𝕧 is dilated in e𝕧/-𝕚d and -𝕚d is contracted. This means -𝕚d as a rotational frequency of a clock is contracted and the clock runs more slowly. That is the same as with a e𝕪×-𝕘d photon, when its clock or rotational frequency is slower then it cannot liberate electrons from a metal with the photoelectric effect.

The electron impulse converted to particles in a collision

When an electron rolling wheel is accelerated towards c in a particle accelerator, this dilates its e𝕪 kinetic electric field and its E𝕐/-𝕠d kinetic impulse in a collision with particles in a target. That can produce more particles, its wave nature is contracted at higher velocities and so the electrons are less likely to pass through a target as waves. Conversely at slower velocities the electron rolling wheels can do -𝕆D×e𝕪 kinetic work in passing through a double slit as waves.

Electrons cannot move at c and be measured

In these particle collisions the photons emitted move away at c, a velocity the electron cannot reach. This is because its velocity can only be increased by absorbing e𝕪×-𝕘d photons, their e𝕪/-𝕘d wavelength to rotational frequency ratio is determined by their angle θ. With the -𝔾D×e𝕪 light work of these photons they can accelerate the electron as they do in the photoelectric effect. But this -𝔾D×e𝕪 light work is being negated by the contracted -𝕚d inertial time in e𝕧/-𝕚d.

A pole fitting in a barn

It is the same with e𝕧 length contraction, this is seen with a well-known Special Relativity problem of a pole fitting into a barn. A 100-foot pole with a velocity approaching c must fit inside a barn 10 feet long, the door to the barn must be closed before the front of the pole hits the back of the barn.

The pole’s length contracts

The pole appears to contract as e𝕧 when the velocity e𝕧/-𝕚d inversely approaches c. This is because the pole has increased its -Id inertial probability through the inertial displacement it has undergone. Initially it may have been close to at rest, then it was accelerated to near c. This inertial history increased its inertial mass, because this is dilated then its e𝕧 length is contracted and it can fit in the barn.

The pole’s time slows down

The pole also has a displacement history E𝕍 because of its inertial acceleration, this is observed with its E𝕍/-𝕚d inertial impulse. Its -𝕚d inertial time is slowed on a clock gauge, that can give enough time to close the barn door before the pole hits the back of the barn.

Inertial mass and inertial time are inverses

The -𝕚d inertial mass and the -𝕚d inertial time then act as inverses, they are conserved and so the electron does not change its Pythagorean Triangle area. This is because -𝕚d×e𝕧 is an integral field, e𝕧/-𝕚d has -𝕚d in the denominator as an inverse and this is a particle. With -𝕀D×e𝕧 inertial work -𝕚d is squared, the two diverse on an exponential curve.

A history of acceleration

A displacement or a duration then is not the same as a position or moment. For example a car moves at 1 meter/second around a circular track. Increasing this velocity 4 times as e𝕧/-𝕚d means e doubles and d halves, but this is not measuring the history of the car’s increase in acceleration. That is a displacement from its initial velocity to its final velocity. A displacement is then not a pair of positions, it is what is in between those positions.

Acceleration slows time

Because of this inertial history as a displacement the car's velocity has increased, its E𝕍/-𝕚d inertial impulse has E𝕍 dilated and so -𝕚d as the inertial time has contracted. This is not seen with the car but its time has also slowed on a clock gauge.

Acceleration contracts distance

Also with its acceleration the car has an increased -𝕀D inertial mass as a force, this would be measured if it collided with another car for example. This is from -𝕀D×e𝕧 inertial work, because -𝕀D is dilated then e𝕧 is contracted, the car has its e𝕧 length contracted. Again this is a small effect, but this time slowing and length contraction would be measurable and observable with a rocket approaching c.

Exponential dilation and contraction

In special relativity γ increases closer to c as an exponential, with this model the exponential curve comes from a squared Pythagorean Triangle side relative to an unsquared Pythagorean Triangle side and a constant area. Inside a rocket a clock can appear to slow with time dilation, this is because it is compared to a stationary observer's clock that did not undergo acceleration with an E𝕍/-𝕚d inertial impulse. Also, the rocket appears contracted compared to the e𝕧 length of a stationary observer. That is because the observer did not undergo -𝕀D×e𝕧 inertial work in accelerating the rocket.

γ and relativity

The relativity equation then gives γ as both the -𝕀D time dilation squared and the E𝕍 length contraction squared, when the square root is taken of -𝕀D and E𝕍 this is the same inverse relationship of time slowing and distance contracting. To accelerate electrons towards c then they must do more -𝔾D×e𝕪 light work, but this causes their e𝕪 kinetic electric charge to contract. That is proportional to the wavelength of deBroglie waves contracting. Also the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse of the electron has increased with this acceleration, that would make its -𝕠d kinetic magnetic field contract. Its time would be slower, this is seen with a muon electron where it decays more slowly when it travels near c.

Fermi energy and the photoelectric effect

With electrons in the atom a higher orbital is associated with an increased -𝕆D×e𝕪 kinetic work and a decreased E𝕐/-𝕠d kinetic impulse. This is because an electron moves with a slower velocity e𝕧/-𝕚d in higher orbitals, proportionally this is a slower e𝕪/-𝕠d kinetic velocity. The electron moves to higher orbitals by an increased -𝕆D kinetic torque, as a -𝕆D kinetic probability this makes it more likely the electron will be found there.

Impulse and orbitals

A E𝕐/-𝕠d kinetic impulse can arise from heating atoms, this increases their vibrations which come from the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse. That is because vibrations are a back and forth motion. This affects electrons less because of their lower velocity and kinetic velocity in higher orbitals, a higher temperature then does not increase the Fermi energy of electrons and so they are not moved out of their orbitals by even very hot temperatures.

The photoelectric effect

Ey×-𝕘d photons with a lower -𝕘d rotational frequency do not eject electrons in the photoelectric effect, only higher -𝕘d frequency ey×-𝕘d photons do as Einstein found. A low frequency photon has -𝕘d contracted and ey dilated, this would have a stronger e𝕐/-𝕘d light impulse and a weaker -𝔾D×ey light work. Because the electrons are moved upwards with a -𝕆D kinetic torque then the -𝔾D×ey light work liberates electrons more in the photoelectric effect, this is because -𝔾D is the light probability and a light torque.

Increasing velocity with impulse

For ey×-𝕘d photons to keep increasing the velocity of electrons to c they would need to do this with the e𝕐/-𝕘d light impulse where E𝕐 is dilated along with the E𝕍/-𝕚d inertial impulse of the electron and its E𝕐/-𝕠d kinetic impulse. Instead, the -𝔾D×ey light work of ey×-𝕘d photons accelerates the electron less, as -𝕚d inertial time, which is inversely proportional to -𝕘d contracts.

Torque versus acceleration

The higher frequency photons can use their -𝔾D light torque to liberate electrons from an atom, but this is a circular force. To accelerate atoms the e𝕐/-𝕘d light impulse is needed because this is a straight-line force. This makes it impossible for a rocket as well as an electron to be accelerated externally past c, the photons themselves have this c limit and so cannot exert a force greater than this.

Cerenkov radiation

Cerenkov radiation is where electrons and alpha particles going faster than c in a medium slow down, ey×-𝕘d photons are emitted by the water molecules as they interact with the particles. The velocity of c decreases in the water to about ¾ of its normal speed. It appears then that particles are not damaged by traveling at greater than c in a medium, they may also be not damaged if they move faster than c in a vacuum.

Electron impulse close to c

Electrons have been observed at close to c in particle accelerators with their E𝕐/-𝕠d kinetic impulse, this is because that is not quantized. They cannot be accelerated to faster than c because the ey/-𝕠d kinetic velocity from the accelerator's photons cannot exceed c.

Self-propulsion and c

It may be possible for a rocket to be self-propelled and exceed c, but it would not be observable or measurable until its velocity was under c again. This is because the -𝕚d inertial mass of the rocket could keep increasing past c so the Pythagorean Triangle angle θ changes are conserved. That is not the same as external ey×-𝕘d photons accelerating the rocket, such as a laser pushing it from behind. This laser have a e𝕐/-𝕘d light impulse acting on the rocket moving it but this loses it force the closer the rocket gets to c.

Observing and measuring past c

When the rocket is self-propelled it has its own -𝕚d proper time and e𝕧 proper length, there is no time dilation on board nor any length contraction. Instead, the increased velocity past c would give a change in what is observed and measured outside. Light from behind could not be measured as -𝔾D×ey light work, the -𝕘d rotational frequency would fall lower than the ground state. Also the velocity of the photons would be less than the rocket. The e𝕐/-𝕘d light impulse would not be observable, the photons would act as particles moving slower than the rocket.

Hyperspace

It may be the rocket would be surrounded by darkness as a version of hyperspace, e𝕪×-𝕘d photons may not be able to interact with the rocket. If there was matter close to the rocket then it might emit Cerenkov radiation like the heavy water in the reactor. Another possibility is seen on Star Trek, space directly forward and behind the ship is black because the e𝕪×-𝕘d photons could not be observed or measured. To one side the ship may have a slower than light velocity and so these photons might be observed and measured. These speculations are beyond the scope of this book but, if this faster than light travel is possible, the measurements and observations should be consistent with this model.

ϕspace

The name hyperspace could come from the hyperbolic geometry of electrons and inertia. This would not be the same as with hypothetical tachyons, special relativity would not be going into reverse in this model. Because of the science fiction connotations of the word hyperspace, another working definition might be more suitable. This could be called ϕspace or phi-space, ϕ is used in this model as the other acute angle in the Pythagorean Triangles than θ. This angle ϕ is not directly observable or measurable, but it would give the right answers in calculations as 90°-θ.

No infinite velocity

In this model the Pythagorean Triangles cannot go to an infinite limit with a Pythagorean Triangle side, they cannot become infinitely large or small. Instead the angle θ in them stops at a maximum or minimum, this happens because of the math of the Pythagorean Triangles. The speed c then is not infinite, that would happen if in e𝕧/-𝕚d the e𝕧 position became infinitely large and -𝕚d infinitely small. But then there would be no constant Pythagorean Triangle area. With a hypothetical ϕspace the rocket would have a velocity with an angle θ below this c minimum.

Minimum angle θ

The Pythagorean Triangles work as before, the barrier of this minimum angle would be exceeded. From behind the rocket might appear to approach an event horizon where its e𝕧 length would contract and its -𝕚d inertial time slow. After this the rocket should disappear as no more photons from it should be measurable as -𝔾D×e𝕪 light work or observable with a e𝕐/-𝕘d light impulse.

The CMB and black holes

This is like with the CMB, the -𝕘d rotational frequency of the photons would be too low to be observed or measured. It would also appear to be like a rocket going into a black hole, the e𝕙 height contraction would be equivalent to the e𝕧 length contraction. The +𝕚d gravitational time slowing would be equivalent to the -𝕚d inertial time slowing. When the rocket reached this event horizon using its own thrust it might then disappear, it would be moving faster than c in this model.

Calculating the velocity

Observing the actual velocity might be difficult, perhaps by monitoring the amount of thrust. Also the photons from the front and behind might be observable at an angle, this angle would change with the velocity > c.

Impulse versus work and the sound barrier

The light barrier might be like the sound barrier, this was broken by using jets, these have an E𝕍/-𝕚d inertial impulse from the E𝕐/-𝕠d kinetic impulse of burning fuel. Propellor driven planes could not break the sound barrier, perhaps because the -𝕀D×e𝕧 inertial work done by the -𝕀D inertial torque of spinning propellors had a decreasing efficiency at higher velocities. This would be the same as with external photons, if they are reflected from a rocket this is similar to a propellor pushing on air molecules. A jet is different because it uses its own matter for thrust.

Obstacles past c

If the rocket encountered atoms in space then it might be slowed by their emitting a kind of Cerenkov radiation, though the number of these atoms would be small. A hypothetical ship might also be detectable with these photons. Atoms traveling near c in a vacuum can enter an area where c is lower, they are then moving temporarily faster than c. This does not appear to damage the atoms so perhaps a rocket would also not be affected with faster than light travel.

Time dilation and deBroglie waves

When an electron rolling wheel approaches c its e𝕧/-𝕚d velocity approaches its maximum. The -𝕚d spin Pythagorean Triangle side is contracted and so time appears to move more slowly. A rocket approaching c also experiences this, with a high e𝕧/-𝕚d velocity the -𝕚d inertial time is contracted appearing as a slower clock in time dilation. With an increased velocity deBroglie waves, measured as the wavelength e𝕧 contracts because of the higher E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse of the electron.

Photon frequency

The slower clocks in special relativity are the same in this model as with a e𝕪×-𝕘d photon, when -𝕘d as the rotation frequency is large then it is like a clock spinning faster. Those photons can do more -𝔾D×e𝕪 light work, their -𝔾D light torque is stronger and it can move electrons in orbitals with a higher -𝔾D probability as seen as the work potential in the photoelectric effect. These photons act as if they have a higher -𝕚d inertial mass which they can impart to the electrons.

The clockwork universe and its limits

The clockwork universe worked well when velocities were not too small, as this caused problems with the uncertainty principle and Zeno's arrow, and not too large as this caused problems with the speed of light. In the same way impulse describes this clockwork universe well as long as time is not measured as being very short, because then objects approach c with their velocity, or very long because this is like a particle being nearly stationary.

Work by springs as an integral

Here the -𝕆D×e𝕪 kinetic work done in compressing a spring is again an integral, the change in position is taken as this force. In this model that would be the time taken to compress the spring squared as a -𝕆D kinetic torque times a e𝕪 kinetic electric charge. The integral would then be -k×1/2$\int_{si}^{sf}$-𝕆D ds (or de𝕪) where k is the spring constant, that changes with the size and thickness of the spring. In this model e𝕧 would be used as the length the spring is depressed, that would give the -𝕆D×e𝕪 kinetic work. The ½ factor would be included in k.

Work Done by Springs

The primary goal of this section is to calculate the work done by a spring. FIGURE 9.20 shows a spring acting on an object as it moves from s_i to s_f. The spring force on the object varies as the object moves, but we can calculate the spring's work by using Equation 9.21 for a variable force. Hooke's law for the spring is $(F_{Sp})_s = -k\,\Delta s = -k(s - s_{eq})$. Thus

$$W = \int_{s_i}^{s_f} (F_{Sp})_s\, ds = -k\int_{s_i}^{s_f} (s - s_{eq})\, ds \tag{9.23}$$

Subtracting the kinetic energy

Here the -𝕀D×e𝕧 inertial work in compressing the spring has an initial and final value of s, the same as using e𝕧 with two different values of e. This gives two values of the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy subtracted, the difference as before is the velocity here is squared in the integral. It goes from e𝕧/-𝕚d to E𝕍/-𝕀D. In this model both sides of a Pythagorean Triangle cannot be integrated or taken as a derivative together, instead only one can be.

Kinetic energy proportional to velocity

After the work is done it can be measured over a distance s or e𝕧, the kinetic energy here is where the E𝕐/-𝕠d kinetic impulse is being observed. This would be for example where the spring was released and the velocity of its motion being proportional to this kinetic energy. In conventional physics the kinetic energy is observed as the difference between two velocities. There is an initial velocity at rest, then the final velocity with the ½ coming from the average of these two.

Integrating velocity

It is also possible to integrate as below, this is not done in this model to keep work and impulse separate. The answers are the same, in (9.24) k would be the -𝕆D kinetic torque applied to the spring to compress it and the amount released. The two ½ factors cancel out. Here then the -𝕆D×e𝕪 kinetic work would be integrated as below with a position s. The E𝕐/-𝕠d kinetic impulse is differentiated, by convention the denominator has its exponent increased by 1 as a derivative. Writing this as the velocity -𝕚d/e𝕧 in seconds/meter this when differentiated with respect to e𝕧 gives -𝕚d/E𝕍 or the E𝕐/-𝕠d kinetic impulse.

Impulse as a derivative

It can also be integrated as e𝕧/-𝕚d with respect to e𝕧 to give ½×E𝕍/-𝕚d, but in this model integration is not used with impulse as an integral is an area or field. A derivative is a slope as a particle, the calculus Pythagorean Triangle defining this slope can shrink down to no area or integral and this slope value remains. This is because in calculus two infinitesimals can be divided, here the e𝕧 position is an infinitesimal but this is divided by -𝕚d as an instant. A particle then in this model is a position from the straight Pythagorean Triangle side representing its size or position. The time divides this as when the particle was at this position. A particle then is defined here as a position that occurs at a time period.

An integral times a derivative

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy can be regarded as an integral times a derivative. This allows them to be separated as an integral of -𝕆D×e𝕪 kinetic work and a derivative as the E𝕐/-𝕠d kinetic impulse. To do this the ½×-𝕠d× e𝕐/-𝕠d linear kinetic energy can be written as ½×-𝕆D/E𝕐×-𝕠d, this is the same value as -𝕆D/E𝕐 would be proportional to seconds²/meter². That would be the same velocity squared and the same final position as E𝕐/-𝕆D in meters²/second. Taking -𝕠d/e𝕪 as the kinetic velocity in proportionally seconds/meter the integral gives ½×-𝕆D leaving e𝕪 as a constant. Taking the derivative of the denominator with respect to e𝕧 gives 1/E𝕐 leaving -𝕆D as a constant, this gives the same -𝕆D/E𝕐.

The velocity is the same when inverted

As a convention here the integral can be done inverted as ∫1/-𝕠d d -𝕠d to give ½× 1/-𝕆D because the final positions and times of motion are the same both ways. Then the numerator has a derivative taken as e𝕪/1 with respect to e𝕧 to give E𝕐. The answer also has the same factor of ½ as in integrating the velocity directly.

Combining work and impulse to give an integral

Using the -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse here then gives the same answer as when the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is created with a single derivative. The integral is taken as d or with respect to -𝕠d and the derivative is taken with respect to e𝕪. Because the integral is in the denominator and the derivative is in the numerator this gives a separate fraction they are with respect to as e𝕪/-𝕠d, they act as the linear scales of the work and impulse squared forces. This model uses many other derivatives times integrals as will be shown later.

Velocity without a force

That also gives the kinetic velocity before a force, the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy or the ½×e𝕍/-𝕀d ×-𝕚d linear inertia then begin as this kinetic velocity e𝕪/-𝕠d or the velocity e𝕧/-𝕚d before an energy change.

This is an integration best carried out with a change of variables. Define $u = s - s_{eq}$, in which case $ds = du$. This changes the integrand from $(s - s_{eq})ds$ to $u\,du$. When we change variables, we also have to change the integration limits. At the lower limit, where $s = s_i$, the new variable u is $s_i - s_{eq} = \Delta s_i$. The lower limit becomes the initial *displacement*. Similarly, $s = s_f$ makes $u = s_f - s_{eq} = \Delta s_f$ at the upper limit. With these changes, the integral is

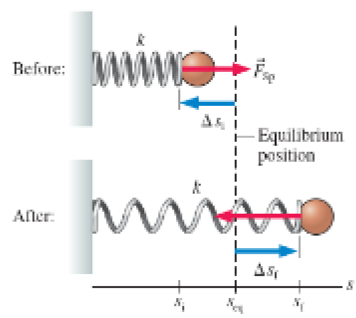
$$W = -k\int_{\Delta s_i}^{\Delta s_f} u\,ds = -\tfrac{1}{2}ku^2\Big|_{\Delta s_i}^{\Delta s_f} = -\tfrac{1}{2}k(\Delta s_f)^2 + \tfrac{1}{2}k(\Delta s_i)^2 \qquad (9.24)$$

With a small rearrangement of the right side, we see that the work done by a spring is

$$W = -\left(\tfrac{1}{2}k(\Delta s_f)^2 - \tfrac{1}{2}k(\Delta s_i)^2\right) \quad \text{(work done by a spring)} \qquad (9.25)$$

Because the displacements are squared, it makes no difference whether the initial and final displacements are stretches or compressions.

FIGURE 9.20 The spring does work on the object.



Macroscopic motion

The macroscopic system can refer to large scale Pythagorean Triangles, these are more often observed as a deterministic impulse. It can also refer to Biv space-time as the interactions of the +𝕚d and e𝕙 Pythagorean Triangles as gravity and the -𝕚d and e𝕧 Pythagorean Triangles as inertia.

Microscopic motion

The microscopic world is more commonly associated with waves and probability, though inside atoms there is still a +𝕚d gravitational field from protons and a -𝕚d inertial mass from electrons. This is more likely to refer to Roy electromagnetism.

Molecular bonds as springs

The kinetic energy referred to here can be the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, this is proportional to the ½×e𝕍/-𝕀d ×-𝕚d linear inertia which uses the same dimensions as (9.24). The molecular bonds are formed by the +𝕆D×e𝕒 potential work mainly from the protons because of the small scale, the spring can represent a twisting or +Od potential torque from this. The electrons can gain -𝕆D×e𝕪 kinetic work from e𝕪×-𝕘d photons absorbed as -𝔾D×e𝕪 light work waves. This can cause them to increase the number of oscillations or waves each has around the nucleus. That can cause them to move to a higher orbital to accommodate them, these are also referred to as deBroglie waves.

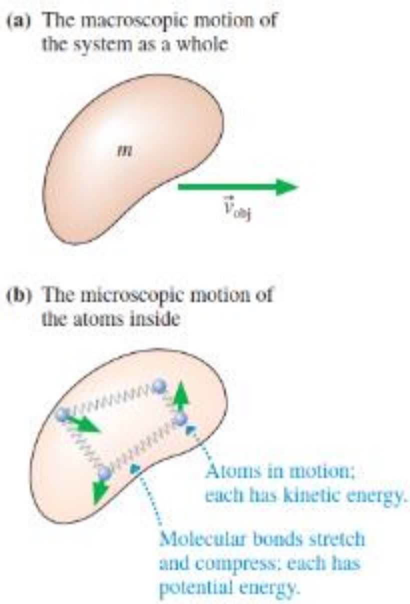


FIGURE 9.22 Two perspectives of motion and energy.

Directions of time

Zeno's arrow is associated with the common expression of an arrow of time. In conventional physics time can move forwards with particles and backwards with antiparticles. For example electrons are associated with moving forward in time, they have a -𝕠d kinetic magnetic field which in this model means that moves forward in time. Positrons have a +𝕠d positronic magnetic field, that rotates in the opposite direction and so would go backwards in time. In impulse time acts as a scale which can be forwards or backwards.

Time as a moment or change

For time to have a direction it must be deterministic over a moment, probability acts as a temporal change from a starting to a final value over a distance or position. In throwing dice there is an initial probability where the dice might start with a 1 facing up. Then its final probability is which face is facing up when it stops moving, in between them there is a position of how far the die traveled.

Conventions of time and space

The concept of a moment is used conventionally, in this model a straight Pythagorean Triangle side has a position. The idea of time changing is also used conventionally, it implies a starting and final position. A position then refers to the size of a straight Pythagorean Triangle side, a displacement refers to a starting and final position with the force that is between the two.

Protons and neutrons

In quantum mechanics a neutron can be regarded as breaking up to form a proton as the +𝕠d and e𝕒 Pythagorean Triangle, and an electron as the -𝕠d and e𝕪 Pythagorean Triangle. It can also be modeled as the positron or +𝕠d and e𝕪 Pythagorean Triangle moving backwards in time to join with the proton to form a neutron.

Time going forward and energy

With the clockwork universe looking at impulse only, the -𝕠d kinetic magnetic field and the -𝕚d inertial mass act as time going forward. There can be a E𝕐/-𝕠d kinetic impulse associated with the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy as particles collide with each other. These can be represented by vectors which are squared with an impulse force, E𝕐 as the kinetic electric force in the E𝕐/-𝕠d kinetic impulse and E𝕍 as the length force in the E𝕍/-𝕚d inertial impulse.

Time moving backwards and the potential

Against this motion are the actions of protons with their E𝔸/+𝕠d potential impulse on the electrons, and gravity with the Eℍ/+𝕚d gravitational impulse on impulse. These act with impulse to be going backwards in time, this is because their spin Pythagorean Triangle sides are positive. With the proton then an electron might move to a higher trajectory as a particle with its E𝕐/-𝕠d kinetic impulse, the proton with its E𝔸/+𝕠d potential impulse moves it down again. The electron is not moving between orbitals because impulse is not quantized.

Forwards or backwards

It can then be the equivalent of the electron moving upwards forward in time, then going backwards in time downwards like a movie being run in reverse. A projectile might be launched from a planet with an E𝕍/-𝕚d inertial impulse moving forwards in time with a parabolic trajectory. When it reaches its apex, it can be regarded as moving backwards in time towards the ground. They do not appear the same because the proton moves time backwards, it is reactionary and is in the center of atoms. The electron has active forces moving forward in time and orbits the protons.

Potential and kinetic entropy

The past and future are not interchangeable like this because of work, the -𝕆D×e𝕪 kinetic work of an electron moves forward in time but as a kinetic probability. The proton with its +𝕆D×e𝕒 potential work moves backwards in time as a potential probability. These are both random and so the potential entropy is added to the kinetic entropy. When the +𝕆D potential entropy is larger, then the randomness is confined in spherical geometry with the orbitals. When the -𝕆D kinetic entropy is larger this disorder moves out with the electrons from the atom.

Entropy and disorder

Entropy is where particles become increasingly or decreasingly disordered, this happens even when a movie is run backwards. For example, cards might be dealt randomly from a deck, running the movie in reverse puts the cards into another random pattern from shuffling. The total entropy in this model does not come from a moment of moving forwards or backwards in time. It comes from the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work done, disorder is where this randomness is spread out more or less over a position or distance. When the -𝕆D kinetic entropy increases then molecular bonds might change such as with erosion, the atoms become more spread out.

Work in random directions

This is because the -𝕆D kinetic probability is acting randomly in different directions so the atoms can be spread in many directions. Conversely the +𝕆D potential entropy is where more molecular bonds are formed, crystals might grow and compounds become more concentrated over a position or distance. The +𝕆D×e𝕒 potential work also acts in random directions but these are directed towards the nuclei of atoms and molecules.

Impulse over chaotic moments

Instead, chaotic motion can approach randomness but can always be rewound to a former state with no changes. There is no entropy or disorder in impulse because there are no alternatives to the state of a system, it can evolve either forwards or backwards in only one possible way. When a movie is run backwards then cars and projectiles might move the same forwards and back. This is because as particles their changes over a moment are deterministic. The movie cannot change in a probabilistic way with determinism.

Random time changes backwards

The movie looks different backwards because of the changes in probability with this model. With increasing -𝕆D kinetic entropy a movie of a casino might have its cards becoming more randomly shuffled. The start of this time change might be when the cards were in order, unwrapped as a new desk. Then reversing the movie will show a +𝕆D potential entropy, the disorder is decreasing. This could be done with many different movies of how new decks are shuffled, when reversed this would show the laws of probability with common and unusual sequences of cards from randomness.

Friction as potential and kinetic entropy

In the diagram motion with friction occurs between the +𝕆D×e𝕒 potential work of the protons maintaining molecular bonds, and with the -𝕆D×e𝕪 kinetic work of the electrons. As the upper surface moves to the right these bonds are formed and broken, that causes a randomization of the motion which slows the upper object. The spring like bonds are being stretched to the side, in this model that would be from the -𝕆D kinetic torque.

Probability and magnetic bonds

It can also be explained by probability, the higher +𝕆D potential probability of the molecular bonds means the atoms are more likely to stick to each other. This attraction occurs through the magnetic forces of the bonds, that acts like a wave function in quantum mechanics where the probability is squared as +𝕠d is squared here to +𝕆D and -𝕠d is squared to -𝕆D.

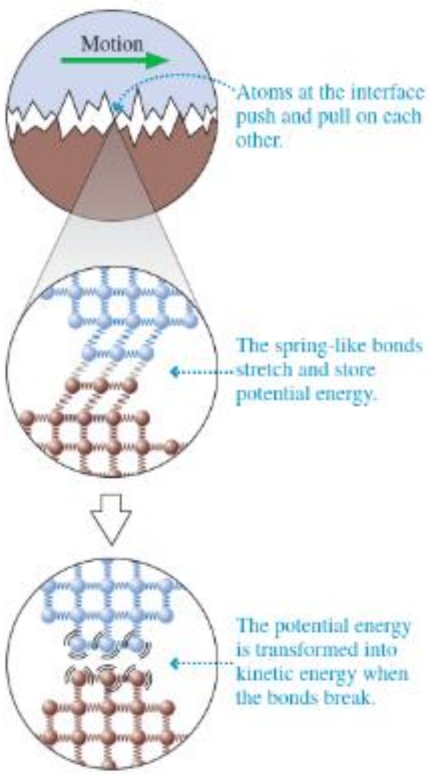
Potential and kinetic wave functions

In quantum mechanics this is referred to as ψ, in this model that gives +ψ for the potential magnetic field and $+\psi^2$ as the potential probability. The electrons have a wave function from -𝕠d as -ψ and a kinetic probability of $-\psi^2$. The motion of the upper surfaces adds a -𝕆D or $-\psi^2$ kinetic probability making it less likely the electrons will remain bound to those protons.

Energy not transformed

In this model the +𝕆D×e𝕒 potential work is not transformed into -𝕆D×e𝕪 kinetic work, instead the moving molecular bonds causes the values of +𝕆D and -𝕆D to change so the overall sum is different. This would have -𝕆D increasing and +𝕆D decreasing as electrons moved further away from the protons. This is not potential energy to kinetic energy as explained earlier, instead these waves of probability are observed as particles from their impulse.

FIGURE 9.23 Motion with friction leads to thermal energy.



The Boltzmann constant

In this model electric work comes from voltage, there is a -𝕆D kinetic difference on the negative terminal of a battery and a +𝕆D potential difference on the positive terminal. Here P or power is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy with a derivative taken over time as 1/-𝕠d. Because the inverse of 1/-𝕠d is e𝕪 this gives ½×e𝕪 /-𝕆d ×-𝕠d, that is k or the Boltzmann.

Converting work to impulse

This can be seen with the -𝕚d and e𝕧 Pythagorean Triangle as inertia, a velocity is e𝕧/-𝕚d or meters/second. If a ball moves 1 meter/second then power would create an acceleration of 1 meter/second^2, in this model that would refer to work because the time squared acts as a force. The position e𝕧 acts as a scale, work is done over a position. This can also be written as meters^2/second which is the E𝕍/-𝕚d inertial impulse, that would go with power as changing the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy which comes from observing impulse.

Power driven by voltage

This change can also refer to the number of e𝕪×-𝕘d photons emitted from a light from this power, that is because the increased voltage of the current leads to more velocity changes of the electrons. When they change, they emit or absorb e𝕪×-𝕘d photons. When this is driven by a -𝕆D voltage the photons emitted would be more quantized as -𝔾D×e𝕪 light work. Using the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy here as the E_{sys} means this is being observed as the E𝕐/-𝕠d kinetic impulse from the electrons not work. That would imply a continuous light spectrum rather than a quantized one.

Power as the rate of energy over time

Here power is a change in the rate of energy over time, in this model that is the E𝕐/-𝕠d kinetic impulse. The E𝕐 kinetic electric force is moving the electrons as particles, not with work and voltage. A current then can have a higher pressure behind it as e𝕪/-𝕠d, that is proportional to its velocity e𝕧/-𝕚d. To make this current go faster the voltage is increased, that is the -𝕆D×e𝕪 kinetic work because -𝕆D is increasing.

An electrical current

There are also electrons as particles in this current, they move with a E𝕐/-𝕠d kinetic impulse where the denominator is kinetic time. When this contracts the power increases as a square E𝕐. A faster current then has a larger kinetic electric force as E𝕐, it is pushed by a larger -𝕆D kinetic difference or voltage.

A river with inertia

The same happens in Biv space-time with a river, there is a current e𝕧/-𝕚d. This can be pushed faster with more -𝕀D×e𝕧 inertial work, the -𝕀D inertial torque might be provided by a spinning pump.

Accelerating a current

This causes the current to accelerate, because the -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse are classically and approximately equivalent, this also gives a faster acceleration of the water as E𝕍/-𝕚d in meters^2/second. That is approximately the same as e𝕧/-𝕀D in meters/second^2. To change from one to the other the values are inverted, this happens because the Pythagorean Triangles have a constant area. Double one Pythagorean Triangle side and the other is halved, and so on.

9.6 Power

Work is a transfer of energy between the environment and a system. In many situations we would like to know *how quickly* the energy is transferred. Does the force act quickly and transfer the energy very rapidly, or is it a slow and lazy transfer of energy? If you need to buy a motor to lift 1000 kg of bricks up 20 m, it makes a *big* difference whether the motor has to do this in 30 s or 30 min!

The question How quickly? implies that we are talking about a *rate*. For example, the velocity of an object—how quickly it is moving—is the *rate of change* of position. So when we raise the issue of how quickly the energy is transferred, we are talking about the *rate of transfer* of energy. The rate at which energy is transferred or transformed is called the **power** P, and it is defined as

$$P = \frac{dE_{sys}}{dt} \tag{9.29}$$

The potential Boltzmann constant

Here the power would be from k as -𝕠d ×e𝕪/-𝕆d, this can also be written in relation to the potential or +𝕠d and e𝕒 Pythagorean Triangle as +𝕠d×e𝕒/+𝕆D. That is referred to as l in this model as the potential value of the Boltzmann constant.

The potential and kinetic difference

The difference between them comes from the forces as the -𝕆D kinetic difference and the +𝕆D potential difference. This pushes the current more which can be written as the e𝕪/-𝕠d kinetic current flowing to be subtracted from the e𝕒/+𝕠d potential current. Closer to the positive terminal then this is being summed so that the current has the same value with Kirchoff's law. The ratio of the Pythagorean Triangle sides and the angle θ remains constant.

Power from food

The athlete has power from chemical reactions in digesting food, these come from the -𝕠d ×e𝕪/-𝕆d or k value of this quantized -𝕆D×e𝕪 kinetic work, that moves electrons against the reactions of the l or +𝕠d×e𝕒/+𝕆D potential Boltzmann's constant as +𝕆D×e𝕒 potential work. The gas furnace has a similar process of work from k and l.

The Boltzmann constant in Biv

In Biv space-time there is also a version of k, so -𝕠d ×e𝕪/-𝕆d is proportional to -𝕚d×e𝕧/-𝕀D or m to continue the lettering after k. With the +𝕚d and e𝕙 Pythagorean Triangle and gravity there would be +𝕚d×e𝕙/+𝕀D as n. Here then k and m are proportional to each other because the electrons in a current have a -𝕚d inertial mass and inertial power. Also l and n are proportional to each other because the protons have a +𝕚d gravitational mass proportional to their +𝕠d potential electric field, they then exert a gravitational difference and a gravitational power as well as their potential difference and potential power.

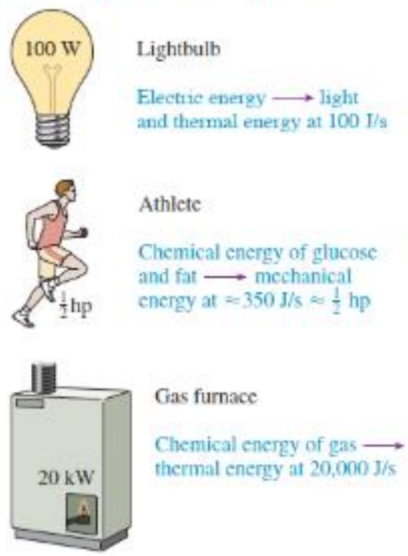
Gravitational difference and inertial difference

Just as power flows in a current from the -𝕆D kinetic difference to the +𝕆D potential difference as voltage, there is a flow where +𝕀D as the gravitational field force attracts the -𝕀D inertial field force. These can be regarded as the +𝕀D gravitational difference and the -𝕀D inertial difference, in between there is a current such as with a wire. This would be e𝕧/-𝕚d as the velocity and e𝕙/+𝕚d which is referred to in this model as the gravitational speed or brevity.

Terminal velocity and current

The action of a falling satellite would then have power according to this +𝕀D gravitational difference and the -𝕀D inertial difference, the stronger the gravity is as the +𝕀D×e𝕙 gravitational work the faster this power motion is. The current in a wire tends to be constant because of the resistance in how the electrons can move as waves with the -𝕆D×e𝕪 kinetic work and as particles with a E𝕐/-𝕠d kinetic impulse. This is like a terminal velocity of a satellite falling with their gravitational and inertial difference, it is slowed to a velocity and a brevity from air resistance.

FIGURE 9.25 Examples of power.



Action reaction pairs of Pythagorean Triangles

In this model work, like impulse operates as an action/reaction pair of forces. In an atom there is an active force from the -𝕆D×e𝕪 kinetic work, this operates with k as -𝕠d ×e𝕪/-𝕆d kinetic power. The reaction force comes from the proton as +𝕆D×e𝕒 potential work, this operates as l with +𝕠d×e𝕒/+𝕆D potential power. The overall power then comes from voltage, in a wire with a battery that is from the -𝕆D kinetic difference and the +𝕆D potential difference.

An atom as a battery

In an atom it is the same, that is why a battery can create this voltage or difference. The protons in the nucleus do +𝕆D×e𝕒 potential work with an l potential power as a constant like k as the Boltzmann constant. There is also the active +𝕀D×e𝕙 gravitational work from the nucleus and its +𝕚d gravitational mass, that acts on the reactive -𝕀D×e𝕧 inertial work from the electrons. They have an m or -𝕚d×e𝕧/-𝕀D inertial power which is reactive against the n or +𝕚d×e𝕙/+𝕀D gravitational power.

Constants from the constant Pythagorean Triangle area

All these power values act as constants like the k Boltzmann constant because they reduce to the constant area of a Pythagorean Triangle, for example n as +𝕚d×e𝕙/+𝕀D becomes e𝕙/+𝕚d so that +𝕚d×e𝕙 is the constant area. It also acts as a constant level of increase of energy as kT which is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, as e𝕪 increases as the temperature then k is acting like a scale.

Four Planck’s constants

There are also four versions of h as Planck’s constant which also describes the work and impulse changes in an atom. Because k is also referred to as power this leads to friendly names such as k or -𝕠d ×e𝕪/-𝕆d kinetic power, l or +𝕠d×e𝕒/+𝕆D potential power, m or -𝕚d×e𝕧/-𝕀D inertial power, and n or +𝕚d×e𝕙/+𝕀D gravitational power. H comes from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy as joules times seconds giving h as -𝕠d ×e𝕐/-𝕠d. Because this refers to the increments between orbitals then h can be regarded as kinetic increments. Then +𝕠d × E𝔸/+𝕠d would be g or potential increments, -𝕚d×E𝕍/-𝕚d would be f or inertial increments, and +𝕚d×Eℍ/+𝕚d would be e or gravitational increments.

The constants h and k

In this model h is -𝕠d ×e𝕐/-𝕠d where the difference compared to k is that E𝕐 is the squared force in the numerator from the E𝕐/-𝕠d kinetic impulse. With k this is -𝕠d ×e𝕪/-𝕆d so that the denominator is now being measured with the -𝕆D×e𝕪 kinetic work. These two constants are used in conventional physics, h describes the quantized values of energy in between orbitals. Then k observes the Gaussian distribution of continuous energy, this was used before quantized energy in orbitals was understood.

Observing orbitals

The h value -𝕠d ×e𝕐/-𝕠d then is observing the E𝕐/-𝕠d kinetic impulse in between orbitals of -𝕆D×e𝕪 kinetic work, this is because in conventional physics first a change is made and then this is measured as work or observed as impulse. It was found that orbitals are where e𝕪×-𝕘d photons are emitted in a linear pattern of 1,2,3,… called a discrete spectrum. This comes from the -𝕆D kinetic probability, because it is the square of an integer square root like d=√2 then squaring it as a force gives an integer.

Particles in Schrodinger's equation

This change is observed as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy because the electrons are regarded as particles in Schrodinger's equation. The wave function is this -𝕆D×e𝕪 kinetic work where the electrons act as waves.

Gaussian distribution and k

With k there is the opposite process, the energy was regarded as continuous using Boltzmann's constant. It was considered to be changing according to e𝕪 as a straight Pythagorean Triangle side as the temperature T. This gave a Gaussian or normal distribution of energy, such as with atoms colliding in a gas.

Boltzmann's constant before Planck's constant

This was first calculated in the motion of atoms and electrons in a gas not inside the atoms, h was discovered to work in the quantized orbitals inside an atom. This was done before the nature of atoms was understood, that there were electrons orbiting protons or that they could act like waves.

Quantized frequencies of photons

Planck first realized that the distribution of the light frequencies from a light bulb could be explained by quantized frequencies of photons. Before this Boltzmann's constant predicted the Gaussian distribution of the velocities of gas particles. These could also glow in a hot gas, so the concept of a light spectrum and k versus h began to be understood.

The Gaussian from work not impulse

As k changed there was a Gaussian or normal curve distribution, in this model that is because the -𝕆D×e𝕪 kinetic work gives the kinetic probability. It can be calculated from an exponent such as $e^{e𝕪-𝕆D}$ where the -𝕆D×e𝕪 kinetic work is a Pythagorean Triangle. This works like the Euler equation with a complex number in the exponent, because -𝕆D is a negative square then the distribution of different values of D gives a normal curve according to conventional math.

Particles are not probabilistic

When the exponent has E𝕐 as a square this is not negative, so it never gives a Gaussian or normal curve. This is why k gives a Gaussian but the temperature itself does not, the E𝕐/-𝕠d kinetic impulse acts as particles not like waves of probability.

Elliptical orbitals and h

With h as -𝕠d ×e𝕐/-𝕠d then this gives quantized values in between orbitals, but it also gives as fractions of h that are not integers such as with elliptical orbitals. Also, when atoms are compressed or in an external magnetic field then h can further change away from being a linear scale. This is because in this model h is based on a continuous force as the E𝕐/-𝕠d kinetic impulse not a quantized one.

Two h constant in Schrodinger's equation

With h then there is a version in relations to protons and the +𝕠d and e𝕒 Pythagorean Triangles as +𝕠d × E𝔸/+𝕠d. In the Schrodinger equation there is the potential energy V minus the kinetic energy K, here the signs are reversed.

Nomenclature of h and k

The potential version of h can be referred to as g going backwards while k, l, m, and n went forward. This means h has an inertial version in the -𝕚d and e𝕧 Pythagorean Triangle as -𝕚d×E𝕍/-𝕚d which would be f, the gravitational version would be +𝕚d×Eℍ/+𝕚d as e. Easier to remember would be $h_{\text{e𝕪}}$, $h_{\text{e𝕒}}$, $h_{\text{e𝕧}}$, and $h_{\text{e𝕙}}$, these all use h while the subscript refers to the straight Pythagorean Triangle side they measure. Then k could be $k_{\text{-𝕠d}}$, $k_{\text{+𝕠d}}$, $k_{\text{-𝕚d}}$, and $k_{\text{+𝕚d}}$.

Inertia and gravity like h

In Biv space-time then $h_{\text{e𝕧}}$ would be the inertial constant -𝕚d×E𝕍/-𝕚d, this can refer to a satellite in a roughly circular orbit with a quantized value of 1 kilometer, it needs to move upwards to an orbital of 2 kilometers on a whole number scale. This reacts against the $h_{\text{e𝕙}}$ constant from gravity as +𝕚d×Eℍ/+𝕚d, to move upwards a quantized amount of -𝕀D×e𝕧 inertial work needs to be done by the satellite. For example, it might use an active amount of h from rocket fuel to move its orbit upward in a spiral.

Height and inertial mass

This increases its E𝕍/-𝕚d inertial impulse with the E𝕐/-𝕠d kinetic impulse of the rocket. The Eℍ/+𝕚d gravitational impulse is actively pulling the rocket downwards, or it can be said this comes from $h_{\text{e𝕙}}$. When the rocket reaches the 2-kilometer orbit its -𝕀D×e𝕧 inertial work would have -𝕀D with D=2 now where before it was D=1, that means Eℍ is now 2 instead of 1 because -𝕀D and Eℍ increase with the same proportions.

Waves are converted to be observed as particles

The use of $h_{\text{e𝕙}}$ here as a quantized increment can be seen to come from Eℍ as having increased from 1 as e𝕙 to √2 so when squared as Eℍ it becomes 2. This means it is derived from the Eℍ/+𝕚d gravitational impulse because Eℍ is squared not +𝕀D, it shows how quantized orbitals from waves can also be converted to calculations as impulse or energy. That is why k is configured as waves giving Gaussians even though it observes collisions in a gas. It is also why h comes from impulse and particles even though it measures waves in quantized orbitals.

Converting work and impulse into each other

However, inverting a Pythagorean Triangle's force does not mean the force changed, it means that the two can be easily converted from one to another. It also raises problems such as in Schrodinger's equation using energy and particles, then needing to explain why this is also a wave equation.

Increments of work or energy

As a classical approximation k is where increments of work are done to give a change in velocities of particles with temperature and energy. The constant h is an increment of energy done to change the waves of electrons, as work, from one orbital to another.

Fermi energy

The constants h and k will be shown to work very differently. When electrons are in orbitals it is very difficult to get them to move to higher orbitals with an increased temperature T or e𝕪. This is known as the Fermi energy, while h is observing these increments the E𝕐/-𝕠d kinetic impulse does not move electrons well.

Move upwards with torque

This is because in Biv space-time a rocket moves to a higher orbit by a spiral or increasing torque, if it tries to go straight up like with h and temperature then it can drop straight down again. For the rocket to move upwards it needs to increase the -𝕀D inertial probability it would be found there. If it uses an E𝕍/-𝕚d inertial impulse then this does not increase that probability, instead the rocket would go into an elliptical orbit. This oscillates up and down like a spring, the probability of where the rocket is lies between the perigee and apogee of the orbit.

Torque and velocity

With atoms in a gas, work is a poor way to increase the velocities of these atoms, a torque just tends to move atoms in circles. So k acts as an increment to increase the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy of a gas, but this acts like a scale not as a force. Instead the E𝕐/-𝕠d kinetic impulse is needed. -𝕆D×e𝕪 kinetic work can be done on a gas by compressing it, this gives a higher -𝕀D inertial probability the gas iotas will be found in a small e𝕧 length.

Carnot engine

This does not affect the velocity of the gas molecules directly, the temperature e𝕪 of the gas increases as an active force of a E𝕐/-𝕠d kinetic impulse. Conversely heating the gas will increase the pressure needed by the -𝕀D×e𝕧 inertial work to hold it to a smaller volume. These two combine to give a Carnot engine. With a larger kinetic velocity e𝕪/-𝕚d the gas molecules push harder on the container against the -𝕀D×e𝕧 inertial work done on compressing it.

Compressing atoms

The gas increases its e𝕧/-𝕚d velocity and e𝕪/-𝕚d kinetic velocity of its molecules from the compression, but this did not directly cause that velocity. When gases are compressed the orbitals inside atoms are also forced closer together, this causes the e𝕪/-𝕠d kinetic velocity of the electrons to also increase closer to the nucleus.

Adiabatic process

If the -𝕀D×e𝕧 inertial work is done gradually over a longer time it becomes more like an E𝕍/-𝕚d inertial impulse, then E𝕍 is contracted and so E𝕐 as the E𝕐/-𝕠d kinetic impulse of heat in the gas is reduced as an adiabatic process.

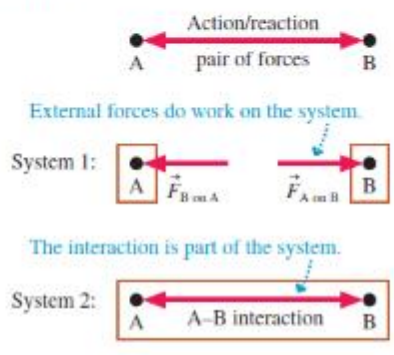
Quantized orbitals with energy increments of h

This is why h acts as a scale between orbitals, -𝕠d ×e𝕐/-𝕠d has -𝕠d as a scale proportional to the electron mass because it is not squared as a force. So because moving to a higher orbital needs a -𝕆D kinetic torque, and a higher -𝕆D kinetic probability of moving upwards, then -𝕠d is a linear scale. This can also be regarded as e𝕪 because that is the inverse of -𝕠d, then the orbitals can be regarded as increasing with an increment of n and which appears as +𝕚d×e𝕙/+𝕀D in quantum mechanics.

Temperature as a scale

The constant k acts as a scale in temperature with gases because -𝕠d ×e𝕪/-𝕆d has -𝕆D squared, while the E𝕐/-𝕠d kinetic impulse increases the velocities of atoms. That means it must act like a linear scale as h did, it is not observing the E𝕐/-𝕠d kinetic impulse and so it uses e𝕪 temperature as a position on a scale. The constant k then is not expanding with the E𝕐/-𝕠d kinetic impulse, it is measuring increments of that impulse on a Gaussian.

FIGURE 10.1 Two choices of the system and the environment.



Potential and kinetic energy

In this model potential energy refers to the protons and the nuclei in atoms only. Adding ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy to the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy can be raising the temperature T or e𝕪. This can be written as being equivalent to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy as kT or -𝕠d ×e𝕪/-𝕆d ×e𝕪. That can be the energy of an interaction, this might raise electrons to higher orbitals or knock them out of atoms.

Vibrating molecular bonds

It can also vibrate molecular bonds with their ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, this moves them up and down with a E𝔸/+𝕠d potential impulse. It does not rotate the molecular bonds because that comes from the +𝕆D×e𝕒 potential work.

Summing potential probabilities

Here this is shown as adding two amounts of work to be equal to the system energy. This internal work would be the -𝕆D×e𝕪 kinetic work done by electrons and the +𝕆D×e𝕒 potential work done as a reaction by the protons. The work can also be summed as both positive, such as the +𝕆D×e𝕒 potential work of two protons in a nucleus exerting twice the +𝕆D×e𝕒 potential work. If negative then two electrons might be summed as double the -𝕆D×e𝕪 kinetic work. When there are twice as many protons the +𝕆D potential probability also doubles, protons are twice as likely to be measured there.

Because system 2 has an interaction inside the system that system 1 lacks, let's postulate that system 2 has an additional form of energy associated with the interaction. That is, system 1 has $E_{sys\,1} = K_{tot}$, because particles have only kinetic energy, but system 2 has $E_{sys\,2} = K_{tot} + U$, where U, called **potential energy,** is the energy of the interaction.

If this is true, we can combine $\Delta E_{sys\,2} = 0$, from Equation 10.2, with our knowledge of ΔK_{tot} from Equation 10.1 to write

$$\Delta E_{sys\,2} = \Delta K_{tot} + \Delta U = (W_A + W_B) + \Delta U = 0 \qquad (10.3)$$

That is, system 2 can have $\Delta E_{sys} = 0$ if it has a potential energy that changes by

$$\Delta U = -(W_A + W_B) = -W_{int} \qquad (10.4)$$

where W_{int} is the total work done *inside the system* by the interaction forces.

Potential and kinetic energy

Kinetic energy as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy here would be where a ball has been thrown into the air, a E𝕐/-𝕠d kinetic impulse might cause it to be launched from a cannon. The interaction energies as the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy are where the fuel is exploded to cause the ball to rise upwards, that comes from the E𝔸/+𝕠d potential impulse of the broken molecular bonds in the fuel.

Reaction forces

In this model the E𝔸/+𝕠d potential impulse, +𝕆D×e𝕒 potential work, and the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy are all reaction forces. They are not directly measurable as work or observed as impulse, instead this is summed to the E𝕐/-𝕠d kinetic impulse or -𝕆D×e𝕪 kinetic work. Because of this the ball does not have potential energy, instead this is often set at an arbitrary level where kinetic energy is added to it. That comes from the +𝕆D×e𝕒 potential work being an integral, there can be a constant C under it as an area so the e𝕒 position as an altitude can be varied on a scale.

Clocks and scales

This is like gauge theory where the position of a straight Pythagorean Triangle side value is on a straight scale, or the moment of a spin Pythagorean Triangle side value on a circular gauge. The term scale might be used in both cases, alternatively scale can be used for positions and a clock for time moments. A clock then would act as a gauge for time, a thermometer would be a scale for e𝕪 temperature.

Action and interaction

The same occurs with the reaction forces of inertia, these are also not measured directly as -𝕀D×e𝕧 inertial work or observed as an E𝕍/-𝕚d inertial impulse. It can be referred to as an interaction energy as well, this is only measured or observed when an active force is exerted on it. For example the ball has inertia from the -𝕚d and e𝕧 Pythagorean Triangle, the E𝕐/-𝕠d kinetic impulse exerted on it has an equal and opposite reaction from the E𝕍/-𝕚d inertial impulse. But it could not be said the ball has inertial forces because these are only when it reacts against these active forces.

Inertial forces disappear

That also occurs with a satellite orbiting a planet, the reactive -𝕀D×e𝕧 inertial work has the satellite in a circular orbit. The planet does +𝕀D×e𝕙 gravitational work which adds to and cancels out this -𝕀D×e𝕧 inertial work so the satellite overall experiences no forces. The -𝕀D×e𝕧 inertial work of the satellite then could not be measured, it seems to be weightless and so should have no inertia. It is only when it is pushed by a rocket that this E𝕍/-𝕚d inertial impulse reacts against a change in its trajectory.

Interaction and reaction forces

The inertia can be regarded as an interaction force, that is where the interactions are not directly observed or measured. It can also be a reaction force such as where a block reacts against being pushed by an active E𝕐/-𝕠d kinetic impulse.

> **NOTE** Kinetic energy is the energy of an object. In contrast, potential energy is the energy of an interaction. You can say "The ball has kinetic energy" but not "The ball has potential energy." We'll look at the best way to describe potential energy when we get to specific examples.

Gravitational potential

Here gravity is referred to as a potential energy, in this model that would be the Eℍ/+𝕚d gravitational impulse because it uses vectors. Gravity is an active force, it is proportional to the E𝔸/+𝕠d potential impulse of the proton with its potential electromagnetism. Because of this the two can be regarded as a kind of potential.

Summing the Eℍ/+𝕚d gravitational impulse and the E𝕍/-𝕚d inertial impulse

In this model the added work in (10.5) would be where the ball did -𝕀D×e𝕧 inertial work which is negative, the planet did +𝕀D×e𝕙 gravitational work which is positive so they are summed together. This would also apply when the ball did +𝕀D×e𝕙 gravitational work and the planet did -𝕀D×e𝕧 inertial work. Here impulse would be summed by vector addition, the changes could also be summed by changes to their times as moments on a gauge or clock.

FIGURE 10.2 The ball + earth system has a gravitational potential energy.

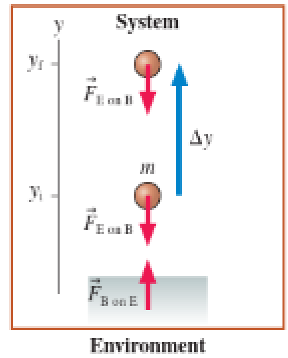


FIGURE 10.2 shows a ball of mass m moving upward from an initial vertical position y_i to a final vertical position y_f. The earth exerts force $\vec{F}_{E\ on\ B}$ on the ball and, by Newton's third law, the ball exerts an equal-but-opposite force $\vec{F}_{B\ on\ E}$ on the earth.

We could define the system to consist of only the ball, in which case the force of gravity is an external force that does work on the ball, changing its kinetic energy. We did exactly this in Chapter 9. Now let's define the system to be ball + earth. This brings the interaction inside the system, so (ignoring any gravitational forces from distant astronomical bodies) there's no external work. Instead, we have an energy of interaction—the gravitational potential energy—described by Equation 10.4:

$$\Delta U_G = -(W_B + W_E) \qquad (10.5)$$

An integral constant C

When the e𝕙 height is used this is from the +𝕀D×e𝕙 gravitational work, the e𝕙 position is on a straight scale. Because this is an integral the area can have rectangles under it so that the slopes of a curve have the same derivatives. This is called a constant C in calculus so the e𝕙 height can be set to a different scale.

Potential work and C

Here the +𝕆D×e𝕒 potential work is also an integral, that can include a constant C added to it. With a curve the integral area under it would be this +𝕆D×e𝕒 potential work, the vertical axis might be e𝕒 as the altitude above the proton. This allows for the e𝕒 scale to be adjusted like with e𝕙. The horizontal axis would be the +𝕆D potential magnetic force as a square. This area can be extended downwards with a constant C, then the e𝕒 altitude above the proton has been changed like the e𝕙 height in the diagram.

Roy electromagnetism and Biv spacetime

The diagram can also show a potential energy proportional to a gravitational potential energy, the kinetic energy is above this potential energy. In this model there is inertia above the gravitational potential energy, the greater the inertia of a satellite for example the higher its orbit is.

Gravitational work and C

The same calculation could be done with +𝕀D×e𝕙 gravitational work, the vertical axis is e𝕙 height which can vary with a constant C. The horizontal axis is the +𝕀D gravitational probability. Work is a force times a position, so this only refers to the different possible positions on the e𝕙 scale.

C can be converted into Pythagorean Triangle areas

It comes from Pythagorean Triangles which have a constant area, these do not change their area with a constant C when integrated. The rectangles would represent additional work being done to change the e𝕙 height or e𝕒 altitude, they can then be each broken up into a pair of Pythagorean Triangles.

Not an exact constant because of General Relativity

One problem is that the +𝕀D gravitational field force changes with e𝕙 height, it would be weaker even in the difference between the ground and moving it upwards a meter. This is then a classical approximation, with an increased eh height the +ID gravitational probability decreases as a square. That causes the -id inertial time to be faster with an increased eh as less of it is added to a +id gravitational time.

Changing the integral rectangles with General Relativity

With this model, changing the scale eh involves changing the Pythagorean Triangle areas under the height as rectangles. These would give different +ID gravitational probability widths of the rectangles with a changing eh height to keep the constant Pythagorean Triangle areas. If C is smaller then the eh height on a scale is moved downwards, the +id and eh Pythagorean Triangles also reduce their areas then there are smaller rectangles in the integral. But that is not allowed in this model and so the rectangles would have to become wider.

Wider rectangles

These have an increased +ID gravitational probability as a width when the eh height decreases. Usually these rectangles are infinitesimally wide in conventional calculus, but in this model the +id and eh Pythagorean Triangle has a constant area. If the eh height decreases the +id side must increase inversely to eh.

Time dilation and height contraction

This increase is observed as +id time dilation, clocks run slower when the EH/+id gravitational impulse is observed from above. When this +ID×eh gravitational work is measured from above the eh height appears contracted. This is like with Special Relativity where with the EV/-id inertial impulse clocks run slower, with the -ID×ev inertial work there is a ev length contraction.

The rectangles are not observed or measured

The Pythagorean Triangles themselves are not observed or measured in their entirety with this model as pairs of rectangles in the integrals, so this problem does not arise in changing the rectangles with the constant C. If they do change then one rectangular side needs to be squared as a force, that gives the starting and final values of that side's change.

Fixed rectangles

With an integral this is the +ID×eh gravitational work so initial and final values of +ID are measured. With General Relativity there is a eh height contraction from this. Parts of the rectangles can have a derivative taken at that eh height and +id gravitational time, this is because as the rectangle parts move they have a velocity ev/-id and a gravitational speed eh/+id.

Uncertainty of the rectangle sides

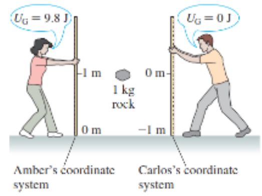
The concept of fixed rectangles changing in height is a classical approximation in this model. It implies both the height and the width of the rectangles can be observed and measured in the same moment and position, this is not allowed because of the uncertainty principle.

The Zero of Potential Energy

Our expression for the gravitational potential energy $U_G = mgy$ seems straightforward. But you might notice, on further reflection, that the value of U_G depends on where you choose to put the origin of your coordinate system. Consider FIGURE 10.4, where Amber and Carlos are attempting to determine the potential energy when a 1 kg rock is 1 m above the ground. Amber chooses to put the origin of her coordinate system on the ground, measures $y_{rock} = 1$ m, and quickly computes $U_G = mgy = 9.8$ J. Carlos, on the other hand, read Chapter 1 very carefully and recalls that it is entirely up to him where to locate the origin of his coordinate system. So he places his origin next to the rock, measures $y_{rock} = 0$ m, and declares that $U_G = mgy = 0$ J!

How can the potential energy have two different values? The source of this apparent difficulty comes from our interpretation of Equation 10.7. Our energy analysis found that the potential energy *changes* by $\Delta U_G = mg(y_f - y_i)$. Our claim that $U_G = mgy$ is consistent with this finding, but so also would be a claim that $U_G = mgy + C$, where C is any constant.

FIGURE 10.4 Amber and Carlos use different coordinate systems to determine the gravitational potential energy.



Inertial and gravitational probabilities

Here there is -𝕀D×e𝕧 inertial work done as the ball rises on a e𝕧 length scale, as e𝕧 contracts there is an increase in e𝕙 height. Because the +𝕚d and e𝕙 Pythagorean Triangle has a constant area an increase in e𝕙 height causes the +𝕀D gravitational probability to decrease as a square. That means the -𝕀D inertial probability increases inversely to the +𝕀D decrease, the ball is more likely to be measured at this greater e𝕙 height.

Exponential decay

This is an exponential decay or log curve, it is like in radioactive decay whereas time doubles the radioactivity decreases by 4 times. When the Pythagorean Triangle area remains constant then a doubling of the e𝕙 height causes the +𝕀D value to decrease by 4 times, that is also the inverse square law.

A zero slope at the highest point

Taking a point where e𝕧 approaches zero this would be where the ball reaches its highest point. This cannot be zero because then the -𝕚d and e𝕧 Pythagorean Triangle would have a zero e𝕧 length. Instead the ball has many -𝕚d and e𝕧 Pythagorean Triangles proportional to its electrons, these have varying velocities as e𝕧/-𝕚d so none have this zero slope.

E𝕧+e𝕙 as a position scale

The value e𝕧+e𝕙 remains constant as a scale, the change in acceleration comes as +𝕀D decreases to give e𝕙/+𝕀D in meters/second^2. The inertia of the ball is also changing as e𝕧/-𝕀D in meters/second^2. The e𝕙 height of the ball then is where +𝕀D-𝕀D has a value, a higher point has a larger -𝕚d inertial mass while a lower point has a larger +𝕚d gravitational mass.

Biv space-time wave functions

The value +𝕀D-𝕀D acts as ψ^2 or Ψ as a capital ψ in quantum mechanics, that gives the gravitational probability minus the inertial probability of where the ball is. In this model a capital letter denotes a square, ψ would be a square root here and ψ^2 or Ψ is the measurable squared probability. Because Ψ is more ambiguous here ψ^2 is often used.

Proportional to kinetic and potential energy

The same happens in Roy electromagnetism, where the +𝕆D×e𝕒 potential work of the proton in a hydrogen atom reacts against the motion of the -𝕆D×e𝕪 kinetic work of the electron. If this electron goes higher its e𝕪 kinetic electric charge plus the e𝕒 altitude or potential electric charge remains a constant when work is being measured. Then the +𝕆D potential magnetic force minus the -𝕆D kinetic magnetic force gives the overall potential probability minus the kinetic probability or the ψ^2 wave function of where the electron is.

Waves in atoms

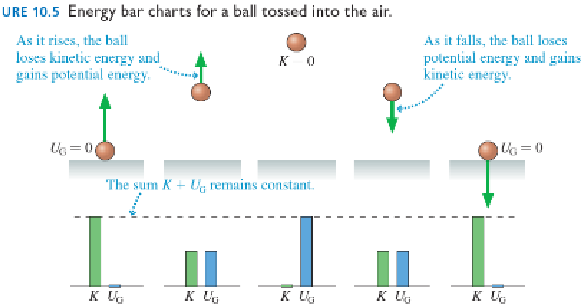
In the atom the work done is stronger than impulse because the positions are much smaller. This makes the spin Pythagorean Triangle sides larger because the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle have constant areas. When the spin Pythagorean Triangle sides are squared as +𝕆D and -𝕆D that makes the proton and electron act more like waves. The electron then moves upwards to a higher orbital, the number of standing waves of the electron increases as deBroglie waves to allow this.

Measuring probability not observing energy

In this model work is not referred to as energy, this is because impulse is associated with the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. Particles are observed to have energy, waves are measured to have torque or probability. Instead this can be referred to as a wave or probability chart, in quantum mechanics the ball as an electron would be measured as a wave function. A function here is an equation that describes the motion of waves and probability, the same as with the ball.

Equation 10.11, which is really just energy accounting, can be represented graphically with an **energy bar chart.** For example, FIGURE 10.5 is a bar chart showing how energy is transformed when a ball is tossed straight up. Kinetic energy is gradually transformed into potential energy as the ball rises, then potential energy is transformed into kinetic energy as it falls, but **the combined height of the bars does not change.** That is, the mechanical energy of the ball + earth system is conserved.

FIGURE 10.5 Energy bar charts for a ball tossed into the air.



Probability as attraction or repulsion

Here again the combined positions of e𝕧 length and e𝕙 height are constant. The probability of where the watermelon might be changes, this acts as an attraction or repulsion. The watermelon at first seems to be repelled from the Earth similar to two north poles of magnets put together, then it turns at the apogee and appears to be attracted.

Constructive and destructive interference

This happens because of constructive and destructive interference of the +𝕆D gravitational field force and the -𝕆D inertial field force. Because they are inverses of each other, the watermelon can move with a squared force up and down. +𝕆D and -𝕆D are inverses as well, because of this the watermelon is in its most probable position at each point of the trajectory.

Gravitational attraction and probability

With no interfering probabilities such as wind there is no measurable other force on it, this would make it weightless because weight is a +𝕀D gravitational probability. A person feels this gravitational weight because the +𝕚d and e𝕙 Pythagorean Triangle has active forces, with a lower e𝕙 height the +𝕀D gravitational probability is greater. This makes it more probable the person is at a lower height, they measure this as a gravitational attraction. On a scale this pushes down a spring or it can make them fall.

Inertial probability and weight

A person in an accelerating car would feel an inertial weight pushing them back, this is because the -𝕀D inertial probability of where they should be is reacting to the acceleration. This is further behind the car and so the person measures an attraction to behind them as an inertial weight.

Inertial inverse square

When these are summed the -𝕀D inertial field force or probability is increasing as a square with a greater eℍ height, this is because with the -𝕀D×e𝕧 inertial work e𝕧 is decreasing and the -𝕚d inertial mass is increasing. This gives an inverse square law, a passing asteroid near a planet would measure the change in its -𝕀D inertial probability according to its eℍ height above the planet.

Repulsion then attraction

The watermelon initially appears to be repelled from the planet like two north poles of a magnet, this happens because of the original -𝕆D kinetic probability if it was tossed upwards with -𝕆D×e𝕪 kinetic work. The -𝕀D inertial probability is increasing more slowly as it is subtracted from the +𝕀D gravitational probability. It becomes increasingly less probable for the watermelon to continue to be repelled upwards without addition -𝕆D×e𝕪 kinetic work.

Magnetic attraction and repulsion

In this model the same happens with magnets, their attraction and repulsion occur from constructive and destructive interference respectively. The attraction of a north and south pole of two magnets is where the -𝕆D spin of the electrons is say clockwise in each. This means when the north and south poles are close to each other this spin is increasingly stronger with a constructive interference. That increases the -𝕆D kinetic probability of their coming together because there is a higher kinetic probability of electrons being measured there. With this higher probability the electrons move to closer e𝕪 positions on a scale with -𝕆D×e𝕪 kinetic work.

Repulsion as destructive interference

Conversely when the north and north, or south and south poles of the magnets are brought together then there is destructive interference. It is measured with -𝕆D×e𝕪 kinetic work as if there are fewer electrons there, that causes the magnets to be repelled. Because the -𝕆D kinetic probability of there being electrons there is lower, the electrons in the magnets must move away to confirm to this.

Most probable electron orbital

In the atoms there is also a destructive interference where the +𝕆D potential magnetic force from the protons is summed to the -𝕆D kinetic magnetic force of the electrons, that determines the probabilities of what orbitals they are in. They then move to where they are most probable.

Gyroscopes and spin

Destructive interference is also seen in the macro world, for example a gyroscope spins with a -𝕀D inertial probability that reacts against this changing. This means for a e𝕧 position as a direction the -𝕀D inertial probability is less likely to change, that is measured as a resistance to the direction of the gyroscope's axis being changed. The axis would be the direction of the e𝕧 straight Pythagorean Triangle side, the -𝕀D inertial torque or probability rotates around this.

The electron as a gyroscope

In this model the same occurs with an electron, its -𝕠d and e𝕪 Pythagorean Triangle has its e𝕪 kinetic electric charge like an axle and the -𝕠d kinetic magnetic field spins around this. The number of oscillations of the axle must be an integer to give standing or deBroglie waves in an orbital.

Electron precession

It also causes an electron to act like a gyroscope, with an external $\vec{B}$ magnetic field doing -𝕆D×e𝕪 kinetic work this causes an -𝕀D×e𝕧 inertial work reaction. It resists a change in its e𝕪 orientation because the -𝕆D kinetic probability is more likely for it to not change, instead it precesses because this does not change the -𝕆D kinetic probability.

Rotating ellipse

Overall, the orientation of the e𝕧 length does not change, instead it rotates around that direction as the center of a cone. The -𝕆D kinetic probability also does not change, with the precession this is like a circle in a conic section initially. Then it becomes like an ellipse that is rotating so that the average probability is still a circle. Because this is a rotation in an orthogonal direction, this also has a -𝕆D kinetic probability from the $\vec{B}$ external magnetic field.

Gyromagnetic ratio

This ratio of the electromagnetic and inertial properties of the electron is called the gyromagnetic ratio. The precession occurs because -𝕆D×e𝕪 kinetic work is being done, there is a reaction against this with -𝕀D×e𝕧 inertial work and leading to a conservation of the probabilities. With a third direction this causes the precession.

Canceling gyroscopic probability

A bicycle wheel can be an example of a gyroscope, when a second wheel is connected onto its axis then both can spin in the same direction with double the -𝕀D×e𝕧 inertial work. This resists a change in its e𝕧 orientation twice as much. When the spins are reversed then there is destructive interference, no matter how fast they spin with the same revolutions per minute the -𝕀D inertial probability is canceled. Then the pair of wheels can be turned as if they are not spinning.

A double slit and interference patterns

The constructive and destructive interference of spin Pythagorean Triangle sides, when squared as forces, creates their attractive and repulsive forces as probabilities. This also occurs with e𝕪×-𝕘d photons in a double slit experiment, where the photons interfere destructively with their -𝔾D×e𝕪 light work they are less likely to be measured. Then this gives a darker area, conversely where they constructively interfere this increases the -𝔾D×e𝕪 light work and -𝔾D light probability of where they would be measured. Because positions on a screen are being measured this is work and so there are -e𝕣𝕘d light probabilities of where the photons are measured.

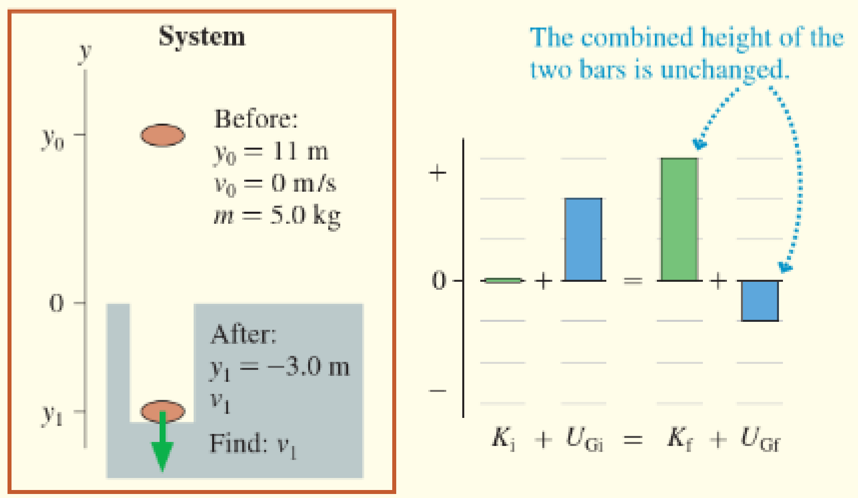


FIGURE 10.6 Pictorial representation and energy bar chart of the watermelon + earth system.

Three orthogonal Pythagorean Triangles

In this model there can be three orthogonal Pythagorean Triangles, that means their forces cannot interact on each other. With the +𝕠d and e𝕒 Pythagorean Triangle as the proton that allows for three e𝕒 directions, the +𝕠d potential magnetic field as spin can be regarded as exerting a potential torque from one orientation to the other. That gives the quaternions as spin with î, ĵ, and k̂.

Quaternions

The +𝕚d and e𝕙 Pythagorean Triangle as gravity also has these three orthogonal Pythagorean Triangles proportional to the +𝕠d and e𝕒 Pythagorean Triangles, with the same î, ĵ, and k̂ changes in spin directions. There cannot be more Pythagorean Triangles in between these three orthogonal directions, they would have a change Pythagorean Triangle area and interfere constructively or destructively with the others.

The proton and neutron

Here this allows for a model to have three generations of particles, an +𝕠d and e𝕒 Pythagorean Triangle would have 2×+𝕠d where d=2/3 as the up quarks, and 1×-𝕠d where d=1/3 as the down quark. These sum to +𝕠d where d=1 with a positive charge for the proton. The neutron has 1×+𝕠d, d=2/3 and 2×-𝕠d, d=1/3 to sum to zero. The difference as -𝕠d, d=1 is the electron which leaves the nucleus. This occurs on a single line as with the complex plane in conventional physics, +𝕠d on the right and -𝕠d on the left as with +i and -i which are the imaginary numbers.

Proton and neutron probabilities

The +𝕠d and -𝕠d Pythagorean Triangle sides are the square roots of -1 as are +i and -i. On this line then the +𝕠d and -𝕠d values are summed, this is like in electron orbitals where their e𝕒 altitude above a proton is according to summing the +𝕠d proton's potential magnetic field and the -𝕠d electron's kinetic magnetic field. It is also the same as with the ball being thrown earlier, when these are taken as forces by squaring the spin Pythagorean Triangle sides they give the probabilities of where the ball is.

Electron probabilities

When the neutron changes into the proton then these probabilities also change with the +𝕆D×e𝕒 potential work, the probabilities sum to this change and so the -𝕆D kinetic probability, d=1 disappears. That is as if the electron is repelled and moves outwards to the ground state where α is $e^{e𝕪-𝕆D}$, d=1.

Three generations of quarks

The up quark as +𝕠d, d=2/3, and the bottom quark of -𝕠d, d=1/3, can also change their probabilities with an additional torque as work. This causes them to be twisted 90° to the next two orthogonal Pythagorean Triangles to give three generations of particles or iotas. In this model iota refers to either a particle or a wave depending on how it is measured or observed.

Probabilities of different generations

This torque then gives the probability of whether they have been twisted 90°, this can also decay so that the quark drops back to a previous torque and Pythagorean Triangle. Because there are only three orthogonal Pythagorean Triangles there are only three generations. The up and down quark can then become the charm and strange quarks, then the top and bottom quarks.

Three orthogonal electron Pythagorean Triangles

The -𝕠d value, d=1, is a kinetic probability that the neutron will become a proton with a potential probability of +𝕠d, d=1. It then is less likely to remain in the proton and moves outwards to where this -𝕠d kinetic probability equals the ground state. This -𝕠d and e𝕪 Pythagorean Triangle also is part of three orthogonal Pythagorean Triangles with a torque between them as î, ĵ, and k̂ defined as the quaternions.

Time forwards and backwards

The positron as the +𝕠d and e𝕪 Pythagorean Triangle can also be emitted when the proton becomes a neutron, this is where +𝕠d represents going backwards in time while -𝕠d is going forwards in time. Also with the proton and neutron being composed of +𝕠d and -𝕠d, there can be an oscillation forward and backwards in time. Protons might go back in time to oscillate into neutrons and then forward back to neutrons.

Muons and τ electrons

The kinetic torque then can twist the -𝕠d and e𝕪 Pythagorean Triangle 90° to another form, it still has the same Pythagorean Triangle area but the angle θ opposite the spin Pythagorean Triangle side changes. That -𝕆D×e𝕪 kinetic work causes the electron to become a muon, and a further -𝕆D kinetic torque would give a kinetic probability of the muon becoming a τ electron. This can also occur for three generations of the positron with a +𝕆D positronic torque or probability.

Probabilities of quark generations

These probabilities would decrease with the higher generations of quarks and so they should be in that state a smaller fraction of the time. That would cause them to quickly decay.

Proton and electron spin directions

The neutron also has three different kinds of spin, this is not from the three orthogonal Pythagorean Triangles. Instead +𝕠d is opposed by -𝕠d, these become orthogonal when the electron leaves the neutron. The proton then can be regarded as spinning like a planet with its +𝕠d spin, the electron moves around it with a -𝕠d spin orthogonally. In this model it is like a ball rolling around the orbital. A point on the ball as the end of the -𝕠d phasor would then trace out a sine wave like deBroglie waves.

The neutrino and precession

The third orthogonal direction is not positive or negative and so in this model it is 𝕠d as the neutrino. It cannot interact with the proton or electron, it also has three orthogonal Pythagorean Triangles. The straight Pythagorean Triangle side is referred to as 𝕡 for precession to give the 𝕡 and 𝕠d Pythagorean Triangle as the neutrino.

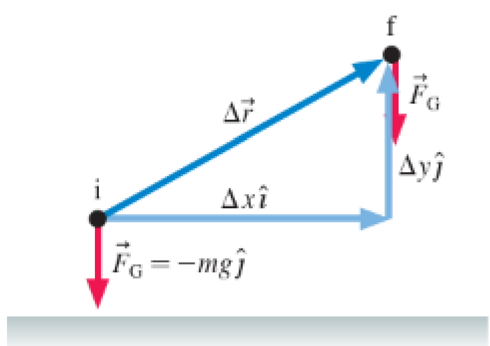
Three orthogonal neutrinos

The neutrino can also change with its own three orthogonal Pythagorean Triangles according to the î, ĵ, and k̂ quaternions. Because 𝕠d cannot add or subtract to the probabilities of the other iotas this makes it equally probably to be a neutrino, muon neutrino, or τ neutrino. That would be consistent with the sun emitting equal numbers of these three neutrinos, there is an equal probability of this neutrino torque changing the Pythagorean Triangle it is in.

Three independent spins

There are then three degrees of freedom with the three orthogonal Pythagorean Triangles, that allows for three orthogonal directions of work that are independent in terms of probability. The three spin directions are also independent, a proton might spin like a planet and the electron roll like a ball around it. A change in one of these spins would not necessarily change the other. The third spin direction as precession would not affect these as well, For example the Earth has its axis precess but this does not change the spinning of the Moon around it.

FIGURE 10.7 Gravity does work on a particle moving at an angle.



Work and vectors

In the diagram, the constant +𝕀D×e𝕙 gravitational work has a force $F^{\rightarrow}$ that is from the +𝕀D gravitational field force or probability. The change in position as Δr$^{\rightarrow}$ is e𝕙 as the height. In conventional physics these are referred to as vectors with an arrow such as e𝕙$^{\rightarrow}$, in this model a straight Pythagorean Triangle side can be a vector but as a scale. It is not observable as a force unless it becomes impulse such as Eℍ$^{\rightarrow}$. A vector implies a change from an additional position to a final position, in this model e𝕙 here would be a position on a scale not a displacement. It is a classical approximation because the +𝕀D×e𝕙 gravitational work can be converted into a E$\vec{\mathbb{H}}$/+𝕚d gravitational impulse with a vectors E$\vec{\mathbb{H}}$.

Circular coordinate systems

When coordinate systems are used, they can be of three types. There is circular or spherical geometry where a change is represented by the radius and two angles. This radius would then be of a sphere and the angles refer to its orientation horizontally and vertically. In this model there would be a circle with the +𝕠d and e𝕒 Pythagorean Triangle, e𝕒 represents the straight Pythagorean Triangle side out from the origin. The +𝕠d Pythagorean Triangle side is orthogonal to this and gives the +𝕠d potential magnetic field at that e𝕒 altitude, or value of the potential electric charge. With the +𝕚d and e𝕙 Pythagorean Triangle this would use the e𝕙 height and the +𝕚d gravitational field at that height.

Changing circular coordinates

The angle used here would be θ at the origin opposite the spin Pythagorean Triangle side. An additional angle α can be used to indicate the e𝕒 Pythagorean Triangle side moved to a different orientation, that would be from +𝕆D×e𝕒 potential work. In conventional math ϕ is used, but here this is already used as the other acute angle in a Pythagorean Triangle. To avoid confusion α is used.

Quaternions and precession

This could also be used with quaternions in this model, the +𝕠d and e𝕒 Pythagorean Triangle would have î as the angle θ corresponding to +𝕚d. Then changing to an orthogonal direction would act as a second generation of the +𝕠d and e𝕒 Pythagorean Triangle with +𝕚d and ĵ. The third direction would be ĵ. With +𝕆D×e𝕒 potential work being done this would increase the +𝕆D potential torque and so the e𝕒 altitude would contract. Also with +𝕀D×e𝕙 gravitational work this would increase the +𝕀D gravitational torque and the e𝕙 height would contract.

Precession and torque

Precession would be spin towards this change of direction, when large enough it might flip the Pythagorean Triangle like a polar wander in Biv space-time. This is seen with a spinning object in a weightless environment, it can spontaneously flip to another orientation. In this model that would be -𝕀D×e𝕧 inertial work because there is not a forward motion, it occurs through the +𝕀D inertial torque.

Quarks and precession

For example quarks might precess in their circular geometry from an external B magnetic field, this could cause them to absorb enough +𝕆D potential and -𝕆D kinetic probability to move to an orthogonal orientation. To conserve this probability there could only be three degrees of freedom or the fourth would be the same as the original orientation.

Gluons

To maintain the same fractions of +𝕠d, d=2/3 and -𝕠d, d=1/3, the change would be from a gluon with a value of 1 like the photon with its -𝔾D×e𝕪 light work. These would then act as a +𝕆D potential and -𝕆D kinetic torque in changing quarks.

Quark colors

This also allows for three times the colors of quarks as in quantum chromodynamics. First the +𝕠d and e𝕒 Pythagorean Triangle can point in three orthogonal directions, with no forces these are superposed. Precession might cause this to switch to three orthogonal directions, there would be no work done because the probability would be the same in all three directions and the average would not change.

Second and third generations from torque

With additional work done on the +𝕠d and e𝕒 Pythagorean Triangle it could either rotate to a second-generation orthogonal orientation, or it could become the sum of two Pythagorean Triangles with a common hypotenuse. A third change would give the third direction or three added Pythagorean Triangles with a common hypotenuse.

Cartesian coordinates

In this model Cartesian coordinates represent a flat space with no spin, and so there are no curved coordinates such as geodesic in General Relativity. This is the coordinate system of the clockwork universe, impulse connects vectors in between particles. A timeline can be on the y axis, the x axis can be a linear or squared displacement force.

Parabolic coordinate system

That can also represent a parabolic coordinate system in this model, in between circular geometry with the +𝕠d and e𝕒 Pythagorean Triangle and hyperbolic geometry with the -𝕠d and e𝕪 Pythagorean Triangle. The integral areas under straight-line vectors in this coordinate system can also have a squared x axis, they would then change according to an inverse square law in representing a gravitational field for example.

Creating axes

In the diagram a single direction of a particle, such as its velocity e𝕧/-𝕚d, is split into two orthogonal axes. In this model that would not be allowed except as a classical approximation, it would be exerting a -𝕀D inertial torque to change the particle's direction. It can be reduced to two Pythagorean Triangles that sum to the particle's velocity but in this model those Pythagorean Triangles must be created with a constant Pythagorean Triangle area.

Hyperbolic geometry

The third type is hyperbolic geometry, which in this model is used by the -𝕠d and e𝕪 Pythagorean Triangle as the electron and the -𝕚d and e𝕧 Pythagorean Triangle as inertia. This can also use straight-line axes where the E𝕍/-𝕚d inertial impulse is observed.

Basis vectors

In General Relativity different coordinate systems can be used as basis vectors, these represent the motion of a particle with impulse compared to other possible trajectories. Because they would be different direction in a geodesic, these would be an approximation because of time dilation and height contraction. In this model then Pythagorean Triangles are not changed into other Pythagorean Triangles without the work and impulse in changing this reference frame.

Straight Pythagorean Triangle sides as an axis

Splitting gravity into two orthogonal directions is not allowed in General Relativity, this is because in that theory space uses curved lines with the +𝕚d gravitational field. It can be done in this model where there is a direct line between two masses, such as a planet and a moon, the line between them is a straight Pythagorean Triangle side as e𝕙 for each of them.

Connecting straight side Pythagorean Triangle sides

There could also be two e𝕙 height straight lines drawn outward so they intersect at a right angle, these represent the straight Pythagorean Triangle side and so are not curved. Then the Eℍ/+𝕚d gravitational impulse could be calculated according to an x and y axis this way. That can also give an accurate answer in General Relativity as the +𝕚d and e𝕙 Pythagorean Triangles are compatible with the Schwarzschild equation, that gives a e𝕙 height contraction and +𝕚d time dilation, This is also calculated from the +𝕚d and e𝕙 Pythagorean Triangles having a constant area.

The clockwork universe and relativity

The process is similar to the clockwork universe of impulse only, the +𝕚d and e𝕙 Pythagorean Triangles here would also confirm to General Relativity. Closer to larger planets and stars there would be a e𝕙 length contraction, these points would be defined by an +𝕚d and e𝕙 Pythagorean Triangle ending there from the center of the mass.

Timelines from stars and planets

Those stars and planets would have an associated +𝕚d gravitational mass associated with them, because this would initially be using the Eℍ/+𝕚d gravitational impulse that acts as a timeline with +𝕚d moments on it using a clock as a gauge.

Particle collisions and vectors

Particles colliding with each other would act as vectors with a velocity e𝕧/-𝕚d, the E𝕍/-𝕚d inertial impulse would square this as Eℍ. The timeline for these would use -𝕚d as the inertial time, it would give positions around the masses where particles would be.

An exponential curve closer to c

Because some of these particles may approach c this is relativistic, the e𝕧/-𝕚d velocity gets closer to c and the angle θ opposite -𝕚d contracts. The E𝕍/-𝕚d inertial impulse has E𝕍 increasing as a square while -𝕚d as the inertial time contracts linearly, this gives an exponential curve.

A displacement of distance

Because E𝕍 is a square it represents a displacement not a position, its value comes from when it was at rest to its current velocity. That is the force required to reach that velocity, because this is dilated then the -𝕚d inertial time is contracted. That is observed as time moving more slowly, or inertial time dilation.

Accumulation of inertial probability

Also these particles, such as those in a rocket, have accumulated a -𝕀D inertial probability or mass force. This is a duration or time change from an initial moment to the final moment of observation. As a squared duration, like a temporal displacement, this has accumulated from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy as fuel to accelerate the rocket.

Inertial weight as probability

This -𝕀D inertial probability can be felt by someone in a car, the higher its velocity the more inertial weight a person feels in slowing the car back to rest. They would have experienced this -𝕀D inertial weight as the car accelerated, to be conserved this force needs to be reduced as the car comes to rest again. In this model it is a reaction force, the -𝕀D inertial probability is how the person measures a force against their moving or changing their acceleration.

Inertial weight is reactive only

At the start this inertial weight is at rest, then they feel the inertial weight reacting against this change from being at rest. Each time the car accelerates or decelerates they feel the inertial weight reacting against this change. The -𝕀D inertial probability is what their velocity e𝕧/-𝕚d would have been without the acceleration. This is a reactive force only, it cannot actively pull them in a direction. It can only react against a change in position e𝕧 from the -𝕀D×e𝕧 inertial work done.

Inertial work and the inertial probability

Because -𝕀D is dilated, this is not the same as the -𝕚d inertial time in the e𝕧/-𝕚d velocity, it causes the e𝕧 length to be contracted. That is because the -𝕚d and e𝕧 Pythagorean Triangle has a constant area, as -𝕚d dilates then e𝕧 must contract. This would represent -𝕀D×e𝕧 inertial work which is not included so far in this straight-line impulse model, it shows how in this model there can be -𝕚d inertial time slowing and a e𝕧 length contraction.

Comparing clocks as gauges

With the Eℍ/+𝕚d gravitational impulse there are moments around all gravitational masses that act as points in time on a clock as a gauge. These are linear in their changes with the +𝕚d and e𝕙 Pythagorean Triangles, just as they are linear with -𝕚d inertial time moments with the -𝕚d and e𝕧 Pythagorean Triangles. Comparing two +𝕚d moments can show their clock gauges are not turning at the same rate.

Displacements in gravitational acceleration

At different points above these masses, defined as +𝕚d moments in gravitational time, there is a different displacement Eℍ from where a particle would have started to where it was observed. So with clocks falling from a large enough e𝕙 height these would have different Eℍ displacements according to their distance.

Displacement is conserved as a force

This Eℍ displacement must be conserved as a force in this model, a +𝕚d gravitational time slowing cannot be separated from it because the +𝕚d and e𝕙 Pythagorean Triangle has a constant area. So when the +𝕚d and e𝕙 Pythagorean Triangle starts at a $e𝕙_s$ with an angle θ, then there is an observation at $e𝕙_f$ with a different angle θ, the slowing of +𝕚d gravitational time comes from that +𝕚d and e𝕙 Pythagorean Triangle having changed through this e𝕙 displacement. Only one Pythagorean Triangle side can squared so time here acts as a clock gauge of moments, not as a duration from a starting to final time.

Exponential change in General Relativity with γ

Because comparing this to the +𝕚d Pythagorean Triangle side gives an exponential curve this begins as an inverse square relationship. Then the exponential grows until the difference in the +𝕚d gravitational time dilation is observable at different +𝕚d gravitational moments. In relativity this is referred to as γ or gamma.

Exponential change in Special Relativity with γ

With the particles, such as in rockets, moving closer to c there is the same exponential relationship. E𝕍 increases as a square while -𝕚d as inertial time contracts, the exponential causes slower velocities to also change with F=ma. Then with higher velocities there is an increasingly exponential difference between the -𝕚d inertial times on different rockets, F=ma is shown to have been a classical approximation.

Subtracting gravitational and inertial time

Because these are all straight Pythagorean Triangle sides there is no curved space and no geodesics, the model would give the +𝕚d gravitational and -𝕚d inertial time dilations. These then have -𝕚d subtracted from +𝕚d, that gives values for the moments that are slowed in different ways.

The other part of this model is to measure the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work in curved coordinate systems, this is because +𝕀D and -𝕀D are squared spin forces. The straight lines are e𝕙 as the height and e𝕧 as the length. It would not be possible to draw a straight-line between two of these +𝕚d gravitational moments except in circular geometry from the center of these masses.

Straight lines in hyperbolic geometry

It is possible to draw a straight line as e𝕧 between two rockets moving at relativistic velocities, this is because the -𝕚d and e𝕧 Pythagorean Triangle is in hyperbolic geometry. It is not possible in this model to regard each rocket as being in circular geometry, drawing straight lines out from the rocket to other objects moving at varying velocities such as planets being passed. That is only for a +𝕚d gravitational mass.

Displacement between two rockets

This is because a single straight-line between the two rockets is E𝕍 as a starting and final displacement between the two, it does not represent two points on a scale. With the rocket passing other objects it is also possible to draw straight lines from the rocket to them. They can be E𝕍 as a starting to final displacement, a small rocket might leave the larger one and travel in a e𝕧 straight-line to a planet. They would be accompanied with a clock gauge of the +𝕚d inertial time difference, this difference in E𝕍 acceleration would give the tine slowing of +𝕚d inertial time for the small rocket.

General Relativity and curved space

This will be explored later in General Relativity, the point here is that impulse can be broken up into a series of straight-line vectors that are not curved as in General Relativity. Because of this different straight-line coordinate systems can be used, this is done below in adding and x and y axis. If one of these axes is time then there can be relativistic effects as described. Curved axes are not used in classical physics, this is why General and Special Relativity were developed.

Gravity is a constant force. In Chapter 9 you learned that, in general, the work done by a constant force is $W = \vec{F} \cdot \Delta\vec{r}$. If we write both $\vec{F}_G$ and $\Delta\vec{r}$ in terms of components, and use the Chapter 9 result for calculating the dot product with components, we find that the work done by gravity is

$$\begin{aligned} W_{\text{by grav}} &= \vec{F}_G \cdot \Delta\vec{r} = (F_G)_x(\Delta r_x) + (F_G)_y(\Delta r_y) = 0 + (-mg)(\Delta y) \\ &= -mg\,\Delta y \end{aligned} \tag{10.12}$$

Because $\vec{F}_G$ has no x-component, the work depends only on the vertical displacement Δy.

Consequently, **the change in gravitational potential energy depends only on an object's vertical displacement.** This is true not only for motion along a straight line, as in Figure 10.7, but also for motion along a *curved* trajectory because a curve can be represented as the limit of a very large number of very short straight-line segments.

Deterministic energy is conserved

Energy is conserved because it is deterministic, in this model impulse can be used to connect interactions between particles. When work is added, here as friction, then there are random interactions which are not deterministic. Here the term thermal energy is a classical approximation, this comes from work and probabilities. Energy as impulse becomes converted into work as waves and randomness.

Friction and increasing entropy

When particles move in a clockwork universe they have a velocity e𝕧/-𝕚d, the -𝕀D×e𝕧 inertial work as inertial friction can slow this so -𝕚d dilates and e𝕧 contracts. That makes the particles slow and stop from this inertial friction. As the process continues the -𝕆D kinetic entropy increases, this is an increasing kinetic disorder in the clockwork universe.

Randomness over distance, chaos over time

Friction occurs over a position or distance, when this is measured then there is an increased or decreased disorder in the clockwork universe. When there are observations this is over a time, that is deterministic so there is chaos instead of randomness.

Motion with Gravity and Friction

What if there's friction? You learned in « Section 9.5 that friction increases the thermal energy of the system—defined to include *both* objects—by $\Delta E_{th} = f_k \Delta s$. For a system with both gravitational potential energy and friction, the energy principle becomes

$$\Delta K + \Delta U_G + \Delta E_{th} = 0 \quad (10.13)$$

or, equivalently,

$$K_i + U_{Gi} = K_f + U_{Gf} + \Delta E_{th} \quad (10.14)$$

Mechanical energy $K + U_G$ is *not* conserved if there is friction. Because $\Delta E_{th} > 0$ (friction always makes surfaces hotter, never cooler), the final mechanical energy is less than the initial mechanical energy. That is, some fraction of the initial kinetic and potential energy is transformed into thermal energy during the motion. Friction causes objects to slow down, and motion ceases when all the mechanical energy has been transformed into thermal energy. Mechanical energy is conserved only when there are no dissipative forces and thus $\Delta E_{th} = 0$.

Elastic potential energy

Here the elastic potential energy would come from the +𝕆D×e𝕒 potential work, the molecular bonds react against a change in the spring. In this model work squares the spin Pythagorean Triangle sides, these also act like mass in Roy electromagnetism. This would then be +𝕆D as a potential torque where the spring reacts against being deformed. That is similar to the +𝕚d gravitational mass where the +𝕀D×e𝕙 gravitational work actively moves the molecular bonds downwards to their previous positions.

Potential and kinetic mass

Because the +𝕚d gravitational mass and the -𝕚d inertial mass change with a e𝕙 height and e𝕧 length, there is no need to assume the spring is massless. When the spring is extended this is caused by an increased -𝕆D×e𝕪 kinetic work, the -𝕆D kinetic torque also acts like a kinetic mass. This is active, it is reacted against by the -𝕀D inertial mass torque. When the -𝕆D×e𝕪 kinetic work is largest then the -𝕚d inertial mass of the electrons in the spring also increases, if the spring was broken then some would be liberated from their atoms.

Inverse square force

The +𝕆D×e𝕒 potential work then reacts against this with a +𝕆D potential torque, that is also like a potential mass. This decreases with an increased e𝕒 altitude as an inverse square, like with the +𝕀D gravitational field force.

10.3 Elastic Potential Energy

Much of what you've just learned about gravitational potential energy carries over to the *elastic potential energy* of a spring. **FIGURE 10.11** shows a spring exerting a force on a block while the block moves on a frictionless, horizontal surface. In Chapter 9, we analyzed this problem by defining the system to consist of only the block, and we calculated the work of the spring on the block. Now let's define the system to be block + spring + wall. That is, the system is the spring and the objects connected by the spring. The surface and the earth exert forces on the block—the normal force and gravity—but those forces are always perpendicular to the displacement and do not transfer any energy to the system.

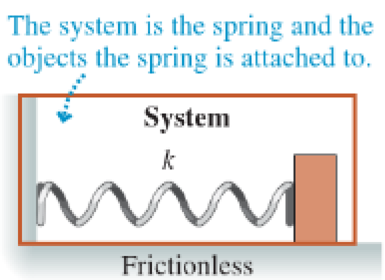
We'll assume the spring to be massless, so it has no kinetic energy. Instead, the spring is the *interaction* between the block and the wall. Because the interaction is inside the system, it has an interaction energy, the **elastic potential energy,** given by

$$\Delta U_{\mathrm{Sp}} = -(W_{\mathrm{B}} + W_{\mathrm{W}}) \qquad (10.15)$$

Spring constant k

The spring would oscillate like a wave, the spring constant k is proportional to e𝕒 as the altitude of how far upwards the +𝕆D molecular bonds are twisted.

FIGURE 10.11 The block + spring + wall system has an elastic potential energy.



Potential work is positive.

In this model the initial position would be positive as the +𝕆D×e𝕒 potential work, then the negative -𝕆D×e𝕪 kinetic work is subtracted from this. This is an energy of position according to the text, here this is not referred to as energy which is impulse.

External interactions

With no active external interactions this would be just the +𝕆D×e𝕒 potential work, the protons react against a change in the e𝕒 altitude of the electrons maintaining them in quantized orbitals. There is also -𝕀D×e𝕧 inertial work which also reacts against a change. Internally there are active forces with the -𝕆D×e𝕪 kinetic work of the electrons, also the +𝕀D×e𝕙 gravitational work.

$$W_B = -\left(\tfrac{1}{2}k(\Delta s_f)^2 - \tfrac{1}{2}k(\Delta s_i)^2\right) \quad (10.16)$$

With the minus sign of Equation 10.15, we have

$$\Delta U_{Sp} = U_f - U_i = -W_B = \tfrac{1}{2}k(\Delta s_f)^2 - \tfrac{1}{2}k(\Delta s_i)^2 \quad (10.17)$$

Thus the elastic potential energy is

$$U_{Sp} = \tfrac{1}{2}k(\Delta s)^2 \quad \text{(elastic potential energy)} \quad (10.18)$$

where Δs is the displacement of the spring from its equilibrium length. Elastic potential energy, like gravitational potential energy, is an *energy of position*. It depends on where the block is, not on how fast the block is moving. Although we derived Equation 10.18 for a spring, it applies to *any* linear restoring force if k is the appropriate "spring constant" for that force.

The energy principle for a system with elastic potential energy and no external interactions is either $\Delta E_{sys} = \Delta K + \Delta U_{Sp} = 0$ or, recognizing that mechanical energy is again conserved,

Potential torque and kinetic torque

Here the -𝕆D×e𝕪 kinetic work would be the green bar, this subtracts the -𝕆D kinetic torque from the blue bar of the +𝕆D×e𝕒 potential work and +𝕆D potential torque. That is in the left-hand side of the equation. When the spring reacts against this change the +𝕆D×e𝕒 potential work rebounds with its +𝕆D potential torque, the -𝕆D kinetic torque is reduced. In this model vectors would refer to impulse only, not work.

Stretching and twisting a spring

A spring oscillates in this model because the direction of change is a straight Pythagorean Triangle side, this is e𝕒 altitude above the protons. The electrons are pulled away from the protons with only part of their motion having an increased individual -𝕆D kinetic torque. When an electron moves to a higher orbital there needs to be -𝕆D×e𝕪 kinetic work done on it, this acts like a -𝕆D kinetic torque. That is like an exponential spiral, the electron must receive this increment in torque because that has a wave nature.

Electrons as a standing wave

The electron in an orbital acts like a standing wave with a number of oscillations, these are also called deBroglie waves. To move to a higher orbital the number of these oscillations must increase by a quantized value, if not then then oscillations do not match where they would join together.

Destructive interference in unquantized orbitals

An orbital that is not quantized then would have destructive interference with parts of its oscillating waves. That would cancel them out as if they did not exist, the electron could not then be at that e𝕒 altitude as a wave.

A rocket with its orbit stretched

Moving an electron to a higher orbital is then accomplished with -𝕆D×e𝕪 kinetic work, when a spring is stretched this work is done on the molecular bonds as a whole. It is not done on individual electrons. It is then like a E𝕐/-𝕠d kinetic impulse, the spring has a circular spiral nature like spin, but it is stretched in a straight-line like impulse. This is like a rocket in orbit around a planet in Biv space-time, its orbit can be stretched by a rocket firing directly away from the planet instead of at a tangent to it.

Increasing inertial torque with a rocket

When the rocket fires at a tangent this increases the -𝕀D inertial torque and does -𝕀D×e𝕧 inertial work. It is like a nut being turned by a wrench screwing the rocket up into a higher orbit. This is how rockets and satellites change their orbits.

The rocket moves like a spring

If the rocket is fired straight upwards against the e𝕙 height of the planet then this is an E𝕍/-𝕚d inertial impulse, that causes the orbit to become elliptical. The rocket will then oscillate upwards and downwards like a spring. In the diagram the spring hanging under gravity illustrates this, the spring is stretched which is like the rocket moving directly upwards. When the rocket stops the Eℍ/+𝕚d gravitational impulse actively pulls it down. The orbit then becomes a combination of a Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work as an ellipse.

Twisting a spring

To stretch a spring completely with -𝕆D×e𝕪 kinetic work it would be turned say clockwise, that would unwind the spring and so it would become longer. If it was released then the spring would turn counterclockwise as the +𝕆D×e𝕒 potential work caused the spring to rebound to its former shape. Conversely if the spring was turned counterclockwise with -𝕆D×e𝕪 kinetic work then released, the spring would react against this by rebounding with a clockwise spin.

Inductors and capacitors

In Roy electromagnetism the same processes occur with the +𝕠d and e𝕒 Pythagorean Triangles as protons, and the -𝕠d and e𝕪 Pythagorean Triangles as electrons. An inductor is a spring shaped coil of wire in a circuit. When an alternating current goes through the inductor this is like the current moving as a spring itself. It changes direction with a frequency, this is because the generator does -𝕆D×e𝕪 kinetic work and creates a -𝕆D kinetic difference with magnets as a voltage, this is reacted against by +𝕆D×e𝕒 potential work from a +𝕆D potential difference.

Current in a wire and a river

The current then moves backward and forward in a wire like tides in water in Biv space-time. The rotation of the Moon does +𝕀D×e𝕙 gravitational work on the oceans, this moves them first in one direction and then back like a spring. In a straight river the tides can go up and down evenly, this is like a straight wire connected to the generator. When the river has twists and turns this acts like a spring, there can be a constructive and destructive interference between the resonations of the river's spring shape and the tides.

Chaotic river flows from destructive interference

That can cause the tide to be slowed in moving up the river, and create a chaotic level of water as the destructive interference cancels out some of the torque. Because the probabilities are being canceled this leads to an unpredictable level of water in the river from the Eℍ/+𝕚d gravitational impulse of the tides.

The 3-body problem and destructive interference

The +𝕀D×e𝕙 gravitational work is more canceled out and so the water acts more with the Eℍ/+𝕚d gravitational impulse, it is similar to in a 3-body problem with gravity. There the spin on a pair of asteroids for example, can interfere destructively. Instead of a pair of asteroids forming a stable resonation with their -𝕀D×e𝕧 inertial work, they move chaotically with more of an E𝕍/-𝕚d inertial impulse.

Lakes as capacitors

The river illustration can be extended with a series of lakes, these can act like electrical capacitors. The tides then might fill up the lakes more easily with the Eℍ/+𝕚d gravitational impulse from the Moon, that can be more stable without turns in the river like a spring.

A generator or moon and frequency

In an electrical circuit then the generator has a frequency in Hertz or cycles per second. This is like the Moon causing water to flow in a wire like river with one tide cycle per day. The coil can interfere destructively with this changing direction of the e𝕪/-𝕚d kinetic current and the e𝕒/+𝕠d potential current reacting against it. This is like the e𝕙/+𝕚d gravitational current from the Moon having the e𝕧/-𝕚d inertial current or velocity react against it.

Inductors and turns in a river

The inductor or spring like shape of wire can resist the alternating current from the generator just as the spring shaped river resisted the alternating tides from the Moon. More turns in the inductor resist this more, just as more turns in the rover do.

Spring like oscillations through an inductor

The generator is creating a E𝕐/-𝕠d kinetic impulse and E𝔸/+𝕠d potential impulse in the wire because part of the -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work is being destructively interfered with in the inductor. This can cause the current through the inductor to oscillate like the spring does.

Direct current and water flows

Adding a capacitor can change the resonation frequency of the current. This can also be done with a direct current, like water from a mountain flowing through a series of lakes and twisting turns in a river. That acts like capacitors in the lakes, they let some water through like a capacitor allows waves of -𝕆D×e𝕪 kinetic work to pass through it but stops E𝕐/-𝕠d kinetic impulse. The water after going through the lakes and spring like river would have an irregular or regular flow depending on their relative sizes.

A capacitor as a dam

A capacitor acts like a dam in a river, the Eℍ/+𝕚d gravitational impulse from the Moon's gravity would be stopped by it. When the river flow is made irregular from the spring like turns the water level can sometimes rise up and over the dam.

Frequency with capacitors and inductors

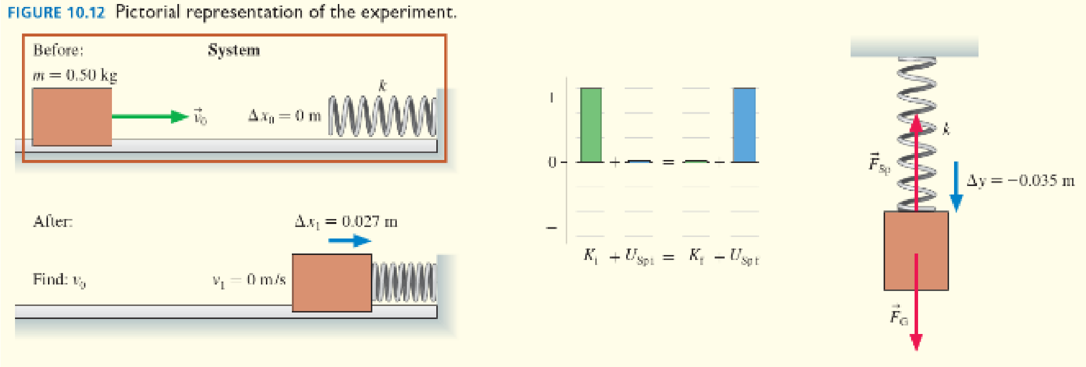
An alternating current can then go through a capacitor because of its -𝕆D×e𝕪 kinetic work, the slower the -𝕠d frequency the more the current is stopped as with the river. Conversely the slower the -𝕠d frequency the less destructive interference there is in the spring like inductor and the easier the current flows through that.

Work and impulse

In this model then the Pythagorean Triangles work in the same way for each case of work and impulse. With a river the +𝕀D×e𝕙 gravitational work is active as the Moon moves, with a circuit the

-𝕆D×e𝕪 kinetic work is active from the generator. With a spring the active Eℍ/+𝕚d gravitational impulse can stretch the spring downwards on the right in the diagram. On the left the E𝕐/-𝕠d kinetic impulse stretches the spring. In each case the spring reacts against this stretching with a E𝔸/+𝕠d potential impulse and +𝕆D×e𝕒 potential work, also with an E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work.

FIGURE 10.12 Pictorial representation of the experiment.



Thermal energy and work

In this model thermal energy comes from, a probability causes increased disorder and entropy. With Biv space-time this also occurs, Jupiter does strong +𝕀D×e𝕙 gravitational work on its moons. This causes them to be in orbits with a resonation like with quantized orbitals in Roy electromagnetism.

Gravitational and inertial torque

The moons also react against this with -𝕀D×e𝕧 inertial work, the difference in the work on different sides of the moons causes a +𝕀D gravitational torque in them. This is reacted against with their -𝕀D inertial torque. As the moons rotate this causes stresses inside them that heats up the moons. It acts then like a gravitational friction, the inertia maintains the relative positions of matter in the moon which is then twisted by the +𝕀D gravitational torque.

Tidal warming and a spring

This also acts like a spring causing oscillations, the side of the Moon nearest to Jupiter experiences more of a Eℍ/+𝕚d gravitational impulse, there is a rebound against this with the moon's E𝕍/-𝕚d inertial impulse and so the insides can also move up and down like the spring. The moon then experiences a twisting from the torque and work as tidal warming, also a stretching and compression from the impulse.

Potential and inertial torque

The heat in this case comes from the +𝕀D×e𝕙 gravitational work as the active force, the -𝕀D×e𝕧 inertial work is reactive. With friction the active force is usually -𝕆D×e𝕪 kinetic work, such as from pushing a block across a rough surface. The reactive force comes from the +𝕆D×e𝕒 potential work of molecular bonds forming and being broken by the motion.

Including Gravity

Now that we see how the basic energy model works, it's easy to extend it to new situations. If a problem has both a spring *and* a vertical displacement, we define the system so that both the gravitational interaction and the elastic interaction are inside the system. Then we have both elastic *and* gravitational potential energy. That is,

$$U = U_G + U_{Sp} \tag{10.20}$$

You have to be careful with the energy accounting because there are more ways that energy can be transformed, but nothing fundamental has changed by having two potential energies rather than one.

And we know how to include the increased thermal energy if there's friction. Thus for a system that has gravitational interactions, elastic interactions, and friction, but no external forces that do work, the energy principle is

$$\Delta E_{sys} = \Delta K + \Delta U_G + \Delta U_{Sp} + \Delta E_{th} = 0 \tag{10.21}$$

or, in conservation form,

$$K_i + U_{Gi} + U_{Sp\,i} = K_f + U_{Gf} + U_{Sp\,f} + \Delta E_{th} \tag{10.22}$$

This is looking a bit more complex as we have more and more energies to keep track of, but the message of Equations 10.21 and 10.22 is both simple and profound: **For a system that has no other interactions with its environment, the total energy of the system does not change.** It can be transformed in many ways by the interactions, but the total does not change.

Conservation of energy

In this model energy is conserved only with impulse, this is because the forces with respect to time are deterministic. The work inside a system means some parts do not have energy conservation, that is because work here is not energy but waves. The sizes of waves in the ocean for example are not conserved, but as an overall system it can be conserved. This is because nothing escapes the system, the overall angles θ of these Pythagorean Triangles in it and their Pythagorean Triangle areas are conserved.

Relativity instead of conservation

Here mass comes from spin Pythagorean Triangle sides, so there is the +𝕚d gravitational mass and the -𝕚d inertial mass in Biv space-time. These are not conserved with energy, in General Relativity the curving of space from this mass meant that classical momentum was not conserved. This was seen for example with the precession of Mercury, it had a different orbit than the conservation of classical energy predicted.

Curved vectors are not conserved

This happens because the spin Pythagorean Triangle sides when measured are not straight, they are curved. Adding impulse forces with vectors can show energy conservation, when some are curved then the vectors no longer add correctly. This is also seen in Roy electromagnetism where magnetic fields have a force called curl, they are not straight and so magnetic friction can degrade the performance of electric motors.

Conservation of mass and energy

This led to the conservation of energy as impulse and mass as work together, that is like the enclosed system where energy can be converted to mass and vice versa. In this model that also occurs with electromagnetism, the -𝕠d kinetic magnetic field can be converted into the e𝕪 kinetic electric field or in reverse.

Mass and energy

With the +𝕚d gravitational mass this does +𝕀D×e𝕙 gravitational work, it can be converted into a Eℍ/+𝕚d gravitational impulse and gravitational energy with this model. When a rocket moves directly upwards from a planet it does this with a E𝕐/-𝕠d kinetic impulse from its rockets, this acts against the Eℍ/+𝕚d gravitational impulse pulling it down. This Eℍ/+𝕚d gravitational impulse is observed from the total e𝕙 height above the planet, if the rocket fell downwards then in free fall its Eℍ/+𝕚d gravitational impulse would be at a maximum just before it hit the surface.

Position versus displacement

The Eℍ then refers to the e𝕙 height it had initially to its final height. Here this is called displacement as the term implies from one place to another. e𝕙 can also be a gravitational position when used with work, then it acts as a scale not a displacement.

Gravitational mass becomes height

When the rocket moves by firing its thrust at a tangent to the planet then it moves upwards with -𝕀D×e𝕧 inertial work against the +𝕀D×e𝕙 gravitational work of the planet. The +𝕚d gravitational mass is lower as the e𝕙 height increases, here this is the same as magnetism or the -𝕠d kinetic mass being converted into e𝕪 as a kinetic electric position.

$E=mc^2$

In this model the formula has E as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. It refers to where the -𝕚d inertial mass, such as a fast-moving particle in an accelerator, is converted into kinetic energy by colliding it with another particle. The Pythagorean Triangles used are the same, here the moving particle has an increased -𝕀D×e𝕧 inertial work because the magnets in the particle accelerator did -𝕆D×e𝕪 kinetic work on it. This also increases its velocity to near c, then the -𝕀D inertial mass force is much larger.

Mass creates other masses

This can be the equivalent of a number of other iotas or particles, also with e𝕪×-𝕘d photons. The formula then refers to the direct conversion of this -𝕚d inertial mass into the inertial mass of other particles. Some can also be converted into the -𝕘d rotational frequency of e𝕪×-𝕘d photons.

Probabilities of particles being created

Different particles can be created by these collisions according to probabilities because this is -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work with a -𝕆D kinetic probability and -𝕀D inertial probability. The values of D correspond to α in this model acting as a probability, this is because it is the -𝕆D×e𝕪 kinetic work of the ground state increasing with integers of D. This leads to the probabilities in Feynman diagrams and quantum electrodynamics later.

The position e𝕧 versus the displacement E𝕍

The -𝕆D×e𝕪 kinetic work done on the iotas as particles causes their -𝕀D×e𝕧 inertial work to increase. Here e𝕧 is not the same e𝕧 as in velocity as e𝕧/-𝕚d, it refers to the e𝕧 length of the particles and this is the same as e𝕧 length contraction with a rocket approaching c. The increased E𝕍/-𝕚d inertial impulse of the particle is where it collides with a stationary particle or one coming from the opposite direction.

Time not the inertial mass

This uses E𝕍 from the E𝕍/-𝕚d inertial impulse, that has e𝕧 from the velocity not the e𝕧 length of the particle as with work. The -𝕚d factor here refers to -𝕚d inertial time, that is not the -𝕚d inertial mass or -𝕀D inertial mass force with the -𝕀D×e𝕧 inertial work previously.

Mass creation from a small position

The two particles do -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work on each other when they get close together in a collision, this is because e𝕧 is small as the position or distance between them. That -𝕚d inertial mass then gets converted into the mass of other particles and the -𝕘d rotational frequency of the photons.

Short moment and large inertial mass

Some of these particles might exist for a short time, this is because their E𝕐/-𝕠d kinetic impulse has their moment as being very small. Because of the high -𝕆D×e𝕪 in the collision the -𝕚d inertial mass is large, these particles can then have a large mass for a short time. That is consistent with Heisenberg's uncertainty principle because that follows from a constant Pythagorean Triangle area.

The entire history of an iota

With the -𝕀D×e𝕧 inertial work of the particle, this -𝕀D inertial mass force represents its entire trajectory. That is, this is not a moment but a time change in the sense that there was a starting and final inertial mass. Without this history it is not possible to measure its -𝕀D inertial mass force.

The twin paradox

This is seen in Special Relativity with the twin paradox. One twin gets on a rocket that leaves a planet at near the speed of light for 10 years then returns home. This journey has a -𝕀D inertial mass force where they accelerated to near c, coasted at a constant velocity, turned around, accelerated back, and then decelerated to the planet. The other twin stays on the planet, their -𝕀D inertial probability is that they stayed there while the -𝕀D inertial probability of the other twin is the history of their journey.

The inertial probability of the rocket

The twin on the rocket then experienced -𝕆D×e𝕪 kinetic work in accelerating and decelerating. With this -𝕀D inertial probability they are less likely to quickly turn around, going in a straight-line near c that makes it very unlikely with this -𝕀D inertial probability they could go backwards. This is dependent on their -𝕚d inertial mass whether they are likely to turn around easily, that is dependent on their -𝕀D inertial probability from their acceleration to near c.

The rocket has a length contraction

Because of this they would be measured from the planet as having a e𝕧 length contraction with their -𝕀D×e𝕧 inertial work as -𝕀D is large. But also they would have slower clocks because their E𝕍/-𝕚d inertial impulse is large, e𝕧/-𝕚d as the velocity has e𝕧 dilated and -𝕚d as the inertial time contracted. This inertial time is what is observed as the slower clocks.

History as a displacement or time change

Their history then depends on E𝕍, this is the displacement from the start of their journey at the planet until the final observation on their return. That is not the same as their velocity which is the scale or position, where on that journey their velocity was at a given position. When they return then the sum of their slower clocks will mean the twin from the rocket has aged less.

A starting and final position

It is like a displacement which refers to a starting and final position, a position is a scale. Taking a ruler as an example, a position is where a position is on the scale of the ruler. A displacement is going from the beginning to the end of the ruler. The reading of a point on a scale is an observation of time with impulse, and a measurement of position with work. In this model then a position as a scale reading of a straight Pythagorean Triangle side can be e𝕒, e𝕪, e𝕙, and e𝕧. A moment is a scale reading of a spin Pythagorean Triangle side which can be +𝕠d, -𝕠d, -𝕘d, +𝕘d, +𝕚d, and -𝕚d.

Positions and moments

A time moment then is like a position, it might be a time on a clock. A time change is from a beginning of a time measurement to the end. A class then might have a time moment where it is a half hour from the beginning. A time change is from the beginning to the end without regard for a time in between. In this model a position is an infinitesimal, and a moment is an instant. They have no range of size because they represent only that scale reading, not the size of the scale itself.

A moment in time

Taking the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work of an electron for example, it might have a large -𝕀D inertial probability as a large inertial mass force from its large acceleration. In the collision this is converted into other masses as particles or iotas. These new particles might last for a short time on a scale with their E𝕍/-𝕚d inertial impulse, that moment is not measuring their inertial mass. It is observing that the particle decays typically at around a moment of time. This might be on a moment as a scale, but for that particle the start to final time is not being measured.

Deriving $E=mc^2$

With $E=mc^2$ then this refers to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia proportionally in Biv space-time. In this model it means the -𝕠d and e𝕪 Pythagorean Triangle is proportional to the -𝕚d and e𝕧 Pythagorean Triangle. The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy has a ½ factor, in conventional physics this acts as the average between an initial velocity e𝕧/-𝕚d and a final velocity.

Average velocity and c

Because c is the same as the initial and final velocity it is the same as its average, so there is no half factor. When an object accelerates then its ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia increase as the average of starting and final velocities. If it is not accelerating then the ½ factor is redundant, they can also refer to the kinetic and inertial energy it would take to slow them to a final velocity or rest.

Converting energy into mass

This can then be written with dimensional analysis as ½×e𝕐/-𝕆d ×-𝕠d → ½×e𝕍/-𝕀d ×-𝕚d where the arrow indicates energy being converted to inertial mass. When this velocity is much less than c then the E𝕍/-𝕀D factors are not relativistic. It then means as the velocity increases from being at rest the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy on the left-hand side increases proportionally.

Proportional energy at c

If this is written using c then it becomes e𝕐/-𝕆d ×-𝕠d → e𝕍/-𝕀d ×-𝕚d where the ½ factors are removed, or they can be canceled out in the previous equation using lower velocities. It then shows that with E𝕍/-𝕀D at a maximum the proportional energy is E𝕐/-𝕆D. In the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia there is a square in the energy as E𝕐/-𝕆D which is the square of e𝕪/-𝕠d. This is on the left-hand side of the equation, on the right-hand side there is c^2 as E𝕍/-𝕀D or the square of e𝕧/-𝕚d.

Compatible with travel faster than c

In this model it may be possible to reach c in a rocket or exceed it, this equation can then apply to that without alternation. This would happen by the rocket's own propulsion, here a particle cannot be externally propelled to exceed c but using an internal mechanism of thrust may be able to. As an example with airplanes and propellors, the propellor cannot push air backwards faster than sound. This is because it compresses air molecules like sound waves do. With a jet there is a thrust backwards which can exceed the sound barrier because the fuel is exploding in a reaction not dependent on the speed of sound.

Converting for different c speeds

These equations could also be converted for when particles are slowed by nearing a gravitational mass, like an asteroid or light rays near a large star. It can also be used to calculate the slowing of particles from a reactor emitting Cerenkov radiation, this is where they are traveling under c in a vacuum but faster than c in heavy water surrounding the reactor.

The inertial mass proportional to the kinetic magnetic field

On the right-hand side there is also m which is -𝕚d as the inertial mass. On the left-hand side there is the -𝕠d kinetic magnetic field or spin Pythagorean Triangle side, this is proportional to the -𝕚d inertial mass on the right-hand side. The two sides are then proportional to each other at nonrelativistic speeds and also at c.

The equation is fully relativistic

In this model when the velocity approaches c then the -𝕚d and e𝕧 Pythagorean Triangle has its angle θ contracted, this is because e𝕧 in e𝕧/-𝕚d is dilated with a large velocity and -𝕚d is contracted. Proportionally on the left-hand side the angle θ is contracted by the same amount, this means that -𝕚d on the right-hand side is still proportional to -𝕠d on the left-hand side. The equation then is fully relativistic, as will be shown this also applies to General Relativity.

Dimensional analysis

The equation is consistent with dimensional analysis, earlier it was shown how the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia could be separated into -𝕆D×e𝕪 kinetic work times the E𝕐/-𝕠d kinetic impulse. Then on the right-hand side the ½×e𝕍/-𝕀d ×-𝕚d linear inertia can be separated into the -𝕀D×e𝕧 inertial work times the E𝕍/-𝕚d inertial impulse. The ½ term can cancel out.

Work times impulse

The -𝕆D×e𝕪 kinetic work comes from the -𝕠d and e𝕪 Pythagorean Triangle where the -𝕠d kinetic magnetic field is squared as the -𝕆D kinetic torque or kinetic probability. This can also be done as an integral ∫-𝕠d d -𝕠d to give ½×-𝕆D, e𝕪 is a constant as a position or scale and remains the same. This can also refer to the area of the -𝕆D and e𝕪 Pythagorean Triangle as being ½ that of a rectangle with those two sides.

Differentiating the numerator

The E𝕐/-𝕠d kinetic impulse can then be derived as e𝕪/-𝕠d with respect to e𝕪, the convention here for clarity is to differentiate the numerator instead of inverting the fraction and then reinverting it. this gives E𝕐, the two together are ½×E𝕐/-𝕆D. Because the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is being observed here the other factor is -𝕠d as the kinetic magnetic field, also proportional to the -𝕚d inertial mass. The same process gives ½×E𝕍/-𝕀D where the integral is multiplied by the derivative. Because this is energy it refers to the -𝕚d inertial mass.

Rotational kinetics and kinetic energy

In this model there is also the 2×-𝕆d/e𝕐 ×e𝕪 rotational kinetics and the 2×-𝕀d/e𝕍 ×e𝕧 rotational inertia, these are used for dimensional analysis as well. They are the inverse of the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia respectively. Here the forces come from the rotational Pythagorean Triangle sides and so these refer to work, energy refers to impulse here.

Inverting kinetic energy

They are created by inverting the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, E𝕐/-𝕆D becomes -𝕆D/E𝕐 and the inverse of -𝕠d is e𝕪. The ½ factor becomes 2 so the two are inverses of each other, that factor is usually incorporated into another constant. These can be separated into work and impulse as before.

Rotational forces

In this model the rotational forces occur for example in atoms where a molecule might be rotated with heat. In the earlier example the moons of Jupiter might have a 2×-𝕀d/e𝕍 ×e𝕧 rotational inertia from the -𝕀D×e𝕧 inertial work done by Jupiter's +𝕀D×e𝕙 gravitational work.

Four rotational forces

Two other terms go with these as the 2×+𝕆d/E𝔸 ×e𝕒 rotational potential and the 2×+e𝕙 ×+𝕀d/eℍ rotational gravitation. Just as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia refer to the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse in conventional physics, the 2×-𝕆d/e𝕐 ×e𝕪 rotational kinetics and 2×-𝕀d/e𝕍 ×e𝕧 rotational inertia refer to the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work.

Separating and combining work and impulse

In this model the Pythagorean Triangles do not correspond with the dimensional analysis of conventional physics. That is, they use fewer factors than the equations in conventional physics. They can be converted as shown by separated and combining integrals and derivatives.

10.4 Conservation of Energy

One of the most powerful statements in physics is the **law of conservation of energy:**

> **Law of conservation of energy** The total energy $E_{sys} = E_{mech} + E_{th}$ of an isolated system is a constant. The kinetic, potential, and thermal energy within the system can be transformed into each other, but their sum cannot change. Further, the mechanical energy $E_{mech} = K + U$ is conserved if the system is both isolated and nondissipative.

The key is that energy is conserved for an **isolated system,** a system that does not exchange energy with its environment either because it has no interactions with the environment or because those interactions do no work. **FIGURE 10.15** shows our basic energy model for an isolated system.

Central Pythagorean Triangles as light and gravitational change

In this model an isolated system would include the central Pythagorean Triangles, these are the e𝕪 and -𝕘d Pythagorean Triangle and the +𝕘d and e𝕓 Pythagorean Triangle. The e𝕪 and -𝕘d Pythagorean Triangle gives the photon with its e𝕐/-𝕘d light impulse or its -𝔾D×e𝕪 light work. This has added to it the virtual e𝕒 and +𝕘d Pythagorean Triangle which gives increments from the +𝕠d and e𝕒 Pythagorean Triangle.

Photon emission

The proton does +𝕆D×e𝕒 potential work or has a E𝔸/+𝕠d potential impulse, when e𝕪×-𝕘d photons are emitted from an electron this can drop it to a lower quantized orbital. This means the +𝕠d and e𝕒 Pythagorean Triangle has a decrease in the e𝕒 altitude or potential electric charge, the electron is closer to the proton. This causes the +𝕠d potential magnetic field is increase inversely to e𝕒 decreasing.

Virtual photons and photons are inverses

When the e𝕪×-𝕘d photon emitted is quantized then this is a change with the +𝕆D×e𝕒 potential work and the -𝕆D×e𝕪 kinetic work, the difference being the -𝔾D×e𝕪 light work of the photon. The change also includes an +𝕘d×e𝕒 virtual photon which is summed to the e𝕪×-𝕘d photon. This is because +𝕘d is from the positive square root of -1 like with +𝕠d, in this model it cannot be directly observed with a E𝔸/+𝕠d potential impulse as a moment on a timescale. With the +𝕆D×e𝕒 potential work it cannot be measured as a change in a +𝕆D potential probability.

Virtual photons cannot be observed or measured

Because of this it cannot be observed or measured, but the change in the E𝕐/-𝕠d kinetic impulse or -𝕆D×e𝕪 kinetic work of the electron depends on the inverse change in the E𝔸/+𝕠d potential impulse and +𝕆D×e𝕒 potential work of the proton. When a e𝕪×-𝕘d photon is emitted then the +𝕘d×e𝕒 virtual photon also has a change in its angle θ opposite the spin Pythagorean Triangle side +𝕘d.

Conserving the angle θ

This means the +𝕠d and e𝕒 Pythagorean Triangle has increased its +𝕠d potential magnetic field by an increment represented by the +𝕘d×e𝕒 virtual photon. Because this is not directly observable as a +𝕘d×E𝔸 virtual light impulse, or +𝔾D×e𝕒 virtual light work, it conserves the angles θ of the Pythagorean Triangles. So with an emission of the e𝕪 and -𝕘d Pythagorean Triangle as a photon the electron has its e𝕪 kinetic electric charge increased and its -𝕠d kinetic magnetic field decreased. The e𝕪×-𝕘d photon has an angle θ of this change.

Virtual light work

The +𝕠d and e𝕒 Pythagorean Triangle also has an angle θ change, it increases because +𝕠d dilates and e𝕒 contracts inversely to the electron. This potential change is the +𝕘d×e𝕒 virtual photon in this model. If the emission of the e𝕪×-𝕘d photon is a wave then the electron changes its -𝕆D×e𝕪 kinetic work in emitting -𝔾D×e𝕪 light work, the proton changes its +𝕆D×e𝕒 potential work in virtually absorbing +𝔾D×e𝕒 virtual light work.

Virtual light impulse

If the electron emits a e𝕪/-𝕘d photon as a derivative then this comes from a collision, for example in Compton scattering. This is a derivative slope of the e𝕪 and -𝕘d Pythagorean Triangle, the E𝕐/-𝕠d kinetic impulse of the electron has a kinetic change with the emission of the e𝕐/-𝕘d light impulse. The electron would increase in e𝕪/-𝕠d kinetic velocity, proportional to an increase in velocity as e𝕧/-𝕚d. This causes a reaction in the proton with a E𝔸/+𝕠d potential impulse, the +𝕘d×E𝔸 virtual light impulse is this virtual photon.

Quantum tunneling

If the e𝕪×-𝕘d photons are reflected from the box walls then it can approximate an isolated system, some photons would tunnel through the box as a wave with their -𝔾D×e𝕪 light work. This is because as waves they have a -𝔾D light probability of where the photon is. That changes as a square according to the e𝕧 length of the box width. It is an exponential decrease because a square -𝔾D decreases while e𝕪 increases linearly. With a constant Pythagorean Triangle area that gives an exponential decay curve.

Gravitational waves and Gravis

The isolated box would also produce gravitational waves, in this model they are the +𝕘d×e𝕓 Pythagorean Triangles. Here e𝕓 is used as the depth of the gravitational well, it is the inverse of e𝕙 height. Depending on whether this comes from +𝔾D×e𝕙 Gravi work or the e𝔹/+𝕘d Gravi impulse they would act as a wave or particle.

Iners

There is a virtual e𝕧 and -𝕘d Pythagorean Triangle in this model called an Iner, like the e𝕒 and +𝕘d Pythagorean Triangle it is virtual and cannot be observed or measured. It is subtracted from the Gravi as the +𝕘d and e𝕓 Pythagorean Triangle, just as the e𝕒 and +𝕘d Pythagorean Triangle is summed to the e𝕪 and -𝕘d Pythagorean Triangle.

Gravitational change

So with a gravitational change in the e𝕓 depth or e𝕙 height of an iota, such as two neutron stars orbiting each other, there can be +𝔾D×e𝕙 Gravi work and a e𝔹/+𝕘d Gravi impulse emitted. This causes the inertia of the neutron stars to increase as their velocity is faster when they are closer together. Subtracted from the +𝕘d and e𝕓 Pythagorean Triangle then is the e𝕧 and -𝕘d Pythagorean Triangle, the emission of the Gravi waves or particles leads to a loss of probability as work or particles as impulse from the neutron stars.

Inertial change

That causes an increase in the -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse of the neutron stars, that also cannot be directly measured or observed. The change is in Iners as the e𝕧 and -𝕘d Pythagorean Triangles, this can be E𝕍/-𝕘d as the virtual inertia impulse or -𝔾D×e𝕧 as the virtual inertial work. Using these conserves the changes in the angles θ with Biv space-time, the same as the virtual photon +𝕘d×e𝕒 does in Roy electromagnetism.

Absorption and collision

When the e𝕪×-𝕘d photon and +𝕘d×e𝕓 Gravi reach another atom the process is reversed, the photon can be absorbed with -𝔾D×e𝕪 light work or collide with a e𝕐/-𝕘d light impulse. This inversely causes a potential change with the +𝕘d×e𝕒 virtual photon with +𝔾D×e𝕒 virtual light work or a +𝕘d×E𝔸 virtual light impulse.

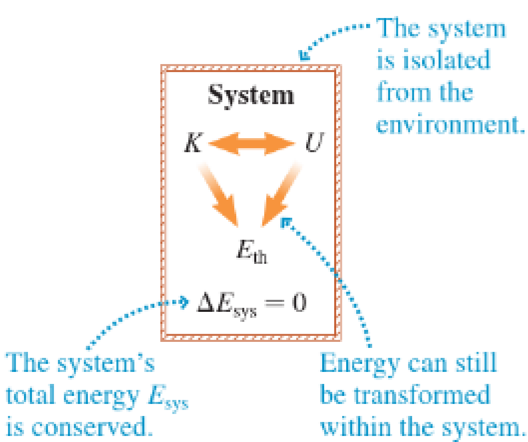
Gravitational work and waves

The Gravi can move another atom with +𝔾D×e𝕙 Gravi work, this may be how gravitational waves are detected. On a scale of e𝕓 as the depth of a gravitational well, the wave causes an oscillation which is measured. The e𝔹/+𝕘d Gravi impulse can also collide with an atom, this causes an acceleration of the e𝕓 depth on a scale of +𝕘d as time.

Gravitational impulse and particles

The receiving atom has an inverse change with its Iners, the absorption of the +𝔾D×e𝕙 Gravi work causes a reaction against this with -𝔾D×e𝕧 virtual Iner work. The collision with the e𝔹/+𝕘d Gravi impulse also causes a reduction in the E𝕍/-𝕘d virtual inertia impulse as a reaction. It may be these are observed as particles because energy is typically used in conventional physics. Waves by their nature cannot be observed, the changes would be a gravitational or Gravi probability.

FIGURE 10.15 The basic energy model for an isolated system.



The potential

In this model the potential refers to the +𝕠d and e𝕒 Pythagorean Triangle, there can be +𝕆D×e𝕒 potential work and the E𝔸/+𝕠d potential impulse. Using the work potential is similar to in conventional physics in that it refers to the nucleus. Here the +𝕚d and e𝕙 Pythagorean Triangle as gravity is proportional to the proton and its +𝕠d and e𝕒 Pythagorean Triangle. In that sense there can be a potential gravitational energy from the Eℍ/+𝕚d gravitational impulse, that is proportional to the E𝔸/+𝕠d potential impulse.

Measuring a field as an integral

The potential is not stored in fields with this model, the +𝕆D×e𝕒 potential work is the measurement of a field or potential integral by squaring its field area. That gives the +𝕆D potential probability, in quantum mechanics a probability comes from a square. Here because the potential is not directly observable or measurable, as in conventional physics, this can be represented in Schrodinger's equation as K-V. That is the kinetic energy minus the potential energy, in this model the signs are reversed to give -K+V from -𝕠d as the kinetic magnetic field and +𝕠d as the potential magnetic field.

A field is measured on a scale of position

For a force to be exerted in a distance or range this requires a scale of a straight Pythagorean Triangle side. With the -𝕚d and e𝕧 Pythagorean Triangle this scale would be a e𝕧 length, it refers to a position on a scale defining where that position is. An example would be a marking on a ruler as a position.

Displacement and impulse

The displacement can refer to the start of the ruler and the final point or end, in this model this must include a force. That is because the start of the ruler comes first in a moment in time as -𝕚d, then the final point is reached as another moment in time -𝕚d.

A moment on a scale of time

Because the displacement requires a moment in time on a scale, this model refers to that as where a particle is at that time. With a field the scale is the position on the ruler as e𝕧, the time is not a moment but is measured as a -𝕀D inertial probability.

Inertial fields

The inertial fields between planets for example would refer to the inertia of a satellite between them. In this model the inertial fields and their -𝕀D×e𝕧 inertial work are not directly measurable, they are subtracted from the gravitational fields and their +𝕀D×e𝕙 gravitational work. The -𝕀D inertial probability is the probability of where the satellite probably is because of its -𝕚d inertial mass, e𝕧/-𝕚d velocity, the +𝕚d gravitational masses of the planets, and the e𝕙 height the satellite is above each planet.

A field at a given position

In this model then a field must be at a position using a scale of a straight Pythagorean Triangle side. It is not a field between two positions, that would mean it becomes a line or displacement. A particle moves along a line from a starting to a final position, a field is an area not a line. With General Relativity a gravitational field has a strength at various e𝕙 heights above a planet.

No common time

These heights, as points on a e𝕙 straight Pythagorean Triangle side, are not connected deterministically with each other as that would be the motion of a particle. Because of this motion is relative, there is no simultaneity of a common time between two points e𝕙. The +𝕀D gravitational probability is not deterministic, so different people can be measuring a different time at different eℍ heights. This means time is not conserved in a velocity e𝕧/-𝕚d through a gravitational field, someone on the surface of a planet would continue to age more slowly than someone in orbit. That is because time is not acting as a scale like with the Eℍ/+𝕚d gravitational impulse.

Simultaneous moments

A simultaneity refers to a moment in time as a +𝕚d instant or fluxion, instead there is a temporal displacement from a starting time to a final time. This includes an acceleration which can have a proper distant between them as an invariant, in relativity this is usually called s.

An invariant timescale

The Eℍ/+𝕚d gravitational impulse remains deterministic because the gravitational acceleration as Eℍ/+𝕚d in meters^2/second, this can be changed in the opposite direction of time by moving particles in reverse. In this model +𝕚d is moving backwards in time and -𝕚d is moving forwards, this is proportional to in quantum mechanics where the +𝕠d positron moves backwards in time and the -𝕠d electron moves forwards in time.

General Relativity and a rubber mat

There is no gravitational probability in impulse and so there is no relativity between particles colliding in a geodesic, the time between them remains invariant like with s or eℍ as the distance in the +𝕀D×eℍ gravitational work. For example, General Relativity and a geodesic are sometimes illustrated with a rubber mat. A ball at one point deforms the mat downwards, another ball rolling into the depression changes its e𝕧/-𝕚d velocity from this.

Particles rolling in a depression

Because the deformation is composed of particles, the trajectory of the rolling ball is deterministic with impulse. The time +𝕚d between various observations of the ball is invariant because it can be reversed with no change in the trajectory.

The rubber mat and waves

If the rubber mat is reversed to make a hill, then covered with a pool of water, this can illustrate the wave nature of General Relativity and photons. Water waves from one end are directed at the shallower water of the hill, when the waves reach this they are slowed down. The same happens when ocean waves cross a sand bar, the slowing can cause the tops of the waves to keep moving and break. This slowing causes them to curve around the depression like e𝕪×-𝕘d photons around a +𝕚d gravitational mass.

Increasing torque with a decreasing wavelength

The waves move with -𝕀D×e𝕧 inertial work and the hill slows this inertia, that acts like the +𝕀D×eℍ gravitational work adding to the -𝕀D inertial probability and canceling some of it. As the waves are slowed above the hill they get closer together, that represents a decrease in the e𝕧 wavelength between them. This increases the -𝕀D inertial torque of the wave, people experience this at the beach where waves slow and break with a rolling force.

A change of wave velocity

When the waves are moving away from the hill they are speeding up, in this model light is also slowed around a gravitational mass.

Electric charge as a scale

A kinetic electric charge can act as a scale from e𝕪, with -𝕆D×e𝕪 kinetic work there is a kinetic magnetic force in an atom. This kinetic field gives the probability of where the electron is. There is also a potential field with the proton, the scale of the e𝕒 straight Pythagorean Triangle side gives the +𝕆D×e𝕒 potential work. This the potential probability of where the proton is.

Constructive and destructive interference

The proton and electron then have their relative positions on the e𝕒 and e𝕪 scales according to the sum of these probabilities. They interfere destructively, there can also be a constructive interference with +𝕆D between protons and another constructive interference between electrons. This can happen in molecules where the constructive and destructive interference result in an attraction or repulsion.

Where Is Potential Energy?

Kinetic energy is the energy of a moving object. The basic energy model says that kinetic energy can be transformed into potential energy without loss, but where *is* the potential energy? If energy is real, not just an accounting fiction, what is it that has potential energy?

Potential energy is stored in *fields*. We've not yet introduced fields in this textbook, although we'll have a lot to say about electric and magnetic fields in later chapters. Even so, you've no doubt heard of magnetic fields and gravitational fields. Our modern understanding of the fundamental forces of nature, the long-range forces such as gravitational and electric forces, is that they are mediated by fields. How do two masses exert forces on each other through empty space? Or two electric charges? Through their fields!

When two masses move apart, the gravitational field changes to a new configuration that can store more energy. Thus the phrase "kinetic energy is transformed into gravitational potential energy" really means that the energy of a moving object is transformed into the energy of the gravitational field. At a later time, the field's energy can be transformed back into kinetic energy. The same holds true for the energy of charges and electric fields, a topic we'll take up in Part VII.

What about elastic potential energy? Remember that all solids, including springs, are held together by molecular bonds. Although quantum physics is needed for a complete understanding of bonds, they are essentially electric forces between neighboring atoms. When a solid is placed under tension, a vast number of molecular bonds stretch just a little and more energy is stored in their electric fields. What we call elastic potential energy at the macroscopic level is really energy stored in the electric fields of molecular bonds.

Energy of position as a wave

In this model an energy of position would be a wave, it has a probability from doing work instead of an energy. The gravitational potential energy would be from the +𝕀D×e𝕙 gravitational work, the elastic potential energy would here be the +𝕆D×e𝕒 potential work.

Free fall

When a particle is observed this is impulse, with gravity that would be the Eℍ/+𝕚d gravitational impulse. Free fall refers to no other forces than the Eℍ height force, this is from the displacement of the starting e𝕙 height to a final height. This is not observed on a e𝕙 height scale as a distance, but when the observation occurs in a +𝕚d gravitational moment on a timescale.

Weightlessness

A falling person might experience weightlessness, this is from the +𝕀D×e𝕙 gravitational work. The position of the person on a e𝕙 height scale is measuring the +𝕀D gravitational weight or probability. The person is more likely to fall with a squared value, this gives an acceleration. The weightlessness comes from the -𝕀D inertial probability, the person experiences no feeling of inertia like they would in an accelerating car. This is because the -𝕀D inertial probability and the +𝕀D gravitational probability are inverses of each other at any e𝕙 height. With neither a gravitational weight, nor an inertial weight, the person feels weightless.

Total work

In this model the line would be on a scale of a e𝕧 length or a e𝕙 height giving positions on it. The total work would be K+U, in Biv space-time this would be K as the -𝕀D×e𝕧 inertial work, and U as the +𝕀D×e𝕙 gravitational work proportional to a potential. In terms of Roy electromagnetism this would use K as the -𝕆D×e𝕪 kinetic work and U as the +𝕆D×e𝕒 potential work. In each case the signs are reversed in this model, the potential and gravity are both positive, the kinetic and inertial are both negative.

Work is not conserved

Because the forces here are of probability the work is not exactly conserved. If this is observed with vectors as the Eℍ/+𝕚d gravitational impulse as U, and the E𝕍/-𝕚d inertial impulse as K in Biv space-time, then the forces are deterministic and are covered. Also, if they are K as the E𝕐/-𝕠d kinetic impulse and U as the E𝔸/+𝕠d potential impulse they are conserved.

Infinitesimals and fluxions

With classical physics the difference is small, then it is assumed that there can be an observation in time and a measurement in distance simultaneously and at the same position. This is also implied by calculus using infinitesimals of distance such as e𝕙, and fluxions of time from Newton such as +𝕚d here. It was later found that infinitely small values did not accurately describe inside atoms, there are minimum values of each. In this model that separates work and impulse, work cannot happen in the same positions and impulse cannot happen at the same time.

The gravitational constant

The gravitational potential energy U here is mgy, in this model that would be m as +𝕀D, the gravitational probability that an object will fall increases as the height e𝕙 or here y decreases. That is measured as an attraction to a planet by the falling objects. The g factor refers to the amount of +𝕚d gravitational mass in the planet according to its size, it is related to the G gravitational constant.

Magnetism and gravity

In this model that also happens when magnets attract each other, the -𝕆D kinetic probability interferes constructively. That makes it more likely the magnets will move closer together with a squared probability, this square creates an inverse square force.

10.5 Energy Diagrams

Potential energy is an energy of position. The gravitational potential energy depends on the height of an object, and the elastic potential energy depends on a spring's displacement. Other potential energies you will meet in the future will depend in some way on position. Functions of position are easy to represent as graphs. A graph showing a system's potential energy and total energy as a function of position is called an **energy diagram.** Energy diagrams allow you to visualize motion based on energy considerations.

FIGURE 10.17 is the energy diagram of a particle in free fall. The gravitational potential energy $U_G = mgy$ is graphed as a line through the origin with slope mg. The *potential-energy curve* is labeled PE. The line labeled TE is the *total energy line*, $E = K + U_G$. It is horizontal because mechanical energy is conserved, meaning that the object's mechanical energy E has the same value at every position.

No net forces in free fall

The energy changes here would be work in this model. They have y as the e𝕙 height with +𝕀D×e𝕙 gravitational work, the particle falls with -𝕀D×e𝕧 inertial work so the sum of the forces is +𝕀D as the gravitational probability and -𝕀D as the inertial probability. Both are squares, with weightlessness as the -𝕀D inertial mass force decreases the +𝕀D gravitational mass force increases. This means the particles experiences no net force other than the squared probability.

Forces as a past

Because a spin Pythagorean Triangle side is a displacement or change when squared, this gives a history. To be observed or measured an iota must have this past history, in this model that is why we experience a past. The present is where this observation of an impulse or measurement of work occurs. The future is a mixture of deterministic impulse and probabilistic work, because these forces have not occurred there is no history of observe of measure.

Probability as a history

Probability is also a history, this means that over a longer scale of positions on straight Pythagorean Triangle sides these give a net force. They are a sum of constructive and destructive interferences with other squared spin Pythagorean Triangle sides, they add up as in a Fourier transform to give a single probability for each Pythagorean Triangle.

Heisenberg's uncertainty principle

Heisenberg's uncertainty principle is also explained in conventional physics in terms of constructive and destructive interference. This is shown with Fourier Analysis, different waves interfere constructively and destructively, such as in a piano note. These give the harmonics and timbre of the sound, in this model they would be the sums of the probabilities of sound waves with their compression and expansion of air molecules.

The unpredictability principle

In the uncertainty principle an iota, the name given here to a particle wave duality, cannot have a fixed position such as e𝕧 because the probabilities -𝕀D interfere constructively and destructively. They give many possible positions on a scale of a straight Pythagorean Triangle side. With observing impulse this model has the unpredictability principle, when E𝕍 or another straight Pythagorean Triangle side is squared this gives a displacement history. If the time of an observation is observed too precisely then the E𝕍 value dilates as a force. Uncertainty then is a combination of probability and predictability in this model.

Observations in the double slit experiment

This is seen in the double slit experiment, defining which slit a e𝕪×-𝕘d photon went through is trying to observe the e𝕧 position of the photon. That would give the E𝕍 history of its displacement, from where it originated to where it was in one slit. This would be on a -𝕘d timescale with the photon, the E𝕐 kinetic electric force of the photon would be observed as proportional to the E𝕍 displacement history.

No interference in observations

This would be observing the e𝕐/-𝕘d light impulse of the photon, this has no probability because both sides of the Pythagorean Triangle cannot be observed and measured in the same time and position. The observation is then deterministic, with no constructive and destructive interference the interference pattern on the screen disappears. This happens even if the photon came from a distant galaxy because then its displacement history would still have been observed.

A change of history needs a force

The sum of histories also ensures the probabilities do not change for no reason or without a force, for example a head on a coin is observed in a coin toss about half the time. This would not veer off to a different proportion on the same coin unless a force changed, such as the coin becoming worn on one side.

Positive and negative time changes

In this model the -𝕠d and e𝕪 Pythagorean Triangle as the electron, and the -𝕚d and e𝕧 Pythagorean Triangle which is proportional to it as inertia, move forward in time. The use of ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy then is to change our observations of the future, for example in burning fuel to drive a car to a future destination. The +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity, they are positive and so they go backwards in time. We cannot then use gravity to power a car, the timeline only goes backwards not to the future.

A forward history

When the spin Pythagorean Triangle sides are squared they give a time change, from an initial value to a measured value. This spans a history moving forwards, with -𝕆D×e𝕪 kinetic work this gives a -𝕆D kinetic probability of what the car will do in burning fuel. The -𝕀D×e𝕧 inertial work also gives a -𝕀D inertial probability of where the car will go, if a collision is unavoidable then the car will move to this future with that -𝕀D inertial probability.

A backward history

With the final positions of the car the -𝕆D kinetic probabilities would be measured. The inverse of those are from the +𝕠d and e𝕒 Pythagorean Triangles as the protons, that is because the electrons are bound in the atoms. Taking this +𝕆D potential probability from that point it gives a history of a time change, the initial point is in that future and the final point is in the present when the car left.

The past and future are consistent with each other.

These two are inverses of each other, it means that the probabilities going forwards in time match the probabilities going backwards in time. This is how probabilities and history is measured in real life, the events from the present to a future position match the events from that future position to the present. Flipping a coin will give a -𝕆D kinetic probability of what the results are over many throws. These will match the sum of histories of a path integral to give a consistent past.

Gravity backwards in time

With the +𝕚d and e𝕙 Pythagorean Triangle there is +𝕀D×e𝕙 gravitational work, this is an active force going backwards in time from the measured present. Some iotas might be measured back to the CMB for example, with e𝕪×-𝕘d photons this is referred to in conventional physics as backwards in time like a temporal displacement.

The distant past has larger gravitational masses

The +𝕆D×e𝕒 potential work would also be measured by this CMB back in time, the protons would appear dissociated with their positive quarks as +𝕠d, d=2/3, going back to this limit and the negative quarks -𝕠d, d=1/3, going forwards in time.

Light moves forward in time

Light is proportional to changes in time going forward, as the -𝕠d and e𝕪 Pythagorean Triangle electron changes its angle θ it emits or absorbs a photon. When the electron drops an orbital this emission of a photon moves forward in time. When the electron absorbs a photon then that photon was also moving forwards in time, this is because the -𝕘d rotational frequency of a photon is negative like the electron and inertia.

Light comes only from past events

For example with an event the electron absorbs a photon, then that e𝕪×-𝕘d photon was traveling forwards in time from a past. That may have been billions of years ago from the CMB. This is how the CMB is measured, the photons travel forward in time to the present.

Light particles on a forward moving timescale

When the photon acts as a particle with impulse, that moves forward in time deterministically because the -𝕘d rotational frequency acts as a moment on a scale. This can then collide without probability with an electron in Compton scattering, that changes its -𝕘d frequency just as a collision between electrons can change their velocities. Because the photon's -𝕘d rotational frequency and e𝕪 or e𝕧 wavelength is the difference between -𝕠d and e𝕪 Pythagorean Triangle electrons, this does not change its velocity only the angle θ with the ratio of this frequency and wavelength.

Inertia from a past event

Inertia is proportional to the electrons as -𝕠d and e𝕪 Pythagorean Triangles, it reacts against changes from e𝕪×-𝕘d photons. When a photon bounces off an electron this is deterministic from a past event, but in this model inertia cannot be directly observed or measured by itself. Instead it is subtracted from gravity which moves backwards in time.

Past acceleration gives the inertia

When inertia is measured as -𝕀D×e𝕧 inertial work then it gives a -𝕀D inertial probability of an event in the past that was measured now. The inertia of a car now is dependent on its past actions such as in accelerating. This can only be different if the car accelerated differently in the past.

Gravity and inertia are inverses

Because gravity works opposite to inertia, to balance this +𝕀D×e𝕙 gravitational work is a displacement from the present to the past event. This is the same as -𝕆D×e𝕪 kinetic work creating a future measurement, then the +𝕆D×e𝕒 potential work of the proton is the inverse from that future event to the present one. The two must be inverses with gravity and inertia as well.

Symmetrical time changes

A rocket might go past a planet's gravitational well in a hyperbolic trajectory, it moves forward in a time change or temporal displacement by burning fuel. From a future measurement of -𝕀D×e𝕧 inertial work past the planet the time can be reversed to show a backward in time history. That is where gravity was increasing its +𝕀D×e𝕙 gravitational work on the rocket when it was closer to the planet. It would then seem like the rocket was falling into the gravitational well, with a symmetrical hyperbolic trajectory this would be the same forward or backwards in history.

A time change is not a time line

A temporal displacement or time change is not a timeline, it does not mean the rocket went back in time. It means when there is a measurement from the present to a past position that there will be +𝕀D×e𝕙 gravitational work. While gravity is an active force it cannot be observed and measured like light, which moves forward in time. Gravity when measures indicates we have a position in the present because it is consistent with a past gravitational event.

Gravity waves are the difference between the present and the past

Gravity waves in this model are a time change towards the past, when -𝕀D×e𝕧 inertial work is smaller than +𝕀D×e𝕙 gravitational work then masses get closer together such as with two neutron stars about to collide. As e𝕙 decreases then +𝕀D as the gravitational probability dilates, the change is quantized and this emits gravitational waves as +𝔾D×e𝕙 Gravi work. Conversely if two masses move further apart, like planets moving outwards in a solar system, then gravitational waves are absorbed.

Measuring inertial waves

In this model gravitational waves are not measured directly because they move backwards in time, instead changes in inertial waves are. An apparatus for this measures the change in e𝕧 length of -𝕀D×e𝕧 inertial work over a long distance. The gravitational waves would be causing a motion of the atoms in between two ends, using an interferometer. The -𝕀D×e𝕧 inertial work is being measured not the gravitational waves, the inertial measurements are where electrons are moving faster closer to a nucleus when these gravitational waves are emitted. This is the same as with neutron stars moving closer together.

Light measures the change in inertia

When the electrons rebound they move to a greater e𝕙 height, the gravitational waves can be absorbed because the -𝕀D gravitational probability has contracted. This cannot be measured directly by the -𝕀D×e𝕧 inertial work because it is only a reaction force, instead a laser interferometer measures the -𝔾D×e𝕪 light work moving forward in time between these events.

Gravity cannot change the future

In this model then gravitational waves cannot be measured directly because of this backward displacement in time. Instead, the -𝕀D×e𝕧 inertial work changes are measured actively with -

𝔾D×e𝕪 light work from a laser. To change the future then e𝕪×-𝕘d photons can be used, there cannot in this model be artificial gravity moving forwards in time.

Inertia and gravity are inverses

The result is consistent because the -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work are inverses of each other, an increase in inertia only happens with a decrease in gravity. This is seen with an elliptical orbit of a rocket around an airless planet. With a higher e𝕙 height the +𝕀D×e𝕙 gravitational work contracts, +𝕚d decreases as a square while e𝕙 increases linearly. Conversely the -𝕀D×e𝕧 inertial work has increased, +𝕀D dilates as a square while e𝕧 contracts linearly.

Reversing history

The rocket then moves slower at a greater e𝕙 height because e𝕧/-𝕚d has e𝕧 contracted, conversely it moves faster at a lower e𝕙 height. This can be reversed in time as a history looking forwards with inertia and backwards with gravity. In the past the rocket might be seen as having measured stronger gravity, in the present at the apogee of the elliptical orbit its inertia has increased with moving forward in time. Conversely if that present is taken as a measurement of +𝕀D×e𝕙 gravitational work then moving backwards a previous value of +𝕀D×e𝕙 gravitational work is measured.

Gravity is like kinetic energy with time reversed

The two act as inverses the same as reversing a movie. When a movie is played backwards then gravity appears as a force moving upwards, inertia reacts against this change. It would then be like -𝕆D×e𝕪 kinetic work being done by a rocket in moving upwards. Gravitational waves would appear to be emitted from a measurement apparatus then travel to the neutron stars moving them further apart.

Approaching a normal curve

With many -𝕆D kinetic and -𝕀D inertial probabilities they interfere constructively and destructively to give a forward history, these remain consistent even when events are widely separated in distance. This sum is why probabilities remain on a normal curve even when widely separated with work, throwing a coin will approach ½ heads and ½ tails because the squared probability gives the history.

Probability is not on a timeline

The displacement or change begins with the first throw, with an inertial probability -$𝕀D_i$ that occurs with the position e𝕧 on a scale where the coin lands. Any initial and final measurement of probability must be consistent as a time change, this is even when for examples coin tosses are separated by intervals of weeks. They are still summed as constructive and destructive interference, it is the same as when e𝕪×-𝕘d photons form an interference pattern even when emitted at long time intervals. This is because probability is not on a timeline, but from an initial time to a final time. If it was on a timeline then it would be deterministic, and so could not give the same answer as a normal curve.

Constructive and destructive interference

The forces of probability add up with constructive and destructive interferences from the way the coin rises with air resistance, then falls to hit the table. The normal forces or +𝕆D×e𝕒 potential work causes the coin to bounce off a surface, the -𝕆D×e𝕪 kinetic work from the coin toss and the

+𝕀D×eℍ gravitational work from falling all sum with more constructive and destructive interferences as probabilities. Overall the coin must have a squared probability.

The Rieman hypothesis for random numbers

When the coin tosses are heads as +1 and tails as -1 these sum towards 0 as the number of tosses N approaches ∞. It was shown by Hardy and Littlewood that the sum for N random numbers grows no faster than $\mathcal{O}N^{1/2+\epsilon}$ where $\mathcal{O}$ is a sufficiently large but finite number, ϵ is a small number not 0. This is the Riemann hypothesis for random numbers using the Mobius conjecture. Because these are random then the spin Pythagorean Triangle sides squared refer to this as probabilities. The author proposed a proof for numbers 1 to N, it showed that the integers in ascending order are equivalent in probabilities to N random numbers.

Probabilities attract and repel

The coin tosses then deviate by a square root value when summed, when squared these are the constructive and destructive interferences from the work probabilities. They also act as forces because an iota is attracted to where it is more probably measured, it is repelled to where it is less probably measured.

Sum over histories

Path integrals are referred to as sums of histories, these are all the possible paths on a scale e𝕧 the iotas could have taken. This can be illustrated with e𝕪×-𝕘d photons and a double slit experiment, Feynman proposed that photons could be regarded as taking many different paths by adding more and more slits. The various light probability histories would then constructively and destructively interfere to give the actual position e𝕧 on a screen the photon was measured at.

Interference patterns

This screen would show the sum of the constructive and destructive interferences as lighter and darker areas respectively. The brighter a e𝕧 position on a scale the more constructive interference there was. Because -𝕘d as the rotational frequency is acting as a history -𝔾D, not a time moment, the histories can add up even when the e𝕪×-𝕘d photons are sent through these slits at widely separated times.

Probability sum when separated

The sum of histories as a path integral is also why probability adds up even when widely separated in time, lotto for example retains an overall probability when it is drawn once a week. A person can have probabilities of their using slot machines that connect when they have long breaks of time between them. A history of events is not the same as a moment on a timeline, looking at a history the individual moments are not measured except as a part of the whole.

Height and length as squared histories

With the Eℍ/+𝕚d gravitational impulse in the diagram below, the particle is observed to have its Eℍ height reducing as a square. The E𝕍 length of its trajectory is increasing with the same rate so these give no net force on the particle, that is observed as free fall.

History of displacement

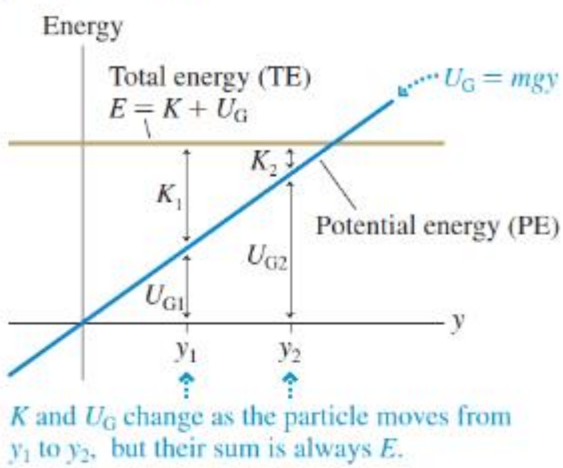
The Eℍ and E𝕍 values refer to the histories of the particle on a +𝕚d gravitational time and a -𝕚d inertial time. The particle might start very high above an airless planet and fall straight downwards.

Its E𝕍 length displacement is then from its initial position e𝕧$_{I}$ at a time -𝕚d$_{o}$ to an observed position e𝕧$_{o}$ at a time -𝕚d$_{o}$. Because this trajectory is observed it is a squared force, E𝕍 then is increasing from its initial position as a square with its E𝕍/-𝕚d inertial impulse in meters^{2}/second. Here then E𝕍 is not the position at a given time, it is the displacement from the initial to the observed position as a square.

All parts of a rocket in free fall

The e𝕙 height starts from the initial position e𝕙$_{I}$ to the observed height e𝕙$_{o}$, this also is the displacement of the history of the trajectory on a timescale, which now is +𝕚d as gravitational time. This gives Eℍ as the squared height force, because this decreases at the same rate as E𝕍 increases the particle is observed to be in free fall. If this was a rocket then every particle in it would also be in free fall, so the occupants could not observe any particle with a different upwards or downwards force.

FIGURE 10.17 The energy diagram of a particle in free fall.



Roy electromagnetism or Biv spacetime

This shows a movie of free fall, the timeline can move forwards with a Eℍ/+𝕚d gravitational impulse as U, that is proportional to the proton's E𝔸/+𝕠d potential impulse. It could then also be an electron moving as a particle in an atom. Then K would be the E𝕐/-𝕠d kinetic impulse, in Biv space-time below K would be the E𝕍/-𝕚d inertial impulse. If the movie is run backwards then the +𝕚d time advances, the particle would still rise and fall.

Gravity becoming kinetic

That would have the Eℍ/+𝕚d gravitational impulse acting like a E𝕐/-𝕠d kinetic impulse, the problem is that the E𝕍/-𝕚d inertial impulse would have to return the particle to the ground. This does not work with the real world, in this model that is because Biv space-time is in circular geometry. The active force acts to draw matter to its center, when this is reversed it is still in circular geometry.

Kinetic becoming gravity

In Roy electromagnetism the active force is the E𝕐/-𝕠d kinetic impulse, that is in hyperbolic geometry. Because of this the active E𝕐/-𝕠d kinetic impulse can cause a particle to move upwards in a way that matches real life. When hyperbolic geometry is reversed it also looks unnatural, an electron might increase its E𝕐/-𝕠d kinetic impulse by colliding with a e𝕪/-𝕘d photon. This causes it to move outwards, if the movie is reversed then it seems to be attracted by the potential which is a reaction force only. This is seen in conventional physics, the positive charge is referred to as a passive potential rather than causing changes to occur.

A reversed movie seems unreal

Reversing a movie then seem to make the potential and the E𝔸/+𝕠d potential impulse look like the Eℍ/+𝕚d gravitational impulse, it also makes the electron with its active E𝕐/-𝕠d kinetic impulse fall backwards as if it was only reacting. Reversing a movie is how particles are supposed to change in conventional physics, it is apparent in real life that this is not accurate.

Gravity becomes inertia

When time is reversed in this model gravity appears to be a reactive force only, the E𝕍/-𝕚d inertial impulse of a falling ball seems to accelerate it upward. Then the Eℍ/+𝕚d gravitational impulse is only reacting against this like inertia.

Making active forces reactive and vice versa

In this model that happens from switching the +𝕠d potential magnetic field to a -𝕠d kinetic magnetic field and vice versa, also switching the +𝕚d gravitational field to a -𝕚d inertial field or vice versa. That would explain the appearance of the time reversal, the +𝕚d gravitational field here is the positive square root of +1. The negative square root of +1 is -𝕚d, that can only be observed and measured by subtracting it first from +𝕚d. Then the result is observed as impulse or measured as work.

A reaction force cannot be observed and measured directly

When this is reversed then -𝕚d becomes the active force and +𝕚d the reaction force. In Roy electromagnetism +𝕠d becomes the active force pulling downwards like gravity, -𝕠d becomes the reaction force like inertia. This happens in this model by switching which spin Pythagorean Triangle side cannot be observed or measured without summing to the other first.

The Pythagorean equation model

It also comes from the form of the overall Pythagorean equation that is used in this model. In conventional math it is $(+𝕆D-𝕆D)^2 + (2\times-𝔾D\times+𝔾D)^2 = (+𝕀D-𝕀D)^2$. This uses the spin Pythagorean Triangle sides as square roots, when they are squared such as $+𝕠d^2$ this is +𝕆D and so on. For values of D then they become integers, the equation can be for example $(2-1)^2+(2\times2\times1)^2=(2+1)^2$ or $3^2+4^2=5^2$. When -𝕀D is used here it becomes positive because this is how it can be measured, when it is the square root of +1 it is negative as -𝕚d. Then it must be subtracted first from +𝕚d.

Subtracting the central Pythagorean Triangles

This can also be written as $(+𝕀D-𝕀D)^2 -(2\times-𝔾D\times+𝔾D)^2=(+𝕆D-𝕆D)^2$. Biv space-time when -𝔾D from -𝔾D×e𝕧 virtual Iner work, times +𝔾D from +𝔾D×e𝕙 Gravi work is subtracted leaves Roy electromagnetism.

Using the straight Pythagorean Triangle sides

The changes in the Pythagorean Triangles are conserved this way, instead of using the spin Pythagorean Triangle sides squared their inverses as the straight Pythagorean Triangle sides squared can be used. In this model that is a classical approximation because the straight Pythagorean Triangle sides add as vectors, without plus and minus signs. This shows that they are also conserved in the overall Pythagorean equation, but the dot product should be used. Adding these vectors with the dot product will give the inverses of how times changes in collisions with impulse.

The dot product comes from the Pythagorean equation

Using the dot product gives the same answers with vectors because that is also constructed from trigonometry using the Pythagorean equation. This would become (E𝔸-E𝕐)^2+(2×E𝕐×Eℍ)^2=(Eℍ-E𝕍)^2. Here again E𝕍 acts as the inverse of the negative square root of a positive number, so when squared it acts like a positive number in the dot product. This can also be written as Eℍ-E𝕍)^2-(2×Eℍ×E𝕍)^2=(E𝔸-E𝕐)^2.

LaGrangian and Hamiltonian

The left-hand side of the Pythagorean equation in this model represents a LaGrangian where the kinetic energy K is subtracted from U as the potential energy. The right-hand side represents the Hamiltonian where the two are added together as K+U. These are both used in conventional physics. In this model the LaGrangian approach is used as a convention for Biv space-time as well, the Hamiltonian could also be used with Roy electromagnetism. It is used in Schrodinger's equation with electrons for example.

The Pythagorean Equation is relativistic

With a clockwork universe then this Pythagorean equation would give the impulse changes with collisions with both Roy electromagnetism and Biv space-time. It is also relativistic and would give a e𝕧 length or e𝕙 height contraction, the angles θ are conserved in the +𝕠d and e𝕒 Pythagorean Triangle, the -𝕠d and e𝕪 Pythagorean Triangle, the e𝕪 and -𝕘d Pythagorean Triangle, the +𝕘d and e𝕙 Pythagorean Triangle, the +𝕚d and e𝕙 Pythagorean Triangle, and the -𝕚d and e𝕧 Pythagorean Triangle. This is because the Pythagorean Triangle areas are conserved, when one Pythagorean Triangle side increases the other must decrease inversely.

Work and impulse

The Pythagorean equation squaring the spin Pythagorean Triangle sides is proportional to work changes, this also works if the signs are reversed to represent time reversed or antimatter. When the straight Pythagorean Triangle sides are squared with the dot product, and used in the Pythagorean Equation, then these represents impulse with time reversed or antimatter.

Reversing the Pythagorean equation

If the timeline is reversed then the terms are rearranged, in each set of brackets the first term becomes the second and vice versa. The central Pythagorean Triangles remain the same, one is made positive and the other made negative. With (2×-𝔾D×+𝔾D)^2 this is the difference between the -𝕠d and e𝕪 Pythagorean Triangles and +𝕠d and e𝕒 Pythagorean Triangles changing their angles θ.

The central Pythagorean Triangles are the changes

The sign then goes with the Pythagorean Triangles, when in Roy electromagnetism these are multiplied to give a negative, then squared outside the brackets to give a positive then summed. When these are from the -𝔾D×e𝕧 virtual Iner work and the +𝔾D×e𝕙 Gravi work they multiply together as -𝕘d×+𝕘d to give +1 because +𝕚d and -𝕚d are the square roots of +1. Then when they are squared they also give a positive value, that is subtracted above from Biv space-time to give Roy electromagnetism.

Anti-photons and anti-Gravis

When the signs are reversed then the e𝕪 and -𝕘d Pythagorean Triangle as the photon would become the e𝕪 and +𝕘d Pythagorean Triangle as a virtual anti-photon. This acts like the e𝕒 and +𝕘d Pythagorean Triangle because each Pythagorean Triangle is reversed in its function. That would give positive values as anti-photons, they would work like virtual photons in this model. The +𝕘d×e𝕙 Gravi has +𝕘d which would become negative, this would make virtual anti-Gravis or anti-gravitational waves that move forward in time and be actively measured.

CPT symmetry

The overall appearance should be like a movie played backwards in all ways, in conventional physics this is called CPT symmetry or Charge, Parity, and Time symmetry. Changing the signs gives a time reversal here, the charges also reverse where the proton becomes negative with -𝕠d as the antiproton. The electron becomes positive as the positron.

Where is the antimatter

In this model this is the answer for why there is matter and not antimatter, when the time is reversed the whole universe acts like antimatter. Then there would only be a few particles appearing as matter, a neutron would decay to give an antiproton with a positron. An antiproton could join with an electron to give a neutron.

Parity

Parity is where left and right switch as in a mirror, the directions of the straight Pythagorean Triangle sides as vectors reverse in the dot product. This makes them consistent with the Pythagorean equations $(+\mathbb{O}D-\mathbb{O}D)^2+(2\times-\mathbb{G}D\times+\mathbb{G}D)^2=(+\mathbb{I}D-\mathbb{I}D)^2$ and $(E\mathbb{A}-E\mathbb{Y})^2+(2\times E\mathbb{Y}\times E\mathbb{H})^2=(E\mathbb{H}-E\mathbb{V})^2$. If they did not flip over, then the two equations would not be inverses. For example a movie might show a bus moving to the right, when reversed the movie shows the bus going backwards to the left.

Anti-gravity

With each sign reversed then the Eℍ/+𝕚d gravitational impulse becomes the Eℍ/-𝕚d anti-gravitational impulse, that is reactive like the E𝔸/+𝕠d potential impulse because the -𝕚d square root of +1 cannot be observed and measured directly. This is like the -𝕠d square root of -1. The E𝔸/+𝕠d potential impulse would become the E𝔸/-𝕠d anti-potential impulse which would be an active force like gravity.

Anti-inertia

The E𝕍/-𝕚d inertial impulse becomes an active force so a rocket appears to move upwards actively with this, that would be an E𝕍/+𝕚d anti-inertial impulse.

Possible propulsion

This is how UFOs if real are able to move. They can hover as if anti-gravity acts like inertia. Their fast acceleration is like their inertia is removed, when a movie of a falling ball is reversed it appears to accelerate upwards in an anti-freefall. This motion would not cause the occupants of a rocket to feel the acceleration just as in freefall. Weightless would become anti-weightlessness, their weight would not increase with time reversed. If so then this hypothetical propulsion system would require large amounts of antimatter shielded from being exposed to the matter around it.

Antimatter and its prevalence

This also describes how antimatter would work in this model, including the subatomic particles created in particle accelerators. Antimatter would then be based on time reversal, this would explain according to this model why it is not commonly observed or measured. By reversing time all matter becomes antimatter, the universe is composed of it and is moving towards the appearance of a big crunch instead of a big bang.

Positrons as antimatter

The more common exceptions to the rarity of antimatter are where positrons are emitted from a proton becoming a neutron, in this model that represents a time reversal. This is also in conventional Quantum Field Theory.

Photon becoming an electron and positron

Also photons may become an electron and positron near a +𝕚d gravitational mass, in this model that is because the e𝕪×-𝕘d photon has -𝕘d as the difference between orbitals in an atom. It also has +𝕘d from the +𝕘d×e𝕒 virtual photon. This can also describe the difference between the +𝕠d value of d in a positron and the -𝕠d value of d in an electron. When this becomes measured near a mass the difference becomes -𝕆D×e𝕪 kinetic work and positronic +𝕆D×e𝕪 kinetic work.

A photon leads to a virtual photon reaction

The electron in an orbital acts as a wave with a -𝕆D kinetic probability, a e𝕪𝕘d photon may cause a reaction near a +𝕚d gravitational mass of a +𝕘d×e𝕒 virtual photon with an opposing spin. When these are measured as -𝕆D×e𝕪 kinetic work and positronic +𝕆D×e𝕪 kinetic work there would be opposing torques that are separated, the e𝕪𝕘d photon and +𝕘d×e𝕒 virtual photon are already separated.

Annihilating the gravitational and inertial mass

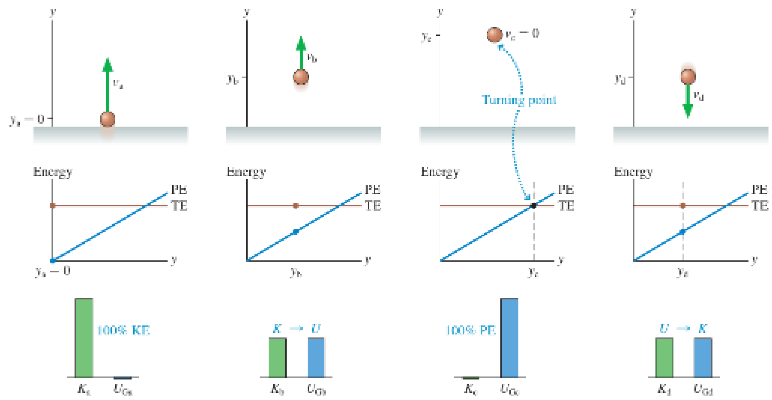
If they then came together and annihilated each other's mass then that would cause e𝕪×-𝕘d photons to be emitted, the +𝕘d×e𝕒 virtual photons would not be observed or measured. The electron would have had a -𝕚d inertial mass and the positron a +𝕚d gravitational mass. This could happen because of the quantization near a mass, the -𝕆D kinetic probability and the +𝕆D positronic kinetic probability become separated making them move apart as iota and anti-iota. If not separated enough the probabilities cancel in destructive interference, the difference between them is emitted as photons.

Reversing gravitational and inertial mass

The E𝕐/-𝕠d kinetic impulse would become a E𝕐/+𝕠d anti-kinetic impulse as a reaction force, perhaps like a positron. The positron has a +𝕚d gravitational mass rather than a -𝕚d inertial mass in this model. That would be hard to observe or measure as a test of this model, if the antiproton has a

-𝕀d inertial mass instead of a +𝕀d gravitational mass then the roles might be reversed with the same appearance. An inertial mass is attracted to a planet in the same way a gravitational mass is, in this model a proton is composed of 2×+𝕠d, d=2/3 and 1×-𝕠d, d=1/3 as quarks. This would be a combination of gravitational and inertial mass.

FIGURE 10.18 A four-frame movie of a particle in free fall.



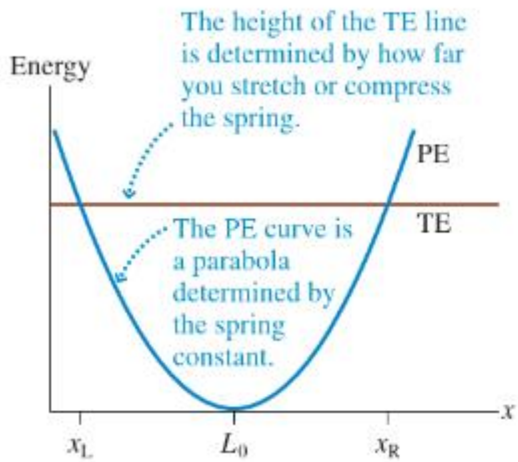
Springs and the Pythagorean Equation

A spring also changes with the overall Pythagorean Equation, the potential energy here would be the +𝕆D×e𝕒 potential work and E𝔸/+𝕠d potential impulse from the molecular bonds in the spring. These molecular bonds would be twisted with a -𝕆D kinetic torque from -𝕆D×e𝕪 kinetic work, in the Pythagorean Equation that would be proportional to the -𝕀D inertial torque from -𝕀D×e𝕧 inertial work reacting against this change.

Probability and torque

The +𝕆D potential torque can also be described as a potential probability, its force is directed towards what is the most probable outcome. A tossed coin for example can be described as having inertial forces, that causes the -𝕀D inertial probability to approach equal numbers of heads and tails. It can also be described as the most probable outcome forcing this to occur, probability in this model acts and reacts as forces which makes events occur approaching a normal curve distribution. The -𝕀D inertial torque would be tending to flip the coin in either direction, torque would then be acting as a probability.

FIGURE 10.19 The energy diagram of a mass on a horizontal spring.



Biv spacetime

An energy diagram here can be Roy electromagnetism or proportionally Biv space-time. Each fits into the Pythagorean Equation. When a particle moves by rolling down the hill in the energy diagram the Eℍ/+𝕚d gravitational impulse can actively pull it downwards, the E𝕍/-𝕚d inertial impulse reacts against this. That increases the e𝕙/+𝕚d kinetic velocity or brevity downwards, from inertia this is also velocity as e𝕧/-𝕚d.

Roy electromagnetism

With Roy electromagnetism this can be described by the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy of a particle, its E𝕐/-𝕠d kinetic impulse reduces as it goes downwards proportional to the reduced E𝕍/-𝕚d inertial impulse. The potential energy here increases as the E𝔸/+𝕠d potential impulse proportional to the Eℍ/+𝕚d gravitational impulse.

A work diagram with waves

Roy electromagnetism is stronger in the micro world, that makes it more wavelike with -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work. This is proportionally -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work. In these diagrams when vectors are used this refers to impulse, here instead the position on a straight Pythagorean Triangle side scale is used such as the e𝕙 height. The path of the particle appears here more like a wave than as a series of impulse vectors.

The path as an integral area

The change in the iota or particle's motion would then be represented by an integral as work, the area under the particle's path would be +𝕀D as the gravitational probability minus -𝕀D as the inertial probability. No vectors are then needed to represent work, the slope of the path can represent the Eℍ/+𝕚d gravitational impulse and the E𝕍/-𝕚d inertial impulse when this is broken down into small vectors with calculus.

Hypotenuses of the Pythagorean Triangles

In this model the segments of the path would not be vectors with impulse, they would be the hypotenuses of the +𝕚d and e𝕙 Pythagorean Triangles and -𝕚d and e𝕧 Pythagorean Triangle where the areas inside give the work. Because the hypotenuse is not used in this model, except as a classical approximation, the areas in the integral represent waves. They are not bounded by a line as a hypotenuse because that would be a vector with impulse.

Derivatives are not hypotenuses

Also, with a derivative slope of these Pythagorean Triangles, they are defined by the Pythagorean Triangle sides not the hypotenuse. There would be rectangles under these Pythagorean Triangles, in conventional calculus the area is broken up into rectangles under the Pythagorean Triangles with an infinitesimal width. These act like the constant C used in integration. They change the probabilities of where the iotas as waves are to a different position such as the e𝕙 height.

The area as torque or probability

Here the e𝕙 height would be an unsquared Pythagorean Triangles side acting as a position. The width of the rectangles would be +𝕀D as a gravitational torque or probability, this would be rotating the path of the particle according to the torque strength. It also gives the most probable path of the particle.

Gravity is weaker than electromagnetism

While not an infinitesimal this squared +𝕀D value is small because the +𝕚d and e𝕙 Pythagorean Triangle is much smaller than the +𝕠d and e𝕒 Pythagorean Triangle. This gives a weaker gravitational force than with electromagnetism, it can extend much further with a e𝕙 height out to the CMB. When the -𝕀D inertial torque is stronger then the path curves upwards, this is because -𝕀D has a larger D value at those positions than +𝕀D has. When the iota is moving along a curved terrain this -𝕀D inertial torque would also come proportionally from the +𝕆D potential torque as the normal force.

Roy electromagnetism and a capacitor

With Roy electromagnetism this diagram could also be a positively charged particle with a path between two plates of a capacitor. A negative plate under it does -𝕆D×e𝕪 kinetic work as an active force like gravity, this pulls the particle downwards except this would be K as a kinetic energy. Upwards would be the potential energy as U, the signs would be reversed.

Path integrals

The same integrals would give the path, because this is work they would include path integrals where the possible paths of the particle constructively and destructively interfere. This would also happen in Biv space-time with gravity and inertia as the ball rolled down the hill, because of the larger distances in the macro world impulse is observed more than work is measured. Then the constructive and destructive interference also cancels out, these are the probable paths the particle might have taken.

Four probabilities

For example the ball might have left the ground at some positions if the +𝕆D potential probability as the normal force and the -𝕀D inertial probability were stronger than the +𝕀D gravitational probability. That would depend on the composition of the ground, some molecular bonds would have a springier normal force than others. It would also depend on the +𝕆D kinetic probability with how fast the ball was forced to move initially.

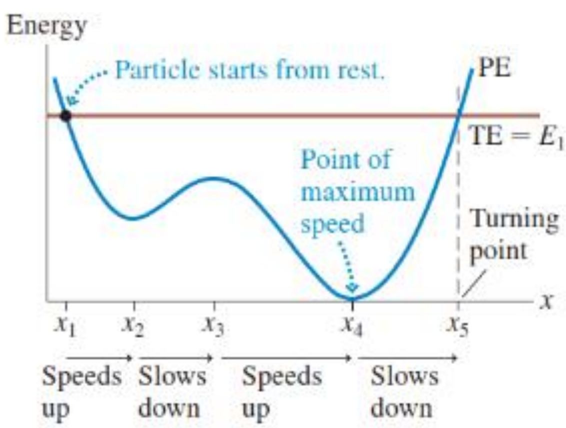
Fourier analysis

These paths can also be represented with Fourier analysis, they are summed like music harmonics for example. The possible paths with their -𝕆D kinetic probability versus +𝕆D potential probability, or +𝕀D gravitational probability versus -𝕀D inertial probability, interfere to create the measurement of the work. The ball might also move chaotically with an impulse when the Eℍ/+𝕚d gravitational impulse, the E𝕍/-𝕚d inertial impulse, the E𝔸/+𝕠d potential impulse, and the E𝕐/-𝕠d kinetic impulse would also be taken into account.

Kinetic and potential torque

The rectangles in the Roy electromagnetism integral would have a e𝕪 kinetic electric charge as a position on the scale instead of height, the width would be -𝕆D as the kinetic probability. This can also be regarded as a -𝕆D kinetic torque like the +𝕀D gravitational torque example, when this is stronger the positively charged particle moves towards the negatively charged plate. When the +𝕆D potential torque is stronger the particle reacts against this, moving towards the positively charged plate.

FIGURE 10.20 A more general energy diagram.



Horizontal slopes

Where the tangent to this curve is horizontal, in conventional calculus that would give a slope of 0 with a second derivative or a second integral. In this model it is not allowed for a Pythagorean Triangle to have a side of 0 or ∞, it could not then have a constant Pythagorean Triangle area. Instead these two Pythagorean Triangles remain separate, if their sum was 0 then the Pythagorean Equation itself would disappear on its left-hand side and right-hand side.

Zero is not used

This could not be observed or measured because there would be no squares. A second derivative gives impulse, a second integral gives work, if they had a Pythagorean Triangle side that was 0 instead of going to 0 this would not be allowed here.

Zero leads to undefined slopes and zero areas

Instead of being a straight Pythagorean Triangle infinitesimal or a spin Pythagorean Triangle side moment or fluxion, there would be problems in multiplying by 0 in an integral because all the integral values would be the same. Dividing by 0 would be undefined in a derivative. These Pythagorean Triangle side positions and moments comes from square roots because they are not denumerable or countable, as long as the d:e ratio remains constant there is no force and these cannot be observed or measured. But 0 itself is not used in this model.

Uncertainty and torque

Instead this is a classical approximation, the Pythagorean Triangles when they approach this are limited by the uncertainty or unpredictability principle. When the e𝕧 length of the -𝕚d and e𝕧 Pythagorean Triangle for example approaches a limit, this dilates the -𝕚d inertial mass. That increases the -𝕀D inertial probability, also the inertial torque which appears to make the particle move around more.

Conservation requires no zero

It avoids this zero because the Pythagorean Triangle would disappear, that cannot happen in this model because the Pythagorean Triangle areas are conserved. If one disappears, such as with an electron and positron annihilating each other, then the change must create other Pythagorean Triangles such as e𝕪×-𝕘d photons.

In conventional math +A-B=0, in this model these are difference because +A comes from +𝕠d or +𝕚d. These are not the same as -𝕠d and -𝕚d in -B so they cannot sum to zero, instead they can cancel each other probabilities or torque.

Zero is different in addition and subtraction

This does not destroy the electrons, also in conventional math A and B are not destroyed by this subtraction. They can be revived by adding or subtracting other values to the equation. Zero in this model then means the spins are opposed, such as clockwise and counterclockwise, or that they had opposite signs.

Calculus is different to arithmetic.

Because measurable values are being added and subtracted this is using squares, they are countable and denumerable while square roots are not. When square roots are multiplied and divided they are not the same in this model as when squares are multiplied and divided, because of this uncountable property. Then when divided they become a particle as a derivative slope, a derivative is not the same as a conventional division. This is why calculus is different to standard arithmetic. Also when multiplied an integral is not the same as conventional multiplication.

Arithmetic as left and right

In the macro world it is dominated by impulse, so the straight Pythagorean Triangle sides are squared to give a deterministic clockwork universe. Because it is deterministic then arithmetic is also predictable, there are no probabilities. The timeline of impulse is where the arithmetical operations are made, writing or processing an equation can be reversed in time to the starting moment. While positive and negative signs are used in arithmetic, in this model left on a line would represent minus and right positive.

Complex numbers

This is consistent with addition on a complex coordinate system in conventional math, the horizontal line would have positive going to the right and negative going to the left. The difference here is that neutralis would be in the center, it represents that the vectors going left and right sum to each other. The Obscure numbers as +𝕠d and -𝕠d, or the Intangible numbers +𝕚d and -𝕚d, go vertically as the y axis from neutralis. Using the Obscure numbers, these can be combined with straight Pythagorean Triangle sides as Obscure complex numbers and Intangible complex numbers.

No zero probability

When these are added and subtracted as their squares, they represent torque or probability. This can be on in circular geometry for +𝕠d and +𝕚d as circular geometry, in hyperbolic geometry for -𝕠d and -𝕚d. Both the circle and the hyperbola are conic sections. When added they give constructive interference, when subtracted they give destructive interference. Because they are probabilities zero is not compatible, there is no zero probability. Instead neutralis can be used as a balanced probability.

Unpredictability and impulse

Pythagorean Triangles react against zero by using a limit as in calculus. When the -𝕚d inertial mass approaches a limit, such as a small time like a fluxion in calculus, this is reacted against deterministically by a dilated e𝕧 and a stronger E𝕍/-𝕚d inertial impulse. The limit of c is where -𝕚d contracts to a minimum and e𝕧 to a maximum.

Limits as slopes and integrals

In calculus the problems from infinities and zero are avoided by using limits. In this model the limits come from the angles θ in Pythagorean Triangles, these cannot go to 0° or 90°. The limits are also constrained by the constant Pythagorean Triangle areas. In calculus a limit might be arbitrary, in conventional physics there are limits as part of reality such as the speed of light. The minimum size of the e𝕪 and -𝕘d Pythagorean Triangle is an integral area, this gives Planck's constant or h. Why these limits exist in physics will be proposed later with this model.

Limits of a calculus Pythagorean Triangle with photons and Gravis

For a path to change, as an observation or measurement in this model, there needs to be a change from the central Pythagorean Triangles. This can be a photon or Gravi being emitted or absorbed as work. It can also be a collision with a photon particle or a Gravi particle. This acts like an incremental change in a calculus Pythagorean Triangle, e𝕧 for example would be a position with -𝕀D×e𝕧 inertial work but here the change comes with -𝕀D not e𝕧 which is a point position only.

Increments and scales

With a fluxion this can be a moment of time with the E𝕍/-𝕚d inertial impulse, the change comes with E𝕍 as a force not an incremental change with that moment or fluxion. The infinitesimal and fluxion then can represent an increment in this model without actually changing themselves.

Calculus is static

Calculus generally refers to a static slope or integral, in this model that allows for the straight Pythagorean Triangle side infinitesimals and spin Pythagorean Triangle side moments or fluxions to be used. But when work is measured the infinitesimals are still on a scale, when impulse is observed the fluxions are still on a scale.

Calculus and Zeno

The problem with calculus is the same as with Zeno's arrow, a calculus Pythagorean Triangle appears to be unchanging but it needs to represent change. In this model that is done by squaring only one side at a time or position.

Proton and electron remain separate

When the +𝕀D×e𝕙 gravitational work has the -𝕀D×e𝕧 inertial work subtracted from it this does not become zero, that is because the -𝕠d and e𝕪 Pythagorean Triangle is the electron. Its -𝕀D×e𝕧 inertial work is separate from the +𝕠d and e𝕒 Pythagorean Triangle as the proton, that proportionally has +𝕀D×e𝕙 gravitational work.

Neutralis instead of zero

These two can combine in some circumstances to become a neutron, then they each disappear. This is not because +1 as the proton is added to -1 as the electron to become 0, instead they become neutral as the neutron. In this model then zero can be represented by the term neutralis from the Latin root, that represents that the positive and negative values still exist.

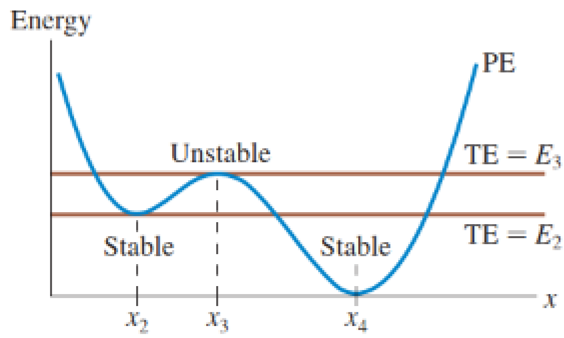
The neutron avoids annihilation

In this model the neutron is created when the proton has 2×+𝕠d, d=2/3, and -𝕠d, d=1/3 as three quarks. That has the -𝕠d, d=1, of the electron subtracted from it to give 1×+𝕠d, d=2/3 and 2×-𝕠d, d=1/3 to give the neutron as neutralis not zero. This avoids the annihilation of +1 and -1 as with the electron and positron for example. When the positron and electron annihilate each other this is still not zero because of conservation, the e𝕪×-𝕘d photons emitted represent the changes which occurred. This is like with +A-B=0, the photons represent the difference between A and B which still exists. With +2-2=0 then the difference remains as 4, this is conserved so that in any addition and subtraction using zero the changes made are still conserved as nonzero.

Nature avoids zero

In this model then nature avoids zero by conserving the change as photons. It also avoids zero by using fractions of 3 in combining the proton and electron to form the neutron. It avoids zero with a stationary arrow as being e𝕧/-𝕚d with d=0, instead the unpredictability principle causes impulse to occur at a limit. It avoids zero with e𝕧×-𝕚d with e=0 by a Pythagorean Triangle having a constant area. All of these are consequences of the Pythagorean Equation with this model.

FIGURE 10.21 Points of stable and unstable equilibrium.



A point is not an interval

In this model a small interaction force is over an infinitesimal position, with +𝕆D×e𝕒 potential work this would be e𝕒. There is not a starting and final position with e𝕒 in between, that could constitute an observation. Instead e𝕒 would be a point on a scale, it is a reference point according to how the force is observed.

A point is associated with an interval

That allows for the infinitesimal to be associated with an interval but to not be an interval itself. The two are a contradiction when there is a constant Pythagorean Triangle area, this is resolved by an angle θ change. The force changes this angle, that causes an +𝕘d×e𝕒 virtual photon to be emitted or absorbed.

Angle θ changes

The potential change is always positive here so as not to confuse +𝕠d and -𝕚d. It can refer to this as the angle θ dilating as +𝕆D increases, or the angle contracting with +𝕆D. It can also be used as +𝕠d increasing or decreasing. With straight Pythagorean Triangle sides they can also be vectors on the straight-line, then they point right for an increase and left for a decrease.

Separate quadrants

These are kept separate with this model, so e𝕪 on the right of neutralis can be added to other e𝕪 vectors pointing right or left to sum them. They can also use the -𝕠d axis as an Obscure complex number, this refers to a kinetic velocity e𝕪/-𝕠d or a field as e𝕪×-𝕠d. On the left there can be other Obscure complex numbers with a potential speed slope e𝕒/+𝕠d as a derivative, or e𝕒×+𝕠d as a slope.

A rolling ball in four quadrants

This can allow a diagram similar to the ball rolling down the curved slope above, the E𝕐/-𝕠d kinetic impulse can be a series of vectors as slopes when e𝕪 is squared, their ratios as derivatives give the kinetic velocity which is proportional to the e𝕧/-𝕚d velocity. Under this can be integrals as e𝕪×-𝕠d, this gives the -𝕆D×e𝕪 kinetic work when -𝕠d is squared. By keeping these two separate they can be combined later to give the total work as the +𝕆D×e𝕒 potential work minus the -𝕆D×e𝕪 kinetic work for example.

The Biv quadrants

Proportionally the rolling ball can use the Biv coordinate system, then its velocity can be a series of derivative slopes as e𝕧/-𝕚d and an E𝕍/-𝕚d inertial impulse. The Eℍ/+𝕚d gravitational impulse is another set of vectors in a separate quadrant, again under these vectors is the -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work respectively. The changes in these Pythagorean Triangles would be emitted and absorbed as -𝔾D×e𝕪 light work and +𝔾D×e𝕙 Gravi work, if impulse then they would be collisions with a e𝕐/-𝕘d light impulse and a e𝔹/+𝕘d Gravi impulse. Together in principle all interactions can be represented with these quadrants.

Photon and virtual photon quadrants

This can be extended to two more coordinate systems, e𝕪𝕘d photons would be on the upper right and +𝕘d×e𝕒 virtual photons would be on the lower left. As the ball moved then the changes in the angles θ would cause photons and virtual photons to be emitted and absorbed, or collide as particles. These quadrants could then show where the photons came from and where they ended or collided in changing course.

Gravi and Iner quadrants

With the Gravi this would be on the lower left as a series of slopes +𝕘d/e𝕓, in the upper right there would be the virtual -𝕘d/e𝕧 as reactive slopes to these changes. Under then can be integrals as +𝕘d×e𝕓 and -𝕘de𝕧.

10.6 Force and Potential Energy

As you've seen, we can find the energy of an interaction—potential energy—by calculating the work the interaction force does inside the system. Can we reverse this procedure? That is, if we know a system's potential energy, can we find the interaction force?

We defined the change in potential energy to be $\Delta U = -W_{int}$. Suppose that an object undergoes a *very small* displacement Δs, so small that the interaction force $\vec{F}$ is essentially constant. The work done by a constant force is $W = F_s \Delta s$, where F_s is the force component parallel to the displacement. During this small displacement, the system's potential energy changes by

$$\Delta U = -W_{int} = -F_s \Delta s \qquad (10.23)$$

Infinitesimals as positions, fluxions as moments

The limit in this model does not go to zero, instead there is a fixed area of the Pythagorean Triangles as well as a maximum and minimum angle θ. This still acts as an infinitesimal or a fluxion because it is a position or moment on a scale when not squared as a force. A position can be regarded as an infinitesimal because it is not a range or displacement, that is where the Pythagorean Triangle side ends or will end. A fluxion can be a moment because it is also not a duration, instead it is a point on a scale with no duration.

Points on a line

This relates to another of Zeno's paradoxes, how many points are on a line. In this model a point is on a scale, its value comes from where on a line it is. With a Pythagorean Triangle the point or position is at the end of the straight Pythagorean Triangle side. A point on a Pythagorean Triangle side might be used to indicate where the Pythagorean Triangle changed from or where it might change to. This is not an initial and final point in the sense of a duration of time or displacement of distance, that would mean there was a measurement or observation.

Moments on a timeline

With a moment there is the same paradox, if a moment has no duration, then how many moments are there in a minute. Again, the moment is a point on a scale with the spin Pythagorean Triangle side. With Zeno's paradox then a point on a line is using it as a scale, like a point on a ruler. The number of points on a line is talking about different things, the line is referred to as a displacement from a starting to a final position with a number of points on it.

Constraints from the force Pythagorean Triangle side

The number of points is constrained by the inverse of its Pythagorean Triangle and its constant area. A force would have a starting and final value, this might be quantized when it is -𝕆D for example and the points are e𝕪 as the kinetic electric charge on the scale. There could then be points on the e𝕪 scale but these could not be measured, the waves around an electron orbital would have destructive interference if those e𝕪 points were used.

Impulse cannot be quantized

If this is the E𝕐/-𝕠d kinetic impulse then the points are on a timeline -𝕠d as moments, they have no starting and final values because then they would be a work measurement. These would be limited also because they could not be in quantized values, otherwise an electron would be a wave and a particle in the same time and position.

From a beginning to an end

A line is a displacement on a straight Pythagorean Triangle side as a square, it has a starting and final position. A timeline has a time change or duration from an initial moment to a final moment, this is a square as a probability.

which we can rewrite as

$$F_s = -\frac{\Delta U}{\Delta s} \tag{10.24}$$

In the limit $\Delta s \rightarrow 0$, the force on the object is

$$F_s = \lim_{\Delta s \rightarrow 0}\left(-\frac{\Delta U}{\Delta s}\right) = -\frac{dU}{ds} \tag{10.25}$$

That is, the interaction force on an object is the *negative* of the derivative of the potential energy with respect to position.

Graphically, as **FIGURE 10.23** shows, force is the negative of the slope, at position s, of the potential-energy curve in an energy diagram:

$$F_s = -\frac{dU}{ds} = \text{the negative of the slope of the PE curve at } s \tag{10.26}$$

Derivatives and fluxions

In this model the slope shown is a calculus Pythagorean Triangle, a derivative slope only refers to impulse. This would not have an infinitesimal, the impulse slope such as the E𝕐/-𝕠d kinetic impulse would use a fluxion -𝕠d.

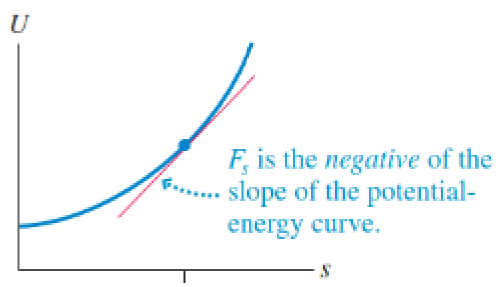
A curve as a wave

With work there is an infinitesimal change such as e𝕪 with -𝕆D×e𝕪 kinetic work. Here this is referred to as Δs. The area under the curve would be an integral, the curve is like a wave while the derivative slope at a point would act as a particle. The integral can be measured by breaking it up into Pythagorean Triangle areas with rectangles under them.

The points are not a displacement

The points on the integral line are on a scale, they sides of the rectangle under it are not observing from one point to the next. This would be a displacement, instead they are measuring from one -𝕠d to another as a duration or time change. This can be a definite integral from a starting to a final probability measurement, for example when a number of coin tosses begins and ends.

FIGURE 10.23 Relating force to the PE curve.



Potential as a positive

Here the potential energy is taken as a negative, this is also used in Schrodinger's equation as K-V where the potential is V. In this model the potential is positive like +𝕠d as the potential magnetic field, the kinetic energy is negative from -𝕠d as the kinetic magnetic field. This is shown as a parabola, that has a squared axis as the +𝕆D potential probability.

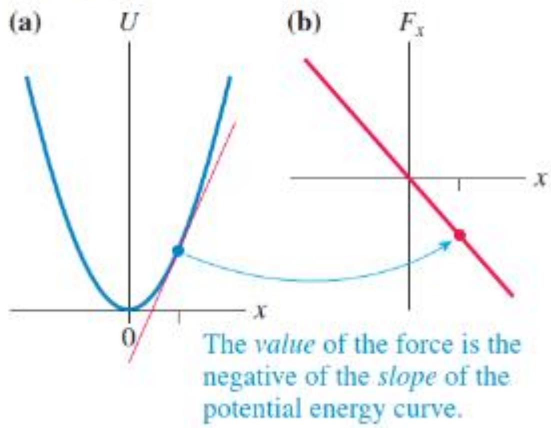
A parabola in between a circle and a hyperbola

The parabola is used here where the +𝕠d and e𝕒 Pythagorean Triangle with its molecular bonds is in circular geometry. Then there is the -𝕠d and e𝕪 Pythagorean Triangle with its compressing the spring, that is in hyperbolic geometry. Both of these are conic sections, when these are added in between there is a parabola.

A ball moves as a parabola

This also happens in Biv space-time, a ball thrown into the air goes up and down with +𝕀D×e𝕙 gravitational work. It can also move to the side with -𝕀D×e𝕧 inertial work, this is a constant velocity because the inertia is reactive only. The -𝕀D inertial probability changes according to the e𝕙 height of the ball, as it goes up the +𝕀D gravitational probability decreases inversely to it.

FIGURE 10.24 Elastic potential energy and force graphs.



Hooke's law

Here the change in the +𝕆D×e𝕒 potential work happens from the molecular bonds being stretched or compressed on a scale of positions as e𝕒. The force has a constant k as a square in Hooke's law. The positive and negative slopes are not used in this model, this is keep the concepts of positive and negative spin separate.

In practice, of course, we'll usually use either $F_x = -dU/dx$ or $F_y = -dU/dy$. Thus

- A positive slope corresponds to a negative force: to the left or downward.
- A negative slope corresponds to a positive force: to the right or upward.
- The steeper the slope, the larger the force.

As an example, consider the elastic potential energy $U_{Sp} = \frac{1}{2}kx^2$ for a horizontal spring with $x_{eq} = 0$ so that $\Delta x = x$. **FIGURE 10.24a** shows that the potential-energy curve is a parabola, with changing slope. If an object attached to the spring is at position x, the force on the object is

$$F_x = -\frac{dU_{Sp}}{dx} = -\frac{d}{dx}\left(\tfrac{1}{2}kx^2\right) = -kx$$

This is just Hooke's law for an ideal spring, with the minus sign indicating that Hooke's law is a restoring force. **FIGURE 10.24b** is a graph of force versus x. At each position x, the *value* of the force is equal to the negative of the *slope* of the PE curve.

Path integrals

When an iota or particle can move along one of several paths, this gives a path integral in this model. The curves to one side or another can be described as a torque, they can also be summed constructively and destructively as interference in Fourier analysis. The area under the path is the field, it represents the different probabilities of the particle for a given path.

Path integral of an electron

An electron for example might move along many possible paths from one e𝕪 position to another. This might be across a -𝕆D kinetic difference such as a negative voltage in a capacitor. The starting and final positions can be the same in terms of the scale of the e𝕪 kinetic electric charge, the -𝕆D kinetic probability is the wavelike nature of the electron in terms of the different probable paths taken.

The potential probability minus the kinetic probability

The potential energy would then refer to +𝕆D×e𝕒 potential work and the positive plate of the capacitor, the -𝕆D kinetic difference repels the electron because there is a lower kinetic probability the electron is measured there. It moves towards the positive plate with an increasing +𝕆D potential probability from its +𝕆D potential difference. It is then more likely to be found nearer the positive plate.

Path of least action

The path refers to an integral area under it, when this path is more wavelike then the iota or particle might move further away from a direct line of A to B. This affects the overall +𝕆D potential probability minus the -𝕆D kinetic probability. Without additional work being done externally it is less likely the electron will have a very curved wavelike path, this is because the integral area under it is conserved. The electron has a constant Pythagorean Triangle area and so this path is most probably one of least action from the conserved Pythagorean Triangle areas.

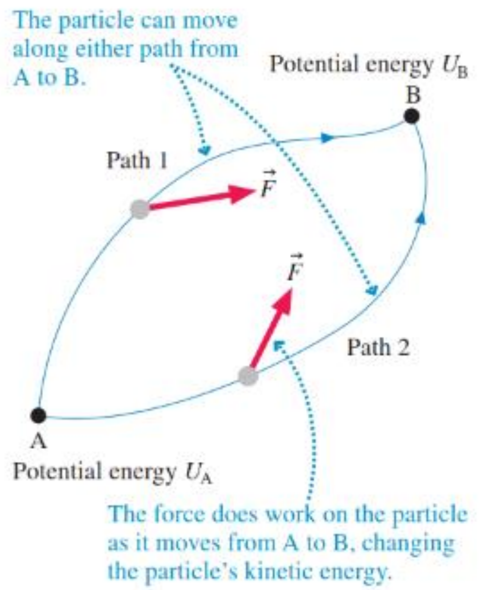
Path of least distance and time

This path would be of a least distance as the most probable outcome, this is because as the e𝕪 path contracts in size the -𝕆D kinetic probability increases. With impulse there is a path of least time which is conserved, without external forces the -𝕠d and e𝕪 Pythagorean Triangle here would have a E𝕐/-𝕠d kinetic impulse so that E𝕐 increases and -𝕠d contracts closer to the positive plate.

Least action and the constant Pythagorean Triangle area

This represents an increased kinetic acceleration, if there was not a least time conservation law here then it would accelerate more slowly. That would take it in a more curved wavelike path as work. The least time then is a consequence of the constant area of the -𝕠d and e𝕪 Pythagorean Triangle, for the time to increase as -𝕠d then E𝕐 must decrease as a square. It would need to lose some of its E𝕐/-𝕠d kinetic impulse such as by colliding with another electron or a photon.

FIGURE 10.26 A particle can move from A to B along either of two paths.



Initial to final position

Here a force from an initial to a final probability is the -𝕆D×e𝕪 kinetic work in this example. When e𝕪 is used this is a series of points, it is not a displacement in the sense that the electron is observed from a starting point to a final point, if so then it is a particle with impulse not a wave doing work. This happens in the double slit experiment for example, if the slit the electron goes through is observed then there is a starting and final position. That makes it a E𝕐/-𝕠d kinetic impulse and so there is no interference pattern.

A changing angle θ and photons

The angle θ of the -𝕠d and e𝕪 Pythagorean Triangle changes as it moves towards the positive plate, that causes it to emit e𝕪×-𝕘d photons because its path is like it was moving to a lower orbital in an atom.

Conserved inverse forces

The forces are conserved because the +𝕆D×e𝕒 potential work and the -𝕆D×e𝕪 kinetic work are inverses of each other, at points between the capacitor plates the +𝕆D-𝕆D values, or the potential difference minus the kinetic difference are approximately the same. Because these are probabilities they cannot be measured exactly because of the uncertainty principle, as the position is narrowed down then the spin Pythagorean Triangle side squared as the probability dilates.

Gravitational and inertial work

In Biv space-time the +𝕀D×e𝕙 gravitational work can refer to a e𝕙 height of a platform, a ball might fall down on different paths with -𝕀D×e𝕧 inertial work. The overall work done is the e𝕙 height with all the paths as with the electron. The most probable path is close to straight down, then the e𝕧 length downwards is the inverse of the e𝕙 height. This is like the e𝕪 kinetic electric charge in the capacitor being the inverse of the e𝕒 potential electric charge at any point between the plates. Because of this the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work together are also conserved forces. There is a lower +𝕀D gravitational probability for the ball to move more to the side, this is again because of the constant Pythagorean Triangle areas.

A force for which the work done on a particle as it moves from an initial to a final position is independent of the path followed is called a **conservative force.** The importance of conservative forces is that **a potential energy can be associated with any conservative force.** Specifically, the potential-energy difference between an initial position i and a final position f is

$$\Delta U = -W_c(i \rightarrow f) \tag{10.27}$$

where the notation $W_c(i \rightarrow f)$ is the work done by a conservative force as the particle moves along *any* path from i to f. Equation 10.27 is a general definition of the potential energy associated with a conservative force.

A force for which we can define a potential energy is called *conservative* because the mechanical energy $K + U$ is conserved for a system in which this is the only interaction. We've already shown that the gravitational force is a conservative force by showing that ΔU_G depends only on the vertical displacement, not on the path followed; hence mechanical energy is conserved when two masses interact gravitationally. Similarly, mechanical energy is conserved for a mass on a spring—an elastic interaction—if there are no other forces. Conservative forces do not contribute to any loss of mechanical energy.

Kinetic heat

Because of the uncertainty principle, measuring an exact return to a starting position has some increased torque and probability. This is random and so is like friction or thermal work, it is measured as -𝕆D×e𝕪 kinetic work because the +𝕆D×e𝕒 potential work cannot be measured except in being added to the -𝕆D×e𝕪 kinetic work. It would then be measured as heat for example.

Thrust and tension

Thrust is not conservative because both the -𝕆D×e𝕪 kinetic work done and the -𝕀D×e𝕧 inertial work are both negative. They do not cancel each other out and so the work done cannot reach the starting point again. Tension is also not conservative because a larger tension can result in a longer path as the rope stretches, this comes from a E𝕐/-𝕠d kinetic impulse in pulling on a rope and the E𝔸/+𝕠d potential impulse in reacting against this stretching. This acts like a spring where the change in displacement is from a E𝔸/+𝕠d potential impulse minus a E𝕐/-𝕠d kinetic impulse.

Nonconservative Forces

A characteristic of a conservative force is that **an object returning to its starting point will return with no loss of kinetic energy** because $\Delta U = 0$ if the initial and final points are the same. If a ball is tossed into the air, energy is transformed from kinetic into potential and back such that the ball's kinetic energy is unchanged when it returns to its initial height. The same is true for a puck sliding up and back down a frictionless slope.

But not all forces are conservative forces. If the slope has friction, then the puck returns with *less* kinetic energy. Part of its kinetic energy is transformed into gravitational potential energy as it slides up, but part is transformed into some other form of energy—thermal energy—that lacks the "potential" to be transformed back into kinetic energy. A force for which we cannot define a potential energy is called a **nonconservative force.** Friction and drag, which transform mechanical energy into thermal energy, are nonconservative forces, so there is no "friction potential energy."

Similarly, forces like tension and thrust are nonconservative. If you pull an object with a rope, the work done by tension is proportional to the distance traveled. More work is done along a longer path between two points than along a shorter path, so tension fails the "Work is independent of the path followed" test and does not have a potential energy.

External forces

In this model external forces come from external Pythagorean Triangles, dissipative forces change impulse into work. When there is conserved energy then this is like the clockwork universe, particles collide in a deterministic way. This can be written as the inverse with work, but that turns the particles into waves. Because there are probabilities the system is less deterministic, that creates a change with drag and heat. Some of this drag can also be chaotic such as with turbulence, that comes from impulse in this model.

FIGURE 10.27 shows a system of three objects that interact with each other and are acted on by external forces from the environment. These forces cause the system's kinetic energy K to change. By how much? Kinetic energy is energy of motion, and the kinetic energy would be the same if we had defined the system—as we did in Chapter 9— to consist of only the objects, not the interactions. Thus $\Delta K = W_{tot} = W_c + W_{nc}$, where in the second step we've divided the total work done by all forces into the work W_c done by conservative forces and the work W_{nc} done by nonconservative forces.

Now let's make a further distinction by dividing the nonconservative forces into *dissipative* forces and *external* forces. Dissipative forces, like friction and drag, transform mechanical energy into thermal energy.

To illustrate what we mean by an external force, suppose you pick up a box at rest on the floor and place it at rest on a table. The box + earth system gains gravitational potential energy, but $\Delta K = 0$ and $\Delta E_{th} = 0$. So where did the energy come from? Or consider pulling the box across the table with a string. The box gains kinetic energy and possibly thermal energy, but not by transforming potential energy. The force of your hand and the tension of the string are forces that "reach in" from the environment to change the system. Thus they are *external forces*. They are nonconservative forces, with no potential energy, but they change the system's mechanical energy rather than its thermal energy.

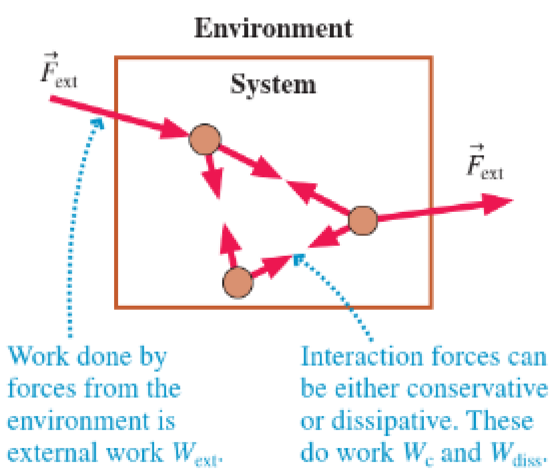
With this distinction, the system's change in kinetic energy is

$$\Delta K = W_{tot} = W_c + W_{nc} = W_c + W_{diss} + W_{ext} \qquad (10.28)$$

Internal interactions and external forces

The external -𝕆D×e𝕪 kinetic work here is active, the interactive forces here are +𝕆D×e𝕒 potential work in between molecular bonds. When a force can reach into a box this happens by waves, that would be from the +𝕚d gravitational field and +𝕀D×e𝕙 gravitational work.

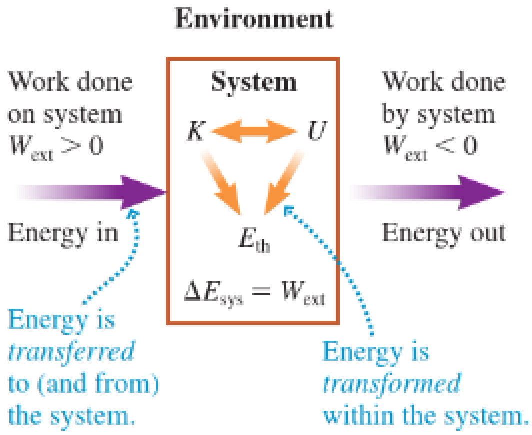
FIGURE 10.27 A system with both internal interactions and external forces.



Work over a distance

In this model the work is not referred to as energy, the change in work done occurs over a distance. No time is used in the diagram, the arrows are not meant to be vectors with impulse.

FIGURE 10.28 The basic energy model.



9 Impulse and Momentum

A position at a moment

In this model impulse works only with particles, because it comes from a second derivative it is an intersection between a straight Pythagorean Triangle sides as a position and a spin Pythagorean Triangle side as a time. This gives a particle with a position at a given moment. When the impulse, for example the E𝕍/-𝕚d inertial impulse, is observed this position is squared as a displacement force. That has a starting position and a final position, it is different from a single position in a single derivative.

Inverting derivatives

A first derivative such as ∂-𝕚d/∂e𝕧 with respect to e𝕧 is a particle but it is not observed or measured without a force. Here the velocity is inverted as -𝕚d/e𝕧 instead of e𝕧/-𝕚d, the velocity is the same. It conforms to the conventional derivative rules this way, ∂e𝕧 becomes E𝕍 but in the numerator it would become 1. This derivative is the slope of the E𝕍 and -𝕚d Pythagorean Triangle.

Integration from fields

Integration begins with a field, this is -𝕚d×e𝕧 here where there is no longer a particle at a position and at a moment in time. Instead, being multiplied gives a field or integral area. With integration this gives ∫-𝕚d×e𝕧 d -𝕚d holds e𝕧 as a constant, in this model partial derivatives and integrals are used because only one Pythagorean Triangle side can be observed or measured at a position or moment. The integral then becomes ½×-𝕀D×e𝕧, this is the area of the -𝕀D and e𝕧 Pythagorean Triangle.

Changing positions and moments

Before a collision a ball moves with a constant velocity e𝕧/-𝕚d, this represents a particle with a position defined by e and a moment in time defined by d. As long as the ratio of d:e remains constant there is no force, the particle has different positions and moments but these are not observable or measurable without a force.

Pilot waves

This does not mean the particle is there and not a field as -𝕚d×e𝕧, instead that assuming a derivative slope there is a particle at that position and moment which is not observable. The two coexist in the concept of a pilot wave, a particle as e𝕧/-𝕚d can be surrounded by a field -𝕚d×e𝕧. The particle is there in the sense that the derivative can be done, but it can only be observed with a second derivative such as the E𝕍/-𝕚d inertial impulse.

Not observable or measurable

In this model there is a Pythagorean Triangle there, for example the -𝕚d and e𝕧 Pythagorean Triangle. It can be regarded as a derivative and integral according to Bohm's pilot wave model. But it is not actually a particle in this model until it is observed with the second derivative as the E𝕍/-𝕚d inertial impulse. It is also not a wave until the -𝕀D×e𝕧 inertial work is measured.

A derivative or integral has no force

Changing the -𝕚d and e𝕧 Pythagorean Triangle into a derivative slope as a particle or a field as an integral does not use any force, because of this it represents the particle/wave duality of the Pythagorean Triangle not a particle with a pilot wave. This would imply that the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work could be observed and measured in the same position and moment. That would violate the uncertainty principle as hidden variables, in this model that is not needed.

Pythagorean Triangles must be conserved

The Pythagorean Triangles exist because in the general Pythagorean Equation with this model they must be conserved, a change in Roy electromagnetism leads to a change in Biv space-time and vice versa. They do not need to be observed or measured to exist, they do need to be at a position or moment so they can be to maintain this conservation as well as symmetry.

A change as a photon emission or absorption

In the collision the E𝕍/-𝕚d inertial impulse reacts against the slowing of the velocity, the e𝕧 position of the particle has changed to a displacement from an initial to a final position. The inertial time is on a clock gauge, this is not squared so it is not a duration of time from a starting to a final moment but is a single moment. Because there is a conflict between the squared and unsquared Pythagorean Triangle sides and the constant Pythagorean Triangle area, this is resolved by the emission or absorption of a e𝕪×-𝕘d photon.

A duration or a displacement

In the diagram the collision is given with a duration in time, as well as a displacement of the amount of compression of the ball. As a classical approximation using either of one of these makes no difference, a change in velocity can be expressed classically as a displacement or a duration. For example the deceleration of the ball can be the E𝕍/-𝕚d inertial impulse as meters^2/second or it can be converted to -𝕀D/e𝕧 as seconds^2/meter. The second term is not allowed in this model except as an approximation, it represents a field only as the -𝕀D×e𝕧 inertial work.

The uncertainty principle and impulse

In the macro world a displacement as E𝕍 and a duration as -𝕀D appear to happen in the same position and moment, in the micro world this is not allowed because of the uncertainty principle. If the two happened together then a position e𝕧 would have an observable or measurable moment -𝕚d associated with it. The uncertainty principle states that if a position of a particle is observed too closely as e𝕧 then the inertial probability -𝕀D dilates. This makes its position more uncertain at a given moment.

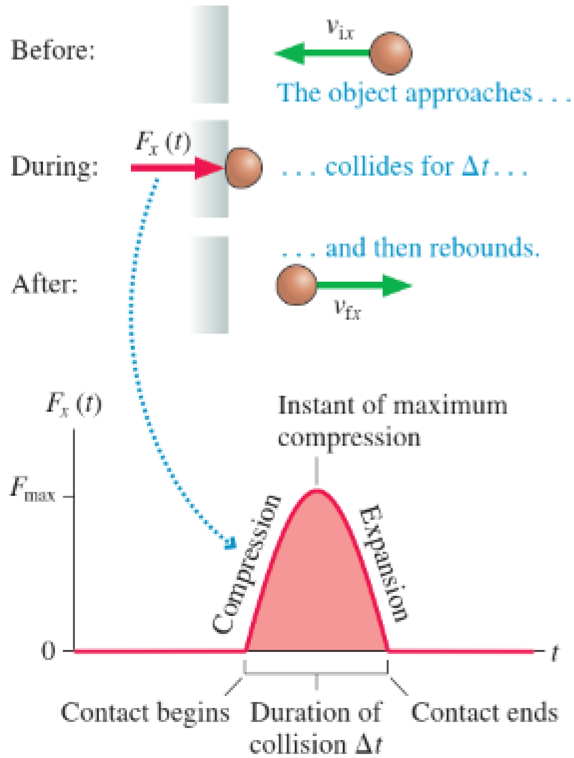
A displacement as a history

Because of this only one of the two Pythagorean Triangle sides can be observed or measured at a position or moment. In this model the compression of the ball would represent the E𝕍 displacement, it has a starting and a final diameter at maximum compression. Because this is a displacement the force represents the history of the impulse, from when the ball started being compressed until its final compression. This force is fixed from the past history of its displacement and cannot be altered like history itself.

A range is not two positions

This is then from a starting position on a scale to a final position but it is not those positions, instead it has no position itself but is instead a range between positions. Because of this is it compatible with the inertial time -𝕚d on a clock gauge. For example a centimeter on a ruler can be from positions on it as 2 and 3. The centimeter is not these positions, its could be from any consecutive integers or any other numbers separated by 1. It is like Zeno's points on a line, a point is a position but a line is a displacement between positions.

FIGURE 11.1 A collision.



History cannot be changed

In this model the large force is the straight Pythagorean Triangle side squared as a displacement, from an initial position to a final position. This force is fixed because it occurs in history, it is not observed or measured in the present as it changes. With E𝕐 then as the kinetic electric force this is from an initial electric charge e𝕪$_s$ to a final position e𝕪$_f$. It does not mean this force can be changed part way through, when it ends there is a clock gauge -𝕠d as the kinetic time. With the -𝕚d and e𝕧 Pythagorean Triangle there is also a displacement force E𝕍 from past history that cannot be changed, it is observed as -𝕚d inertial time on a clock gauge.

History from the present to the past

With the Eℍ/+𝕚d gravitational impulse there is also a displacement force from Eℍ$_s$ as a starting position to Eℍ$_f$ as a final position. This extends backwards in time as a history from the present to the past that is also fixed. With the proton there is the E𝔸/+𝕠d potential impulse that also has this E𝔸 potential displacement from the present to a past position. They then connect the past to the present by going backwards, this conserves the changes going forwards in time with E𝕐 and E𝕍. The two are connected just as a movie can be run backwards and forwards.

Adding impulses

As a classical approximation the E𝕐/-𝕠d kinetic impulse of a ball, and its E𝕍/-𝕚d inertial impulse as a reaction on hitting a racquet, can be described as many smaller impulses from their molecules. While each of these has a fixed history in this model, the ball's forces can be adjusted in the present by how hard it is hit by a racquet. These would be summed together with a vector addition of squared straight Pythagorean Triangle sides. With single Pythagorean Triangles and atomic particles, the distinction of a fixed history is more important.

Mass times acceleration

Here ma is mass times acceleration, in this model that can be from inertia as -𝕚d×E𝕍/-𝕚d. This inverts the acceleration as meters^2/second from the conventional meters/second^2, the two are classically equivalent. That is given as a derivative of the velocity v as e𝕧/-𝕚d, in conventional physics this would become ∂e𝕧/∂-𝕚d with respect to -𝕚d = e𝕧/-𝕀D in meters/second^2. In this model that would be an integral from work, the force -𝕀D is a square which is changing with a position e𝕧 on a scale.

Inverting velocity

That would be written as a field with the -𝕀D×e𝕧 inertial work, they are multiplied instead of divided. When the E𝕍/-𝕚d acceleration is used, from the E𝕍/-𝕚d inertial impulse, this gives ∂e𝕧/∂-𝕚d with respect to e𝕧 to give E𝕍/-𝕚d. In this model the numerator is being treated as a denominator, instead it can be inverted first to give ∂-𝕚d/∂e𝕧 with respect to e𝕧 = -𝕚d/E𝕍. The two are the same because seconds/meters^2 gives the same acceleration as meters^2/second for the same d and E.

Integral for position, derivative for time

In (11.2) this becomes an integral with respect to -𝕚d as time, in this model that would be the E𝕍/-𝕚d inertial impulse not the -𝕀D×e𝕧 inertial work which is with respect to e𝕧. The answers are then classically the same, this model keeps integrals for work and derivatives for impulse. That allows for an integral to be a field area, a derivative to be a slope as a position over a moment in time as a particle. Newton used fluxions to represent a time derivative, here they would be used for integrals only.

The force of a collision is usually very large in comparison to other forces exerted on the object. A large force exerted for a small interval of time is called an **impulsive force.** The graph of Figure 11.1 shows how a typical impulsive force behaves, rapidly growing to a maximum at the instant of maximum compression, then decreasing back to zero. The force is zero before contact begins and after contact ends. Because an impulsive force is a function of time, we will write it as $F_x(t)$.

> **NOTE** Both v_x and F_x are components of vectors and thus have *signs* indicating which way the vectors point.

We can use Newton's second law to find how the object's velocity changes as a result of the collision. Acceleration in one dimension is $a_x = dv_x/dt$, so the second law is

$$ma_x = m\frac{dv_x}{dt} = F_x(t)$$

After multiplying both sides by dt, we can write the second law as

$$m\,dv_x = F_x(t)\,dt \qquad (11.1)$$

The force is nonzero only during an interval of time from t_i to $t_f = t_i + \Delta t$, so let's integrate Equation 11.1 over this interval. The velocity changes from v_{ix} to v_{fx} during the collision; thus

$$m\int_{v_i}^{v_f} dv_x = mv_{fx} - mv_{ix} = \int_{t_i}^{t_f} F_x(t)\,dt \qquad (11.2)$$

Three orthogonal Pythagorean Triangles

In this model there can be three orthogonal Pythagorean Triangles, these are independent of each other because of the right angle 90°. A straight Pythagorean Triangle side force would not change another straight Pythagorean Triangle side at 90° to it. An +𝕚d and e𝕙 Pythagorean Triangle can for example by decomposed into three orthogonal Pythagorean Triangles, but in this model that represents a change and so there must be an observable or measurable force.

The proton and three generations

The proton could then have three orthogonal Pythagorean Triangles, but to change from one to another it requires a torque or spin. In this model that is proposed to give three generations or iotas or particles, additional work causes a torque to change to the orthogonal Pythagorean Triangle and then the next as the third.

Changing a reference frame

Changing a reference frame in this model than is a classical approximation, but it represents a force and so it changes the Pythagorean Triangles. This happens in Special Relativity, different observers do not have a common -𝕚d inertial time because moving an inertial reference frame from one to the other requires a force. That must change the -𝕚d and e𝕧 Pythagorean Triangle, with E𝕍 as a displacement from an initial to a final position in history that means the -𝕚d inertial time on a clock gauge also changes. When the differences in velocity e𝕧/-𝕚d between the observers is close to c this becomes an exponential change as γ.

Decomposing a vector

Here in (11.3) this can also be regarded as breaking up a vector into an x and y axis, in this model that can be done with the y axis being time or mass as -𝕚d for the -𝕚d and e𝕧 Pythagorean Triangle. The x axis would be a position on a scale of distance as e𝕧. The vector is not actually decomposed in this model because it is a hypotenuse ζ, that is rarely used. Instead the vector is defined by the Pythagorean Triangle sides -𝕚d as the inertial time and e𝕧 as position. When this Pythagorean Triangle is small the vector appears more as a particle in a e𝕧 position at a -𝕚d moment.

Impulse of the hypotenuse vector

Using a vector means that this would be the E𝕍/-𝕚d inertial impulse, that is because the vector is squared to change its size. Knowing the vector is there implies a force, when observed this would be the E𝕍/-𝕚d inertial impulse. If this was measured as a -𝕀D inertial probability that would give the probability of where it was. Without a Pythagorean Triangle side being squared it is not known the vector is there.

Integral of the hypotenuse vector

The -𝕀D×e𝕧 inertial work would have this square as an area or field not a vector. Instead, this integral would be to the left of the vector going to the -𝕚d y axis. That would be a squared duration from an initial to a final value, this is like a definite integral which also has these two values. On the x axis the e𝕧 position represents the final -𝕚d moment of this duration.

A displacement or duration as a history

That is because history in this model is not changeable, it represents a force here from the past which cannot be changed. That duration of time with the -𝕀D inertial probability acts as an inertial mass with inertial momentum. This momentum is dependent on the history of the iota, if it was accelerated then its inertial mass -𝕀D is higher. If it collides with another particle then this inertial mass will cause the other particle to rebound more. This acts as the -𝕀D inertial probability because when it is large it is much more likely to make the other particle rebound more.

Newton's first law

So the mass tends to continue moving forward unless it meets another force, here the -𝕀D inertial probability is that it continues on unless interfered with by another probability. That is because the -𝕚d and e𝕧 Pythagorean Triangle has reaction forces only, it can be subtracted from those forces it reacts against but it cannot actively change otherwise. This is Newton's first law of inertia, that it does not change unless from an active force.

Changing from work to impulse

If the iota is observed then this changes to the E𝕍/-𝕚d inertial impulse and the -𝕀D probability ends, it becomes -𝕚d inertial time on a clock gauge. In a collision the inertial time as -𝕚d is observed, the two particles would move off with a change in their relative velocities.

Waves do not collide

The -𝕀D×e𝕧 inertial work is also measured as a classical approximation, work acts as a probability wave so as in the ocean two waves would cross each other without colliding. This is because there is no position of a particle e𝕧 at a moment -𝕚d, instead as a field -𝕚d×e𝕧 they can only pass through each other.

Impulse is the inverse of work

Because of the constant areas of the Pythagorean Triangles the impulse is the inverse of the work, the more -𝕀D inertial mass probability there is then the less of a change there would be from a collision. This is because E𝕍 would be the inverse of -𝕀D, when -𝕀D is dilated then E𝕍 is contracted which gives a smaller E𝕍/-𝕚d inertial impulse change and a smaller velocity change.

Dimensional analysis of the inertial momentum

Because the inertial momentum has both a -𝕚d inertial mass and a -𝕚d inertial time, then both are included here for dimensional analysis as -𝕚d×e𝕧/-𝕚d which would be kilograms×meters/second.

Superposing a derivative and an integral

The Pythagorean Triangles here are not observable with a single derivative as e𝕧/-𝕚d, nor with a single derivative as -𝕚d×e𝕧. This then represents a single Pythagorean Triangle where both the particle and wave duality are superposed for dimensional analysis. This allows for an observation of this inertial momentum as the E𝕍/-𝕚d inertial impulse, or a measurement as -𝕀D×e𝕧 inertial work.

Simultaneous equations

The concept of simultaneous equations is that they can be done at the same time, then the answers are combined to a single value. It is a classical physics idea, the assumption is that the equations be be solved instantly. For example if a ship was calculating how to point its guns then there might be simultaneous equations, but if these were too slow then the target would have moved.

Entanglement

In physics then the idea of simultaneous equations is not compatible with many aspects of reality. In this model there are no simultaneous equations, one exception is where entangled photons might be measured with the EPR paradox. Using these Pythagorean Triangles means that each one has a limited number of mathematical operations associated with it, the -𝕠d and e𝕪 Pythagorean Triangle can for example by observed with a E𝕐/-𝕠d kinetic impulse or measured with -𝕆D×e𝕪 kinetic work.

Coordinates and the uncertainty principle

Breaking it into two Pythagorean Triangles and solving them simultaneously violates the uncertainty principle, it requires forces to do this. Then it requires more forces to observe and measure these other Pythagorean Triangles and to compare them to each other. When coordinate systems are used like this they imply two more Pythagorean Triangles.

Decaying iotas

Another exception is where a Pythagorean Triangle such as a muon breaks up into other Pythagorean Triangles, then each of these might be observed or measured separately. There may be e𝕪×-𝕘d photons also as Pythagorean Triangles, but these are all different from the original Pythagorean Triangle. There are uncertainties as to what decay products will be measured, these occur according to probabilities.

Momentum

The product of a particle's mass and velocity is called the *momentum* of the particle:

$$\textbf{momentum} = \vec{p} \equiv m\vec{v} \qquad (11.3)$$

Momentum, like velocity, is a vector. The units of momentum are kg m/s. The plural of "momentum" is "momenta," from its Latin origin.

The momentum vector $\vec{p}$ is parallel to the velocity vector $\vec{v}$. **FIGURE 11.2** shows that $\vec{p}$, like any vector, can be decomposed into x- and y-components. Equation 11.3, which is a vector equation, is a shorthand way to write the simultaneous equations

$$p_x = mv_x$$
$$p_y = mv_y$$

F=ma

Here F=ma is written in terms of momentum, in this model there can be a -𝕠d×e𝕪/-𝕠d kinetic momentum where an electron is in a stable orbital. The -𝕠d and e𝕪 Pythagorean Triangle is in a superposition of being a derivative as the kinetic velocity e𝕪/-𝕠d and the kinetic momentum -𝕠d×e𝕪. The two -𝕠d factors are shown for dimensional analysis, in this model only one is used as neither is observable or measurable. When there is a second derivative with respect to e𝕪 this gives -𝕠d as the kinetic mass × e𝕐/-𝕠d, here the kinetic acceleration is inverted but is still the same.

Change in momentum

With the -𝕚d and e𝕧 Pythagorean Triangle proportional to this it would have an inertial momentum as -𝕚d×e𝕧/-𝕚d, F=ma would be -𝕚d as the inertial mass ×E𝕍 as the inertial displacement/-𝕚d as the inertial time. In this model the force would not be the change in momentum with respect to time as -𝕚d, that would give an integral as a field. It is the change in momentum dp⃗/de𝕧 or with respect to a distance. In classical physics the two are convertible into each other and are equivalent, in this model derivatives are only used with impulse.

Inertial mass and inertial time

The denominator contains information about the integral field as the -𝕚d inertial mass, though here it acts as inertial time. With the inertial momentum -𝕚d×e𝕧/-𝕚d doubling the -𝕚d inertial mass in the numerator would double the inertial momentum of a thrown ball. If the ball was thrown twice as fast then the inertial momentum would also double. The rate of change of inertial momentum would be affected by a rocket using up fuel as -𝕚d×e𝕧, as -𝕚d contracted then e𝕧 would dilate. With the same proportion its velocity would also have the -𝕚d inertial time contract and the e𝕧 length dilate.

An object can have a large momentum by having either a small mass but a large velocity or a small velocity but a large mass. For example, a 5.5 kg (12 lb) bowling ball rolling at a modest 2 m/s has momentum of magnitude $p = (5.5\text{ kg})(2\text{ m/s}) = 11\text{ kg m/s}$. This is almost exactly the same momentum as a 9 g bullet fired from a high-speed rifle at 1200 m/s.

Newton actually formulated his second law in terms of momentum rather than acceleration:

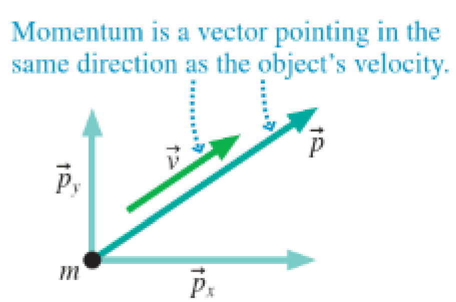
$$\vec{F} = m\vec{a} = m\frac{d\vec{v}}{dt} = \frac{d(m\vec{v})}{dt} = \frac{d\vec{p}}{dt} \qquad (11.4)$$

This statement of the second law, saying that **force is the rate of change of momentum,** is more general than our earlier version $\vec{F} = m\vec{a}$. It allows for the possibility that the mass of the object might change, such as a rocket that is losing mass as it burns fuel.

Momentum is not a vector

In this model the inertial momentum would not be a vector, it would be an integral field of the wave like nature of the -𝕚d inertial mass. This is not being observed or measured so there is no force. Decomposing an iota with this -𝕚d inertial mass is like a particle in an accelerator, when it approaches c its -𝕀D inertial probability is much larger. In a collision this is decomposed into other particles and photons, this is like decomposing a momentum vector into components.

FIGURE 11.2 The momentum $\vec{p}$ can be decomposed into x- and y-components.



Impulse and integrals

Here the change in the inertial momentum is defined as impulse, it is an area under a curve as an integral. In this model the inertial time -ⅈd can be converted into its inverse as a e𝕧 length, that makes this force -𝕆D×e𝕪 kinetic work as an integral. When a velocity is changed, such as a ball hitting a tennis racquet, it slows so that e𝕧 as a length contracts and -ⅈd as the inertial time dilate. This change in velocity is the same whether it is described by a change in a distance in a given time or a change in time to travel a given distance.

Impulse

Equation 11.5 tells us that the particle's change in momentum is related to the time integral of the force. Let's define a quantity J_x called the *impulse* to be

$$\textbf{impulse} = J_x \equiv \int_{t_i}^{t_f} F_x(t)\,dt = \text{area under the } F_x(t) \text{ curve between } t_i \text{ and } t_f \quad (11.6)$$

Strictly speaking, impulse has units of N s, but you should be able to show that N s are equivalent to kg m/s, the units of momentum.

Inertial momentum to work

Here the impulse is shown as an integral, the -ⅈd inertial time would become the inverse as the e𝕧 length. From the inertial momentum as -ⅈd×e𝕧/-ⅈd in kg×meters/second the change in the inertial momentum can also be -𝕀D×e𝕧/-ⅈd, the difference is the inertial time is squared to become the -𝕀D inertial probability. Because the -𝕀D×e𝕧 inertial work is being measured over a length e𝕧 the inertial time -ⅈd in the denominator is not needed. In conventional physics it is not possible to know exactly a position as e𝕧 as well as a time as -ⅈd because of the uncertainty principle.

Integral areas as two Pythagorean Triangles

The integral area is shown to be the same as a rectangle, in this model that is approximately two -ⅈd and e𝕧 Pythagorean Triangles. This would be where a ball was slowed by a racquet, its -𝕀D×e𝕧 inertial work reacts against this. It can also be +𝕀D×e𝕙 gravitational work where a ball lands on a surface and bounces up. With gravity this would have the e𝕙 height decreasing as the ball was compressed in the impact, that would cause the +𝕀D gravitational probability to dilate as an integral.

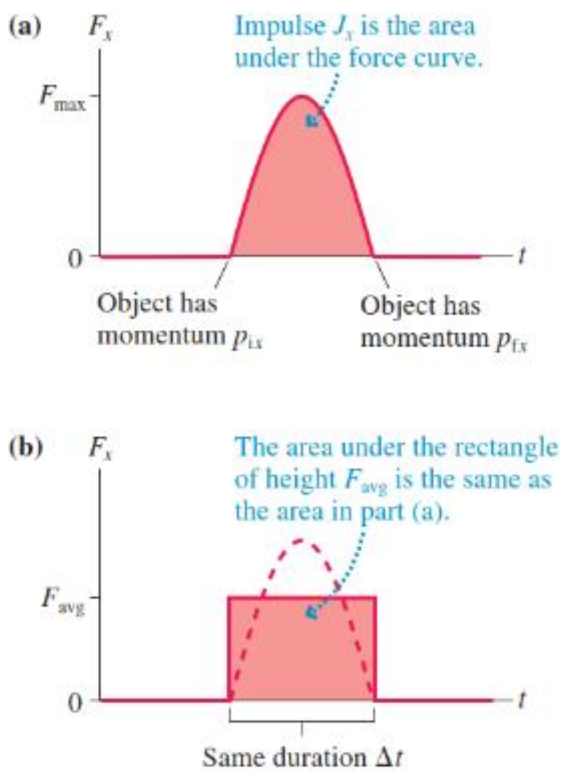
The rectangle flattens

The rectangle can be changing shape, e𝕙 can be the vertical side and +ⅈd as the horizontal side. The impact causes the ball to deform and its e𝕙 height to decrease with a deceleration. The e𝕙 vertical side on the left and right can be from two +ⅈd and e𝕙 Pythagorean Triangles, the sides width would be the temporal duration from an initial +ⅈd gravitational moment to a final gravitational moment. The rectangle would then become wider as its e𝕙 height contracted. In between is the changing +𝕀D gravitational probability of how the ball's acceleration is likely to decrease, then increase as it bounces up again.

The rectangle's slope and impulse

The gravitational deceleration would be measured by the horizontal force +𝕀D measuring this +𝕀D gravitational probability in +𝕀D×e𝕙 gravitational work. If the Eℍ/+ⅈd gravitational impulse was being observed then a diagonal of the rectangle would give the changing slope. The e𝕙 height would become Eℍ as the gravitational displacement, the horizontal +𝕚d gravitational mass would become the gravitational time. The two are classically equivalent as meters/second² and meters²/second.

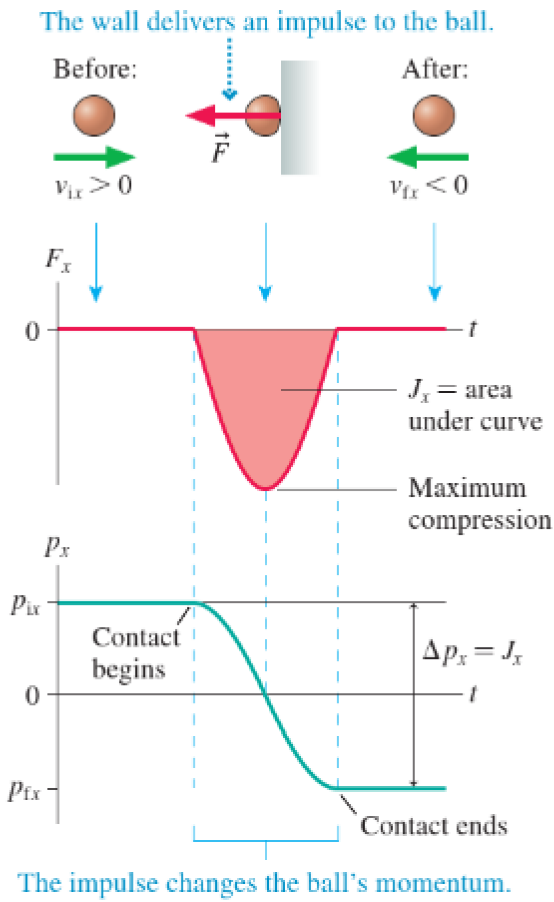
FIGURE 11.3 Looking at the impulse graphically.



Integrals and momentum

Here the integral is shown as a change in momentum, the -𝕚d×e𝕧/-𝕚d inertial moment can also change as -𝕀D×e𝕧/-𝕚d doing -𝕀D×e𝕧 inertial work.

FIGURE 11.4 The momentum principle helps us understand a rubber ball bouncing off a wall.



A change in momentum

This shows the -𝕚d×e𝕧/-𝕚d inertial momentum has different d and e values after the rebound, the direction is reversed but this is done by vector addition and subtraction and the dot product. In this model it is not done by subtracting vectors, in the example below the negative area would come from -𝕀D in the -𝕀D×e𝕧 inertial work.

Inertial torque

The ball moves with an inertial momentum -𝕚d×e𝕧/-𝕚d in kg·m/s, it does -𝕀D×e𝕧 inertial work towards the wall with a -𝕀D inertial torque as a -𝕀D inertial probability. When it rebounds this torque is removed with a destructive interference, reappearing as the ball moves away.

Newton's first law

With the inertial probability this is from Newton's first law, the ball will probably move with the same velocity and direction unless acted upon by an external force here as a probability. The -𝕀D inertial probability is reactive only, it is only measured as a reaction against a force. So hitting the wall initially reduces the probability the ball will keep going through the wall, this is also the -𝕀D inertial torque being destructively interfered with the by +𝕆D×e𝕒 potential work and the +𝕆D potential probability of the normal force.

Quantum tunneling

In this model quantum tunneling occurs when iotas act as waves, the electron would have -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. This is in relation to points or position on a scale, when tunneling through a barrier the thickness of it is in relation to these positions. It is not a displacement E𝕐 or E𝕍 from the initial entrance into the barrier to the final exist from it. Instead, there is a -𝕆D kinetic probability and a -𝕀D inertial probability of the wave electron passing through the barrier.

Particles are easier to observe

This gives an exponential decay curve of the electron being observed as a particle on the other side of the barrier, it is observed as a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse because particles are typically observed not waves measured. That is because particles are easier to observe, a wave function probability is then converted into an observation at a moment in time on a clock gauge.

Exponential decay of tunneling

The kinetic and inertial exponential decay curves are formed by the squared -𝕀D inertial probability of the electron passing through the barrier, that decreases as a square when the e𝕧 positions increase linearly for a thicker barrier. This is because the Pythagorean Triangles have a constant area, when one Pythagorean Triangle side changes as a square and the other inversely changes linearly that gives an exponential curve. Here this is decreasing and so it is an exponential decay.

A tunneling ball

When the ball hits the wall with -𝕀D×e𝕧 inertial work then there is some quantum tunneling, part of it would go into the wall as a wave. This is destructively interfered with by the +𝕆D×e𝕒 potential work of the wall as a normal force. That reflects the -𝕆D probability as a wave.

Light reflections

This also happens with -𝔾D×e𝕪 light work where e𝕪×-𝕘d photons are reflected as waves, There is a -𝔾D light probability of the photons being reflected or tunneling through a barrier such as glass. Some are then reflected while other photons go through the glass as a probability wave. When the photons have the right -𝕘d rotational frequency they can also be absorbed by electron in the glass.

Electron does not spin

This inertial torque does not appear as an active spin, in this model that is why the electron has spin but this is not actively observed as spinning. That is because the electron has an active spin as the -𝕆D kinetic torque, but this acts through magnetism and as a kinetic probability. For example, this kinetic magnetism can make an electric motor spin.

Inertial spin not directly measurable

The inertial torque as -𝕆D reacts against a change in its spin, this can be measured with a bowling ball for example. When someone attempts to spin the ball, it reacts against this with inertia. If the ball is spinning it reacts against being slowed. This spin is not directly measurable then except as a reaction to a change. The ball can be spun by using -𝕆D×e𝕪 kinetic work, this is where the hand would spin the ball while the -𝕀D×e𝕧 inertial work reacts against it.

The bowling ball has spin

The bowling ball has spin as a property because it can be spun, and it can react against being spun. This is like the electron, it has a property of -𝕚d as a half spin because the -𝕚d and e𝕧 Pythagorean Triangle is half a rectangle. This spin is only measurable by a force, there is no way to measure an actual spin by itself.

> **FIGURE 11.4** illustrates the momentum principle for a rubber ball bouncing off a wall. Notice the signs; they are very important. The ball is initially traveling toward the right, so v_{ix} and p_{ix} are positive. After the bounce, v_{fx} and p_{fx} are negative. The force *on the ball* is toward the left, so F_x is also negative. The graphs show how the force and the momentum change with time.
>
> Although the interaction is very complex, the impulse—the area under the force graph—is all we need to know to find the ball's velocity as it rebounds from the wall. The final momentum is
>
> $$p_{fx} = p_{ix} + J_x = p_{ix} + \text{area under the force curve} \qquad (11.10)$$
>
> and the final velocity is $v_{fx} = p_{fx}/m$. In this example, the area has a negative value.

Energy and momentum

In this model the energy principle is an active force, that would be the -𝕆D×e𝕪 kinetic work here. The momentum principle is a reactive force, that would be the -𝕀D×e𝕧 inertial work.

Gravity and protons

That reverses with the positive probabilities, the +𝕀D×e𝕙 gravitational work is an active force so it can move iotas. The +𝕆D×e𝕒 potential work is a reactive force like inertia, it has a constant position e𝕒 as the potential electric charge until acted only by another force.

Fusion

This can be gravity with the +𝕀D×e𝕙 gravitational work, for example in a star this compresses Hydrogen so that the orbitals are closer together. This is because +𝕆D as the potential probability increases as the e𝕒 altitude decreases. It is like the +𝕀D×e𝕙 gravitational work where the +𝕀D gravitational probability increases as an attraction with a decreased e𝕙 height. When this probability is large enough then Hydrogen can fuse together and become Helium.

An Analogy with the Energy Principle

You've probably noticed that there is a similarity between the momentum principle and the energy principle of Chapters 9 and 10. For a system of one object acted on by a force:

$$\begin{aligned} &\text{energy principle:} && \Delta K = W = \int_{x_i}^{x_f} F_x\,dx \\ &\text{momentum principle:} && \Delta p_x = J_x = \int_{t_i}^{t_f} F_x\,dt \end{aligned} \qquad (11.11)$$

In both cases, a force acting on an object changes the state of the system. If the force acts over the spatial interval from x_i to x_f, it does *work* that changes the object's kinetic energy. If the force acts over a time interval from t_i to t_f, it delivers an *impulse* that changes the object's momentum. **FIGURE 11.5** shows that the geometric interpretation of work as the area under the F-versus-x graph parallels an interpretation of impulse as the area under the F-versus-t graph.

Impulse as a derivative, integrals as work

Here impulse and work are both regarded as integrals, the difference in this model is that only work is. On the right the E𝕍/-𝕚d inertial impulse of a ball hitting a wall can be the changing derivative slope. Because this change is not constant, like a tangent to a circle, this is an acceleration and an impulse force. With E𝕍 in the E𝕍/-𝕚d inertial impulse this is the inverse of -𝕀D as the inertial probability in -𝕀D×e𝕧 inertial work, the two can then be shown on the same diagram.

Normal curve from an exponent

This also occurs with the normal curve as an integral, it is formed from squared exponents of spin Pythagorean Triangle sides in this model. For example $e^{1/-𝕀D}$ with different values of D will give a Gaussian or normal curve, in this model it acts as a negative inverse square. This also happens if the exponent is the square root of +1 in this model, it could also be +𝕀D or -𝕀D so all 4 Pythagorean Triangles have the same normal curve probabilities.

Tangent of a normal curve

The normal curve is an integral because the spin Pythagorean Triangle side is squared, the tangent of the curve can also be observed as an impulse. It changes with an acceleration as the tangent is moved across the curve. On the edges of a normal curve there is a stronger E𝕐/-𝕠d kinetic impulse in moving towards the center, the horizontal axis would be E𝕐 as a kinetic displacement force.

Galton box

This happens in a Galton box where pegs and falling balls give a normal curve at the bottom. The forces towards the center add up more on the edges so the balls make a higher pile in the middle of the normal curve. This can also be -𝕆D×e𝕪 kinetic work where there is a higher -𝕆D kinetic probability of the balls moving to the center. Instead of E𝕐 as a kinetic displacement towards the center the -𝕆D×e𝕪 kinetic work would use e𝕪 as horizontal positions. Then the highest -𝕆D kinetic probability is in the center where there is the smallest e𝕪 variation of position to one side.

Equal probability of left or right

Proportionally with the -𝕚d and e𝕧 Pythagorean Triangle the balls are released at the top of the Galton box in the center. These bounce off each peg with an equal -𝕀D inertial probability 50:50 of going left or right, this is also a -𝕀D inertial torque from being spun by the pegs. Each is a constructive or destructive interference, if constructive then the ball keeps moving further away from the center as an exponential like quantum tunneling. If destructive then left, right, left, right is canceling out the -𝕀D inertial probabilities.

Exponentials and probabilities

This gives an exponentially lower probability of the balls moving to one side, $1/2^n$ has n as an exponential, it is the inverse of a logarithmic curve to base 2. The exponential curve then comes from the constant Pythagorean Triangle area, as the position e𝕧 increases linearly from the center of the Galton Box the -𝕀D inertial torque acts as a square.

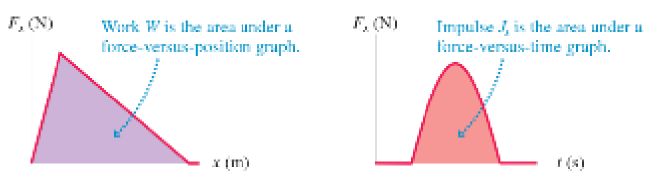
Spin as an exponent

When the exponential is taken as a negative inverse, here from a spin Pythagorean Triangle side squared, then this directly gives the normal curve shape. This works with all spin Pythagorean Triangle sides because ni in an exponent also represents spin as the positive and negative values of the square root of -1. So, it is the same for any spin representation in an exponent.

Exponentials and Gaussians

This is like an exponential curve, when the -𝕀D inertial probability is inverted as a fraction then it gives the normal curve. When -𝕀D is not inverted this gives an exponential curve. Both come from a constant Pythagorean Triangle area with one side squared. In the diagram the ball forms a normal curve integral in its probabilities of tunneling through the wall or reflecting, this tunneling becomes increasingly improbable because of the normal force of the walls +𝕆D×e𝕒 potential work. This normal force also forms a normal curve.

FIGURE 11.5 Impulse and work are both the area under a force curve, but it's very important to know what the horizontal axis is.



Kinetic energy as an integral

In this model the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy has the same dimensions as below, it is proportional to the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. This comes from the velocity taken as an integral with the inertial momentum as -𝕚d×e𝕧/-𝕚d. When the velocity as e𝕧/-𝕚d is taken as a single variable, then the integral of this is squared with a ½ factor to give the ½×e𝕍/-𝕀d ×-𝕚d linear inertia.

Velocity as a single variable in an integral

Here the velocity cannot be taken as a single variable because e𝕧 represents a position and -𝕚d a moment in time. When taken together they imply a position and a time can be observed or measured exactly, which goes against the uncertainty principle. From this comes a fundamental uncertainty that is addressed in Schrodinger's equation by using h.

Work and impulse are two forces

Below it is claimed both work and impulse can act on a particle, in this model that is not possible. Either one can be used to give a different answer, but here there are two separate forces of different types not one force.

This does not mean that a force *either* creates an impulse *or* does work but does not do both. Quite the contrary. A force acting on a particle *both* creates an impulse *and* does work, changing both the momentum and the kinetic energy of the particle. Whether you use the energy principle or the momentum principle depends on the question you are trying to answer.

In fact, we can express the kinetic energy in terms of momentum as

$$K = \tfrac{1}{2}mv^2 = \frac{(mv)^2}{2m} = \frac{p^2}{2m} \tag{11.12}$$

You cannot change a particle's kinetic energy without also changing its momentum.

Integrals with a constant C

In calculus an integral has a constant C added to it. A curve for example can have a ball moving left to right, up and down over a series of hills and valleys. The +𝕀D×eh gravitational work pulls the ball downwards, this makes it move down into the valleys. There is also -𝕀D×ev inertial work from the ball's initial velocity ev/-id and its -id inertial mass. This causes the ball to react against changing its velocity, at the bottoms of the valleys it then keeps moving and rises over the hills to continue.

Area under the hills as an integral

The area of the hills under the ball would be the +𝕀D gravitational mass force, also the gravitational torque or probability. This torque causes the ball to turn downwards in its motion, it is like a ball thrown into the air in a straight-line direction. It has its trajectory curved with this +𝕀D gravitation torque into a parabola. The area acts as the gravitational mass force, the Earth would have this integral area as a slice through the center.

Relative heights

The integral has a constant C, this means that the relative heights eh of where the ball goes can be moved up and down. This does not affect the motion of the ball as long as the gravitational attraction remains constant. With this integral area as the +𝕀D×eh gravitational work it has a gravitational acceleration downwards as eh/+𝕀D in meters/second^2. This would be writing work like it was impulse, as a classical approximation.

Gravitational and inertial torque

The ball also does -𝕀D×ev inertial work, this is a negative -𝕀D inertial probability or torque. The ball reacts against the +𝕀D gravitational torque of the ball by subtracting itself from the active +𝕀D value. When -𝕀D is larger the ball moves upwards, when it reaches the top of a hill the +𝕀D gravitational torque curves it downwards again.

A constant C and work

Moving up the eh heights with a constant C does not affect the -𝕀D×ev inertial work done by the ball, the +𝕀D gravitational torque is the same and so the subtracted -𝕀D inertial torque as the inverse is the same.

The Pythagorean Triangles do not change

The Pythagorean Triangles do not change because the Pythagorean Triangle sides did not change, the gravitational attraction is assumed to be constant as a classical approximation, the +𝕚d gravitational mass is also assumed to be constant with this increase in e𝕙 height. In this model that is not accurate, this decreases inversely to an increase in e𝕙 height. With a large planet this change is not significant for some calculations.

Gauge and scale invariance

This is equivalent to making a clock gauge in impulse invariant, also a ruler or scale in work invariant. It assumes that a force is constant, also that there are no relativistic effects. In this model the constant is an approximation only, this is because the Pythagorean Triangles automatically give the changes in acceleration as the angles θ change. It also changes according to General and Special Relativity to give the right answers.

The gravitational impulse is not gauge invariant

This gauge and scale invariance then does not account for e𝕙 height contraction and +𝕚d gravitational time dilation in General Relativity. In this model moving up the e𝕙 heights would cause the Eℍ/+𝕚d gravitational impulse with its Eℍ displacement to decrease. This is because it observes the change from an initial e𝕙 height above a planet to the final e𝕙 observation position. In between these heights the +𝕚d gravitational time changes, this proportionally changes the rotation of a clock so that time is slowing at a lower height.

The gravitational work is not scale invariant

It also does not take into account the e𝕙 height contraction, this comes from the +𝕀D×e𝕙 gravitational work. The +𝕀D gravitational probability is measured from an initial +𝕚d gravitational mass at a given e𝕙 height. This is to a final +𝕚d gravitational mass, the temporal or mass duration between the two is the gravitational probability or torque. This is not a pair of gravitational moments themselves, it is in between one and the other. With the ball moving over the hills then sometimes the temporal or mass duration is larger, in a valley the +𝕚d gravitational mass is larger than on a hill. In between these there is a e𝕙 height contraction, the height will be contracted in the valley compared to on the hill.

A duration or a difference

In this model a squared spin Pythagorean Triangle side has an initial and a final value, this is also called a difference here. With voltage there is a +𝕆D potential difference from +𝕆D×e𝕒 potential work and a -𝕆D kinetic difference from -𝕆D×e𝕪 kinetic work. This voltage drives a potential current e𝕒/+𝕚d and a kinetic current e𝕪/-𝕠d. In Biv space-time there is also a gravitational difference +𝕀D from +𝕀D×e𝕙 gravitational work and an inertial difference -𝕀D from -𝕀D×e𝕧 inertial work. These terms can be used as well as a duration for squared spin Pythagorean Triangle sides.

The slope of a hill as a derivative

In this model derivatives also have this constant C, the slope of where the ball is on the hills at a given +𝕚d gravitational moment is from the Eℍ/+𝕚d gravitational impulse. This tangent line can also be regarded as a hand on a clock gauge, it might start on a flat area pointing horizontally at 3 and 9 o'clock. Then as the ball moves this tangent observes the changing slope on the clock gauge.

A positive and negative slope on a clock gauge

When the ball is going down a hill the slope is negative, in this model the clock gauge might be imagined as being reversed so this is a positive slope in association with +𝕚d in gravitational time. When the ball climbs a hill the slope turns positive, again with a reversed clock this would be negative.

A changing rotational frequency

The changing Eℍ/+𝕚d gravitational impulse accelerates and decelerates according to the Eℍ displacement, the clock hand would then show it moving at different rotational frequencies. At the end on the right the ball might stop on a horizontal surface, again the clock gauge measured a 9 to 3 horizontal hand.

Rotational frequency and photons or Gravis

If at a given moment this rotational frequency was observed it would relate to a e𝕪×-𝕘d photon frequency with -𝕘d. The ball could be regarded as emitting and absorbing photons as its velocity changed, in Biv space-time this could also be modeled with +𝕘d×e𝕓 Gravi, the ball does +𝔾D×e𝕙 Gravi work going up and down the hills.

Reactive Iners are subtracted

From this is subtracted the -𝕘d×e𝕧 Iner with -𝔾D×e𝕧 virtual Iner work As the rotational rate changed then the difference could be emitted and absorbed, this is like with an electron emitting and absorbing e𝕪×-𝕘d photons as it goes up and down in orbitals.

A capacitor

The proton acts as gravity in Roy electromagnetism but with reactive forces, with this model the +𝕀D×e𝕙 gravitational work would be +𝕆D×e𝕒 potential work and the Eℍ/+𝕚d gravitational impulse would be the E𝔸/+𝕠d potential impulse. It could also be modeled with a capacitor so that changes in the positive and negative plates would make an electron move this way.

Free electrons don't absorb photons

In this example the electron would be free of an atom, it then could not absorb or emit e𝕪×-𝕘d photons with -𝕆D×e𝕪 kinetic work. This is because only orbitals are quantized and these end at the ionization level. The -𝕆D×e𝕪 kinetic work of an electron uses the -𝕆D kinetic torque to move up and down in orbitals, also it acts as a standing wave in an orbital. An electron in free space can only collide with photons with a e𝕐/-𝕘d light impulse.

The CMB as an ionization level

In Biv space-time with this model the equivalent of an ionization level is the CMB, the e𝕙 height extends out to there. In Roy electromagnetism the e𝕒 altitude above a proton is much smaller, and so the electron can escape the proton completely. Beyond the CMB then electrons could not emit photons which could be measured, this is because they would be lower than the ground state.

Subtracting inertial from gravitational time

The motion of the ball then is modeled by the subtraction of the -𝕚d inertial time from the +𝕚d gravitational time. When the ball is moving downwards the +𝕚d value would be higher, when moving back upwards then -𝕚d would be higher but being decreased by +𝕚d as the ball decelerated. At the top of a hill nearly stopped this would be close to a balance of +𝕚d and -𝕚d.

Moments of time not a duration as in work

These times are not a temporal duration from an initial to a starting moment, that occurs in the +𝕀D×eh gravitational work. It shows how the impulse can be converted into work by taking this temporal duration as a force.

Adding time as a constant C

The constant C can be added to this by moving the clock hands, instead of starting horizontally they might point at 10 and 4 for example. The constant then is an angle of rotation, it would give a different ratio of +𝕚d gravitational and -𝕚d inertial time at each moment. In terms of elapsed time with a clock this is closer to the math definition of the constant C, adding an integral area under the hills would also increase the +𝕀D gravitational torque. That would cause the ball to not climb the hills as much unless its -𝕀D inertial mass force was increased by making it heavier.

Clock gauge invariance

Using the clock as a starting and final moment, not a temporal duration or difference, this would be like starting the ball at first as a minute starts and for example when the minute ends it reaches the final hill on the right. Adding a constant C can start the time at 15 seconds, then it ends at 15 seconds past the minute.

A clock gauge with electron orbitals

The derivative or tangent of the motion of an electron can be modeled as +𝕠d potential time and -𝕠d kinetic time in the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse. The electron might move chaotically as a particle, the derivative of its e𝕪/-𝕚d kinetic velocity would depends on its motion towards or away from the proton with its derivative as the e𝕒/+𝕠d potential speed. The derivative tangents with the proton and electron would act as hands on a potential clock and a kinetic clock respectively, the slope changes of the hands proportional to the impulse as with the ball rolling.

Gravitational and inertial clocks

This can be extended in Biv space-time to motions of asteroids for example, when not in actual orbit they still experience some Eℍ/+𝕚d gravitational impulse out to the CMB. So they can have this tangent derivative between their E𝕍/-𝕚d inertial impulse and the Eℍ/+𝕚d gravitational impulse. That gives a +𝕚d gravitational clock and -𝕚d inertial clock where the hands would again rotate relative to each other as the impulse acceleration changed.

A derivative tangent close to c

In Special Relativity the rotations of these clocks would also be slowed, as a rocket approached c its E𝕍/-𝕚d inertial impulse would be observed with a slower clock gauge. Also as its E𝕍/-𝕚d inertial impulse changed then this tangent to its derivative would change as a hand on an inertial time clock. The changes on this clock would vary according to the different E𝕍/-𝕚d inertial impulse the rocket had as it accelerated or coasted for example. This would be relativistic in this model because as the velocity approached c then this E𝕍/-𝕚d inertial impulse would have E𝕍 dilated, the -𝕚d inertial time would be contracted and so the clock hand would change its direction more slowly.

A derivative tangent and General Relativity

With General Relativity the +𝕚d gravitational clock would also slow its changes with the Eℍ/+𝕚d gravitational impulse, for example a rocket falling towards the surface might vary its overall e𝕙/+𝕚d gravitational speed. With an increased +𝕚d time slowing the derivative tangent as the clock hand would also change more slowly.

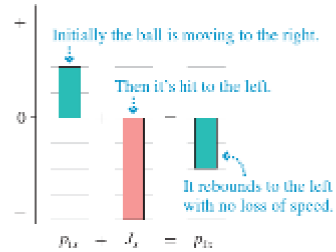
Momentum Bar Charts

The momentum principle tells us that **impulse transfers momentum to an object.** If an object has 2 kg m/s of momentum, a 1 kg m/s impulse delivered to the object increases its momentum to 3 kg m/s. That is, $p_{fx} = p_{ix} + J_x$.

Just as we did with energy, we can represent this "momentum accounting" with a **momentum bar chart.** For example, the bar chart of FIGURE 11.6 represents the ball colliding with a wall in Figure 11.4. Momentum bar charts are a tool for visualizing an interaction.

> **NOTE** The vertical scale of a momentum bar chart has no numbers; it can be adjusted to match any problem. However, be sure that all bars in a given problem use a consistent scale.

FIGURE 11.6 A momentum bar chart.



Inertial momentum a superposition

In this model the inertial momentum as -𝕚d×e𝕧/-𝕚d is a superposition, a derivative and an integral of the -𝕚d and e𝕧 Pythagorean Triangle. Because of this the final velocities depend on the -𝕚d inertial mass of the objects from the -𝕚d×e𝕧 inertial field. This is the -𝕚d inertial mass times a e𝕧 length or a moment times a position. When two objects collide the inertial mass will change after they separate, and at what angle. The one moving faster will have a higher -𝕚d inertial mass and a contracted e𝕧 position, this is like a wave where the mass is denser.

Inertial mass and velocity

The collision also has two final velocities, the one with the larger -𝕚d inertial mass will move inversely slower, so with -𝕚d×e𝕧 -𝕚d is dilated and with e𝕧/-𝕚d the -𝕚d inertial time is dilated by the same proportion.

Inertial displacement

Here the E𝕍/-𝕚d inertial impulse has E𝕍 as an inertial displacement from an initial e𝕧 position to a final e𝕧 position. In between these is a force, the elastic collision would give the compression of the objects as a contraction of E𝕍. The amount of this E𝕍 displacement determines the relative times in the velocities after the collision. If this happened close to c then there would also be slower clocks on each as a clock gauge, the stronger E𝕍 is the more contracted -𝕚d as the inertial time is which is a slower clock.

Time and length contraction

This is referred to as time dilation in conventional physics, here the contracted spin Pythagorean Triangle side causes a slower clock so it would be called a time contraction here. The reason both contract is that both have the opposing Pythagorean Triangle side dilated, the E𝕍/-𝕚d inertial impulse close to c has the velocity e𝕧/-𝕚d where e𝕧 is dilated and -𝕚d is contracted.

Inertial displacement history and inertial temporal history

With the E𝕍/-𝕚d inertial impulse observed the E𝕍 inertial displacement is from an initial e𝕧 position to the e𝕧 position of observation. This contains the inertial displacement history of the object which causes the -𝕚d inertial time contraction Ro slowing. In accelerating to near c the -𝕀D×e𝕧 inertial work accumulates -𝕀D from the initial -𝕚d inertial time to the final time of measurement. This is also part of its inertial temporal history, with that being dilated then the e𝕧 length is contracted like the -𝕚d inertial time.

The inertial impulse and work are not inverses

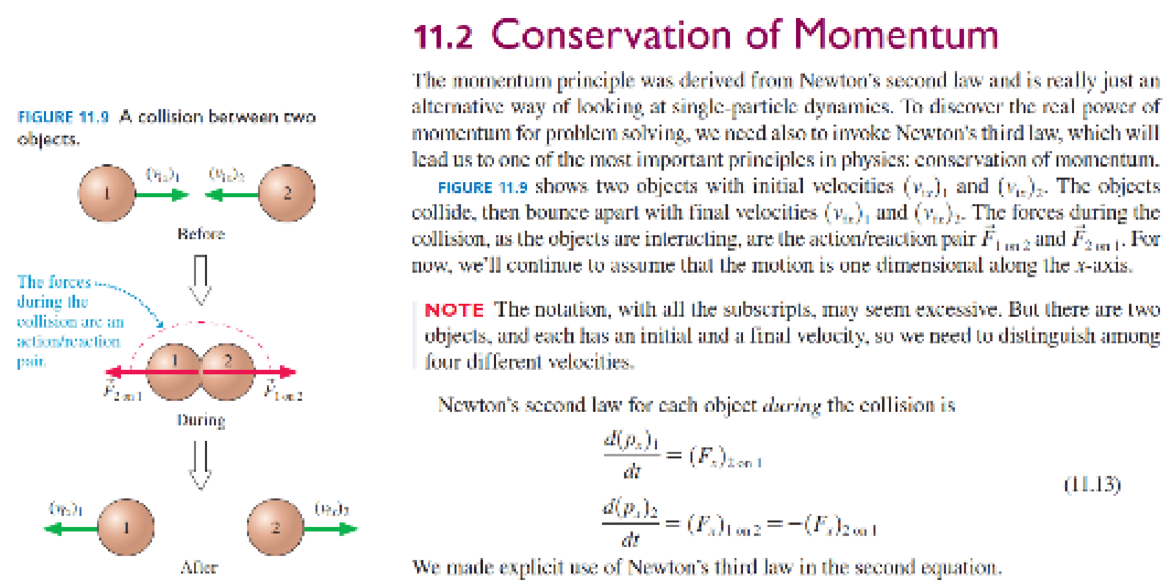
The two are separate because a Pythagorean Triangle cannot be observed and measured in the same position and moment. An observation of particles and impulse requires a timescale, a measurement of waves and work requires a distance scale. Accelerating the rocket was done with both the E𝕍/-𝕚d inertial impulse and the -𝕀D×e𝕧 inertial work, if they worked here as inverses of each other the object would not have moved.

A change in inertial mass

When this is measured with -𝕀D×e𝕧 inertial work then the objects have a change in their -𝕀D inertial mass difference, this is a duration from an initial inertial mass value to a final value. The difference is not those mass values but the interval between them. The objects then have a changed -𝕀D inertial mass difference in their histories, if this happened with objects moving close to c then it would give an observable e𝕧 length contraction in them.

Taking the inertial momentum as a displacement

The equations in (11.3) can be regarded as taking the inertial momentum as a single variable, then p would have a derivative taken with respect to -𝕚d inertial time as impulse. In this model that would be a classical approximation, the inertial momentum with dimensional analysis is a superposition of a derivative and an integral. This would assume the inertial momentum acts as a displacement, there is an initial momentum value and a final value after the collision.



11.2 Conservation of Momentum

The momentum principle was derived from Newton's second law and is really just an alternative way of looking at single-particle dynamics. To discover the real power of momentum for problem solving, we need also to invoke Newton's third law, which will lead us to one of the most important principles in physics: conservation of momentum.

FIGURE 11.9 shows two objects with initial velocities $(v_{ix})_1$ and $(v_{ix})_2$. The objects collide, then bounce apart with final velocities $(v_{fx})_1$ and $(v_{fx})_2$. The forces during the collision, as the objects are interacting, are the action/reaction pair $\vec{F}_{1\,\text{on}\,2}$ and $\vec{F}_{2\,\text{on}\,1}$. For now, we'll continue to assume that the motion is one dimensional along the x-axis.

NOTE The notation, with all the subscripts, may seem excessive. But there are two objects, and each has an initial and a final velocity, so we need to distinguish among four different velocities.

Newton's second law for each object *during* the collision is

$$\frac{d(p_x)_1}{dt} = (F_x)_{2\,\text{on}\,1}$$
$$\frac{d(p_x)_2}{dt} = (F_x)_{1\,\text{on}\,2} = -(F_x)_{2\,\text{on}\,1} \qquad (11.13)$$

We made explicit use of Newton's third law in the second equation.

Conserving inertial momentum

Here the sum of the inertial momentum before the collision equals the sum afterwards. This is equivalent to the constant Pythagorean Triangle area in this model. With two particles each can have a different angle θ in their -𝕚d and e𝕧 Pythagorean Triangles. Particle 1 has a dilated -𝕚d inertial mass compared to particle 2, this means it is a heavier particle. Here the -𝕚d inertial time is also dilated with the same d value as the -𝕚d inertial mass to make the calculation simpler. For example if particle 2 has double the inertial mass of particle 2, then its -𝕚d inertial time is also doubled so its velocity is halved.

Particle 2 is lighter

Particle 2 has -𝕚d contracted as both the inertial mass and the inertial time, this means it is also a lighter particle that has a higher velocity. In a collision the resulting angles are proportional to the angles θ in the -𝕚d and e𝕧 Pythagorean Triangle, the heavier particle 1 has a larger angle θ opposite the spin Pythagorean Triangle side. This means its direction is inversely less changed by the collision, particle 2 with a smaller angle θ has its direction changed more.

The sum of the angles is conserved like the velocities

Because the sum of the velocities is the same, before and after the collisions, then the Pythagorean Triangle areas remain the same. For example, if Particle 1 has d=3 and e=4 in $e𝕧_1$/-$𝕚d_1$ then this is -$𝕚d_1$×$e𝕧_1$=12. If particle 2 has d=2 and e=5 in $e𝕧_2$/-$𝕚d_2$ then -$𝕚d_2$×$e𝕧_2$=10. In this model the areas must add up the same after the collision as before, this is 22. The sum of the velocities is 4/3 +5/2=8/6+15/6=23/6. If particle 1 decreased its velocity to 7/6 then particle 2 must decrease it to 16/6=23/6. The sum of the areas before is 48+90=138 and after is 42+96=138 so the areas are conserved if the velocities are.

Pythagorean Triangle areas are conserved

Because the Pythagorean Triangle areas also remain constant, then this shows the conservation of momentum is equivalent to the Pythagorean Triangle areas remaining constant. This leads to other conservation laws, for example the e𝕪 and -𝕘d Pythagorean Triangle acts as a photon. Its e𝕪×-𝕘d Pythagorean Triangle area is a constant, when an electron emits a photon then this area is absorbed into another electron later.

Conserved photon areas

This can happen even if the e𝕪×-𝕘d photon is redshifted, such as from a longer e𝕙 height in a gravitational well. Then the -𝕘d is contracted and the e𝕪 kinetic electric charge dilates proportionally to its e𝕧 wavelength. It can be absorbed by an electron in a different orbital because the Pythagorean Triangle area is the same, the second electron has the same -𝕠d and e𝕪 Pythagorean Triangle area and the e𝕪×-𝕘d photon retains this same area. The electron does not increase its area when it absorbs a photon, instead its angle θ changes.

Light work and temporal history

The photon when it is absorbed does -𝔾D×e𝕪 light work on the electron, its -𝔾D light temporal history is from the first electron to the second. This is like the particles with their -𝕀D inertial temporal history from past collisions. This photon moved forward in time, it is balanced by the e𝕒 and +𝕘d Pythagorean Triangle as a virtual photon that is not observable or measurable. It goes backwards in time with its +𝔾D light temporal history so the photon area is conserved.

Conservation of temporal history

This conservation of temporal history must occur, when an event happens in the present it must be consistent with the past leading up to that present. The e𝕪×-𝕘d photon and the +𝕘d×e𝕒 virtual photon conserve the changes in electrons so histories remain conserved.

Time travel

It illustrates the problems of time travel because then the temporal histories from past to the present, and present to the past, would not be conserved.

Photon collides with an electron

When a e𝕪×-𝕘d photon collides with an electron outside an atom there is a e𝕐/-𝕘d light impulse, this is like particle 1 colliding with particle 2. Then there is a transfer of light momentum as -𝕘d×e𝕪/-𝕘d to the electron. This is called Compton scattering, the electron has its -𝕠d×e𝕪/-𝕠d kinetic momentum changed by the collision. The velocity of the electron might increase or decrease, the photon does not change its c velocity but its angle θ as a ratio of the -𝕘d rotational frequency and e𝕧 wavelength does change.

Conserving Pythagorean Triangle angles

This angle change sums to the same as when particles 1 and 2 had their angles θ change after a collision. It also preserves the areas of the -𝕠d and e𝕪 Pythagorean Triangle as the electron and the e𝕪 and -𝕘d Pythagorean Triangle as the photon, that is the same as particles 1 and 2 retaining their same Pythagorean Triangle areas.

Displacement history

The particles 1 and 2 were initially accelerated by an active force such as the E𝕐/-𝕠d kinetic impulse or the Eℍ/+𝕚d gravitational impulse. With the E𝕐/-𝕠d kinetic impulse the particles both reacted against this kinetic acceleration with inertia as an E𝕍/-𝕚d inertial impulse. In a collision this E𝕐/-𝕠d kinetic impulse has a E𝕐 kinetic history of what happened to the particles before it. It is not possible for a particle to have this increased velocity without a fixed history, this could also be from a Eℍ/+𝕚d gravitational impulse where both were accelerated with gravity.

Displacement history versus temporal history

This displacement history is not backwards or forwards in time, but it is observed on a clock gauge such as the -𝕠d kinetic time. The E𝕍 displacement history sums with vector addition, it was observed at various past moments in time as -𝕠d. The difference is a -𝕀D inertial temporal history measures what happened to an iota in the past to the present as a force. +𝕀D as the gravitational temporal history measures this time in reverse, from the present to a point in time earlier.

Position to position or moment to moment

The displacement history observes a previous position to a current position, not a previous moment to a current moment. The distinction is important closer to c, the displacement history then causes time to contract or a clock to be slower. A temporal history causes a distance to contract.

Kinetic and inertial history

This allows for a force from particle 1 to particle 2, as well as 2 to 1, each has an active kinetic history as well as its reactionary inertial history. This can vary according to how fast the particles were originally accelerated with a E𝕐/-𝕠d kinetic impulse, if this was a short -𝕠d kinetic time then that is different from a slower kinetic acceleration over a longer -𝕠d kinetic time.

History is contained in the angle θ

However the faster acceleration also did more -𝕆D×e𝕪 kinetic work on the particle for a shorter distance e𝕧, so -𝕆D as the inertial probability or inertial temporal history is also larger. Because of this the E𝕐 kinetic displacement history and the -𝕆D kinetic temporal history are proportionally the same. With different previous accelerations both particles would still have the same -𝕆D inertial temporal history as their E𝕐 kinetic displacement history, as along as their final velocity e𝕧/-𝕚d was the same. This has the same angle θ opposite -𝕚d.

Dilation and contraction cancel out

The first is a displacement of position and the second is a duration of time, these give a constant Pythagorean Triangle area. This is because while E𝕐 was dilated in one particle its -𝕠d Pythagorean Triangle side was contracted, also its -𝕆D inertial probability was dilated while its e𝕪 distance was contracted. The dilation and the contraction cancel out overall with the same final velocity.

Changing the Pythagorean Triangle area

For example if the faster acceleration corresponded to a larger E in the E𝕐 kinetic displacement history, and also a larger D in the -𝕀D inertial temporal history then their corresponding -𝕚d and e𝕪 Pythagorean Triangle sides would have to be larger. That would mean the Pythagorean Triangle area had dilated. But the squared Pythagorean Triangle sides come from observations and measurements, not from changing the Pythagorean Triangle itself.

Different acceleration and Special Relativity

If a rocket is accelerated to near c with a fast or slow kinetic acceleration, then this is observed and measured in Special Relativity. For the same velocity there would be the same e𝕧 length contraction from the E𝕐/-𝕠d kinetic impulse and the same -𝕠d kinetic time slowing or contraction from the -𝕆D×e𝕪 kinetic work.

Different acceleration and General Relativity

In General Relativity a rocket would experience the same e𝕙 height contraction and +𝕚d gravitational time slowing at a given height regardless of its E𝕍 inertial displacement history and its -𝕀D inertial temporal history. It would not matter then if the rocket was in free fall to that height or descended slowly, in relation to its Eℍ/+𝕚d gravitational impulse there would be a slowing of +𝕚d gravitational time and with its +𝕀D×e𝕙 gravitational work there would be a e𝕙 height contraction.

Combining inertial and gravitational histories

Its velocity might be closer to c in either case, then it would have a e𝕧 length contraction orthogonal to this e𝕙 height contraction. It would also have a -𝕚d inertial time slowing along with the +𝕚d gravitational time slowing. But the history of the rocket's acceleration would not matter except for its final velocity.

Consistent histories

The histories of particles 1 and 2 are not relevant, in this restricted case, as long as this resulted in the same velocities. After a collision these histories are not relevant, however the displacement and temporal histories must still be consistent forwards and backward in time and space. For example with the -𝕀D inertial probability there is a normal curve, history needs to conform to a temporal probability. With tossing a coin then the history of previous coin tosses matters, this is even when the coin is at rest before being thrown again.

Histories are not erased

The displacement and temporal histories are not erased after a collision, these histories need to remain consistent forward and backward in time but also in a forward or reversed direction in distance. This history may be important for other reasons, as well, for example if two electrons had their spins entangled then this would affect future -𝕆D×e𝕪 kinetic work in observing their spins.

Inertial rest mass as a constant

Particle 1 can have its velocity added to particle 2 as a constant, this is the same as adding their -𝕚d×e𝕧/-𝕚d inertial momentums because the -𝕚d inertial rest mass is assumed in conventional physics to not change. With the different E𝕍/-𝕚d inertial impulse from the collision then particle 1 acts on particle 2 with its E𝕐 kinetic history, particle 2 acts on particle 1 with its own E𝕐 kinetic history.

Summing velocities

After the collision the sum of their velocities are the same. This comes from the constant areas of the -𝕚d and e𝕧 Pythagorean Triangle, if one Pythagorean Triangle had its area dilated from this E𝕍/-𝕚d inertial impulse then the two would no longer have the same sum of their velocities.

Transferring history in a collision

The -𝕆D×e𝕪 kinetic work done by particle 1 on particle 2 is larger than 2 on 1, this comes from its larger -𝕆D kinetic mass force because it is heavier. This increases the -𝕀D×e𝕧 inertial work particle 2 does because its -𝕀D_2 temporal history now incorporates the active force received from -𝕆D_1. Conversely the -𝕀D×e𝕧 inertial work particle 1 does also incorporates the kinetic temporal history from -𝕆D_2. Inversely to this, particle 1 has a E𝕐/-𝕠d kinetic impulse transferred to particle 2, this causes particle 2, being lighter to increase its velocity.

Balancing histories

It also increased its -𝕀D inertial mass force or inertial probability because its velocity increased, but because it is lighter this -𝕀D inertial temporal history must balance with those of other particles. So its overall E𝕍 inertial displacement history and its -𝕀D inertial temporal history are conserved through all collisions, if the sums of the velocities changed after a collision then this would be the same as an additional particle hitting both at the same point of collision. That would mean the added Pythagorean Triangle areas in the velocities came from particle 3, that would have lost velocity so the three velocities would still sum to conserve the Pythagorean Triangle areas. This also happens in atomic physics, the neutrino was discovered because when a neutron broke up into a proton and an electron there was missing momentum.

Relativistic velocities

This is consistent with Special Relativity, if this was a head on collision near c in a particle accelerator then the angles θ of Particle 1 and 2 would both be contracted. Each has an E𝕐 kinetic displacement history and a -𝕆D kinetic temporal history from being accelerated, even at different rates.

Relativistic momentum is conserved

Each then has a e𝕧 length contraction and a -𝕚d inertial time contraction or slowing. This still has the velocities summing to the same value before and after the collision, one difference can be that this forms other particles and photons. When these are summed with their Pythagorean Triangles and velocities the Pythagorean Triangle areas are still conserved in this model.

Although Equations 11.13 are for two different objects, suppose—just to see what happens—we were to *add* these two equations. If we do, we find that

$$\frac{d(p_x)_1}{dt} + \frac{d(p_x)_2}{dt} = \frac{d}{dt}\left[(p_x)_1 + (p_x)_2\right] = (F_x)_{2\text{ on }1} + (-(F_x)_{2\text{ on }1}) = 0 \qquad (11.14)$$

If the time derivative of the quantity $(p_x)_1 + (p_x)_2$ is zero, it must be the case that

$$(p_x)_1 + (p_x)_2 = \text{constant} \qquad (11.15)$$

Equation 11.15 is a conservation law! If $(p_x)_1 + (p_x)_2$ is a constant, then the sum of the momenta *after* the collision equals the sum of the momenta *before* the collision. That is,

$$(p_{fx})_1 + (p_{fx})_2 = (p_{ix})_1 + (p_{ix})_2 \qquad (11.16)$$

Furthermore, this equality is independent of the interaction force. We don't need to know *anything* about $\vec{F}_{1\text{ on }2}$ and $\vec{F}_{2\text{ on }1}$ to make use of Equation 11.16.

Two pairs of action/reaction forces

Here there are two pairs of action/reaction forces, in Roy electromagnetism there is the active E𝕐/-𝕠d kinetic impulse from electrons and the reactive E𝔸/+𝕠d potential impulse from protons. In Biv space-time there is the active Eℍ/+𝕚d gravitational impulse pulling the molecules downward and a reactive E𝕍/-𝕚d inertial impulse.

The total momentum here would have the kinetic momentum as -𝕠d×e𝕪/-𝕠d, the potential momentum as +𝕠d×e𝕒/+𝕠d, the gravitational momentum as +𝕚d×e𝕙/+𝕚d, and the inertial momentum as -𝕚d×e𝕧/-𝕚d.

Gravity and inertia

Each particle has a Eℍ/+𝕚d gravitational impulse and does +𝕀D×e𝕙 gravitational work in Biv space-time, it also has an E𝕍/-𝕚d inertial impulse and does -𝕀D×e𝕧 inertial work. These interact with each other because each proton has a +𝕚d gravitational mass and each electron has a -𝕚d inertial mass.

Chemical reactions

With Roy electromagnetism the protons have a E𝔸/+𝕠d potential impulse and do +𝕆D×e𝕒 potential work, they interact with each other in the nuclei and also connect to other atoms in molecules. When these other atoms come close there are also possible chemical reactions from this. The electrons have a E𝕐/-𝕠d kinetic impulse and do -𝕆D×e𝕪 kinetic work, these connect the nuclei together in molecules and there are also free electrons.

Angles of interference and collisions

When there is impulse the iotas act as particles, the angles of collisions before and after are deterministic with no randomness. With action/reaction pairs there is often an action, such as from a Eℍ/+𝕚d gravitational impulse and a reaction from the E𝕍/-𝕚d inertial impulse. But there can also be action/action and reaction/reaction pairs.

Active gravity and reactive protons

When there a is Eℍ/+𝕚d gravitational impulse it creates a reaction with the E𝔸/+𝕠d potential impulse. For example, in molecular bonds there is a +𝕚d gravitational attraction between protons, this also acts externally from a planet below an isolated system. When this gravitational attraction increases, such as in the sun, then the Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work can be much stronger. The E𝔸/+𝕠d potential impulse and +𝕆D×e𝕒 potential work react against this, but it can cause Hydrogen to fuse together into Helium.

Roy action/reaction pairs

There can also be reaction/reaction pairs where the E𝔸/+𝕠d potential impulse of protons reacts against the inertia of the E𝕍/-𝕚d inertial impulse with electrons. A spring can oscillate with this -𝕀D×e𝕧 inertial work, being periodic this comes from work while the back and forth motion would be the E𝕍/-𝕚d inertial impulse. These affects the molecular bonds in the spring, the nuclei react against the periodic motion with +𝕆D×e𝕒 potential work, the +𝕆D potential torque reacts against the spring and the molecular bonds being twisted.

Action/action pairs

The action/action pair of the Eℍ/+𝕚d gravitational impulse and the E𝕐/-𝕠d kinetic impulse is also common, for example a rocket burns fuel with a E𝕐/-𝕠d kinetic impulse against the Eℍ/+𝕚d gravitational impulse in moving upwards. It also reacts against this acceleration with an E𝕍/-𝕚d inertial impulse, the fuel is reacting against the breaking of molecular bonds in its combustion with a E𝔸/+𝕠d potential impulse.

Constructive and destructive interference from angles

The angles of interaction also create constructive and destructive interference with probability, electrons in molecular bonds are attracted to where their -𝕆D kinetic probability is greatest. To this is added the +𝕆D potential probability from the nuclei, these also give the attraction and repulsions between ferromagnetic and diamagnetic objects.

Interference in liquids and solids

When other molecules are close, such as in a liquid there are also constructive and destructive interferences as molecules form and break. The +𝕀D×e𝕙 gravitational work is stronger and the -𝕀D×e𝕧 inertial work is weaker, this is because the molecules move with less inertia compared to a gas. That allows for the +𝕆D×e𝕒 potential work to form more molecular bonds such as water crystals.

Van der Waal and Casimir interference

Van der Waal forces happen when the +𝕆D×e𝕒 potential work reacts against the -𝕆D×e𝕪 kinetic work of electrons in other molecules. The Casimir effect happens when materials are close together, the probabilities interfere constructively between them as destructive interferences externally are shielded. This causes them to be attracted.

Stirring and shaking

There are also +𝕀D gravitational and -𝕀D inertial probabilities, some materials will attract others gravitationally when neutral with Roy electromagnetism. Others will move with a stronger -𝕀D inertial probability, for example the material in the system might be stirred or shaken. This can break some molecular bonds, the -𝕀D×e𝕧 inertial work done causes electrons to break off and leave atoms or remain with some atoms as the molecular bonds break. When the material is stirred this is more -𝕀D inertial torque as a rotation, there is also an E𝕍/-𝕚d inertial impulse when shaken which can cause chaotic turbulence.

Reynold's number

Chaotic effects can depend on the Reynold's number of a liquid, whether the E𝕍/-𝕚d inertial impulse dominates or -𝕀D×e𝕧 inertial work. With a low Reynold's number a liquid can be stirred, then reversing this stirring restores the original composition of the fluid. This comes from a higher +𝕆D potential and -𝕆D kinetic gradient of the liquid, stirring it is like moving molecules back and forward on this gradient.

Changing quantized levels

There is little change or turbulence over time, instead the gradient is like a quantized level. An electron in a quantized orbital might move up to a higher orbital by absorbing a e𝕪×-𝕘d photon. Then it emits the photon and returns to the original -𝕆D×e𝕪 kinetic work like with the liquid.

Higher Reynold's number

A higher Reynold's number has a stronger E𝕐/-𝕠d kinetic impulse and so there is more turbulence. It changes more over -𝕠d kinetic time rather than oscillating between two state like the more viscous fluid. This turbulence comes from δ which approaches the work value of α, it causes cascades of parabola like curves in a high Reynold's number fluid. It also comes from β as the second Feigenbaum number, this approaches √(2π) which is also associated with work and quantization.

Cascades and tines

That gives tines at the ends of the cascades, the turbulence then changes over time with the cascades and tines. It also gives shapes that are close to the conic sections such as vortices close to circles. These cascades are close to parabolas.

Roy electromagnetism and viscosity

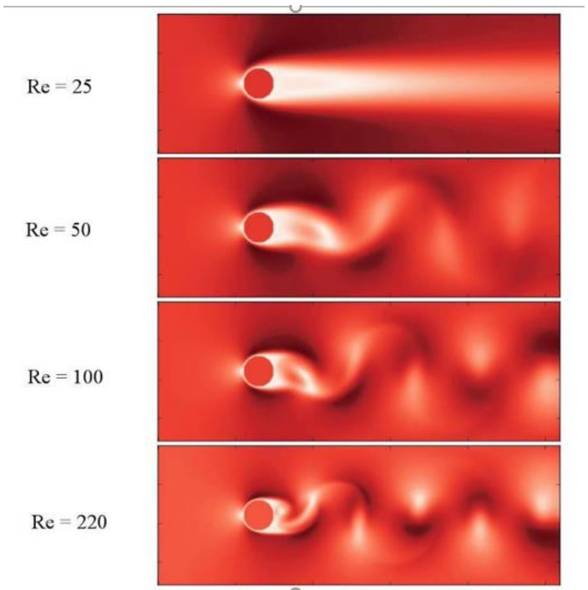
This comes from the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work of the viscous fluid, the molecules do more work on each other as it is closer to being a solid. This changes less over time compared to a liquid or gas, it changes over a distance from work so the solid can be moved like rolling a ball. A liquid can only move by changing more over time with a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

The constants h and k

This comes from k as -𝕠d ×e𝕪/-𝕆d, the -𝕆D×e𝕪 kinetic work is being measured, this gives a Gaussian distribution in gases for example. With h the particles are being observed with impulse deterministically, because of this it is observing particles in orbitals with their impulse and then converting this into a wave function. In this model then h relates to the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse in less viscous fluids.

Photons as particles and waves

In a viscous fluid with a low Reynold's number the e𝕪×-𝕘d photons are more like waves doing -𝔾D×e𝕪 light work, they move between the atoms maintaining quantized and regular shapes such as a laminar flow. This does not change over time, the laminar shape looks like layers of atoms. When the Reynold's number increases the wake can oscillate more as a quantized level of +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. As this deviates more from α and π it becomes more turbulent as δ and β.



Chaos and Fiegenbaum numbers

In chaos there are two Fiegenbaum numbers called δ and β, there are found nearly everywhere in chaos, turbulence, etc. In this model they represent a limit approaching α and π which give work and probability. Because of this they can produce chaotic and aperiodic motion, when they reach this limit they can become periodic which relates to oscillations.

The ground state

In this model that happens because of α in the ground state of atoms, also from 2π where this gives the e𝕒 altitude above a proton. When this circular ground state has the circumference of 1 it can be added as n quantum numbers, 1,2,3,.. and so the radius of that circle as the e𝕒 altitude or e𝕙 height is associated with quantized orbitals and work. The value √(1/2π) is also used in probability as a renormalization constant, before this is reached then there is a chaotic impulse.

From a normal curve to impulse

A normal curve has an area of 1 when divided by 1/(√2π), if the atoms are more chaotic then the normal curve has spikes in it where the distribution is less random. That √(2π) approaches \beta and the quantized levels become tine distances which change in chaotic cascades.

The reduced Planck's constant ℏ

The term ℏ refers to h as -𝕠d ×e𝕐/-𝕠d divided by 2π, in this model this gives +𝕠d × e𝔸/+𝕠d or $h_{e𝕒}$ Where instead of E𝕐 as a kinetic vector orthogonal to E𝔸 around a circle of 1 this expresses h in terms of the +𝕠d and e𝕒 Pythagorean Triangle. It becomes then a unit of angular momentum where +𝕆D as the potential probability decreases as the square D when the orbitals increase in e𝕒 altitude.

Aperiodic motion becomes periodic

In this model then chaos and turbulence form when there is more impulse than work, this is deterministic and so can be reversed in time as with a low Reynold's number fluid. When 2π is approached then there is more +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work from probability, the normal curve or Gaussian is associated with 2π as opposed to approaching this value. Before 2π then there can be aperiodic motion and chaos forming fractals for example. With 2π this changes into a periodic oscillation such as deBroglie waves in an electron orbital.

Quantized periodic values

This is seen in the diagram above where the E𝕍/-𝕚d inertial impulse of the low Reynold's number fluid becomes periodic with higher numbers. In between these periodic values there is more aperiodic motion because it is also between √1/2π. These are like quantized orbitals where there are periodic or integer numbers of electron waves with -𝕆D×e𝕪 kinetic work. In between these orbitals -𝕆D×e𝕪 kinetic work cannot exist because there is no -𝕆D kinetic probability, an electron would move chaotically there.

Discrete and continuous spectra

A discrete spectrum comes from -𝔾D×e𝕪 light work as photons are emitted and absorbed in these orbitals related to 2π. A continuous spectrum comes from a e𝕐/-𝕘d light impulse where photons collide with electrons acting as particles, this is where they are not in quantized 2π orbitals.

2π and α

α in conventional physics is the ratio of e𝕧/-𝕚d or the velocity of the electron in the ground state compared to c. It then represents an angle θ here of the -𝕠d and e𝕪 Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle at this e𝕒 altitude above the proton. This ground state as 1 then has a radius of 2π and the square root of this is √π/2 as β. α is close to √δ/

α and δ

In this model α is also √(δ/2π) where δ is the first Feigenbaum number. This is a square root here and so this is also connected to chaos, when an electron reaches the ground state after leaving a neutron then this does -𝕆D×e𝕪 kinetic work as a wave. This also gives it a -𝕆D kinetic probability where D=1. The α value is also approximately $e^{-𝕠d}$ with d=1 and it also approaches $e^{2\pi}$, where 2π comes from β^2 as the second Feigenbaum number.

Between quantized orbitals

In between quantized orbitals then, where the exponent D in $e^{-𝕆D}$ is n in quantum numbers, there can be chaotic motion where work is impossible. From this comes turbulent motion, low Reynold's numbers, and fractals with a fractional dimension.

Quantized orbitals and chaos

When molecules do more -𝕆D×e𝕪 kinetic work on each other than their electrons have a higher -𝕆D kinetic probability, their positions e𝕪 are expressed in a periodic form. This is because 2π is used instead of approaching it with β and impulse. It is also because the first Fiegenbaum number δ becomes part of the ground state as α doing -𝕆D×e𝕪 kinetic work. This determines their viscosity and Reynold's number in this model.

Navier Stokes equations

With the Navier Stokes equations, when a fluid is less viscous it changes more over time with impulse. That makes it more turbulent with δ and β. The laminar flow from work changes more over time chaotically.

An isolated system

The isolated system then contains work causing random motions from constructive and destructive interference, these comes from probabilities and the spin Pythagorean Triangle sides squared. Where there is impulse this motion can be chaotic, this comes from the straight Pythagorean Triangle sides squared.

Quantized orbitals and e

The two come together with α that defines the ground state, this is the first orbital with +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work in an atom. These also connect proportionally with the +𝕀D×e𝕙 gravitational work of the proton and the -𝕀D×e𝕧 inertial work of the electron. As this is approached then e is also approached as an infinite series, before this there are different exponent bases.

α and e

In this model α is also approximately e^{-1} as well as $e^{2\pi}$, this connects 1 as the first quantum number n to 2π as β^2. It also connects the ground state to e and exponential curves as well as logarithms. The exponential curve and exponential spiral are from impulse and work respectively, the curve is a straight-line increase in for example E𝕐 compared to -𝕠d with a fixed Pythagorean Triangle area. The exponential curve is from -𝕆D×e𝕪 kinetic work where the -𝕆D kinetic torque causes an electron to move upwards or downwards in orbitals.

Exponential curves and spirals

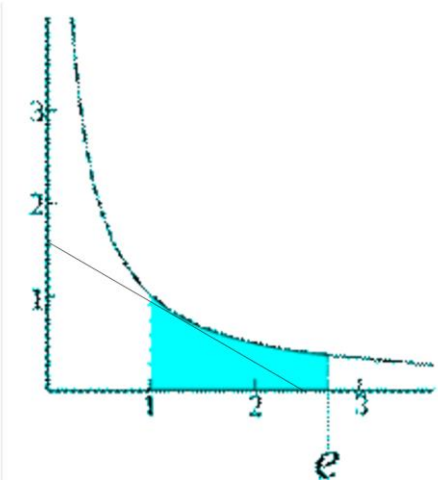
Both of these then connect 2 to 2π and α, this allows for logarithms to work in the Euler equation. The +𝕠d and e𝕒 Pythagorean Triangle as the proton is in circular geometry, its exponent as $e^{e𝕒+𝕠d}$ can then be expressed as a logarithm to give an exponential curve or spiral. The exponents and Pythagorean Triangle sides will be explored more later, the main point here is the connection to e. Changing the angle θ in the +𝕠d and e𝕒 Pythagorean Triangle can give an exponential curve with E𝔸 and an exponential spiral with +𝕆D, both expressible as exponents of e.

Mathematical constants

In this model many of the interactions between Pythagorean Triangles come from approaching mathematical constants. With hyperbolic geometry this comes from the hyperbola, when a Pythagorean Triangle is under the hyperbola it has a constant Pythagorean Triangle area such as with the -𝕠d and e𝕪 Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle.

Exponentials in hyperbolic geometry

The hyperbola also has a relation with e, that gives logarithms as an area. The e𝕒 altitude above a proton, and the e𝕙 height from gravity, come from the straight Pythagorean Triangle sides but the hyperbola comes from a rotation of the Pythagorean Triangle. This also gives exponentials which relate to two exponents, for example e𝕪 and -𝕠d from the electron.



Exponential curves over time

In this model the exponential curve is formed when one straight Pythagorean Triangle side is squared and the spin Pythagorean Triangle side is linear, for example with E𝕍 as a displacement length and -𝕚d as inertial time this gives an exponential or logarithmic curve. The changes in the constant area Pythagorean Triangles then create the hyperbolic trajectory of asteroids for example with their E𝕍/-𝕚d inertial impulse past a Eℍ/+𝕚d gravitational impulse of a planet.

Exponential spirals over a distance

It also creates the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work of planets in a star system conforming to an exponential and log spiral. For example the planets are slowing moving outwards in an exponential spiral from the sun.

Logarithms with circles and hyperbolas

Because of this relation to the hyperbola the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle can have their Pythagorean Triangle sides expressed in terms of a hyperbola. With logarithms this allows for the Pythagorean Triangle sides to act as exponents while maintaining a constant Pythagorean Triangle area. Because of the relation between e^{-1} and $e^{2\pi}$ with α the Pythagorean Triangles can be expressed as exponentials in relation to circular geometry as well. The 2π exponent can be expressed as radians, this refers to the spin Pythagorean Triangle sides.

Eigenvectors

In this model that explains why logarithms conform to reality so well, the exponential curve comes from impulse and the exponential spiral comes from work. Both come from a constant Pythagorean Triangle area. In conventional physics taking a derivative of the straight Pythagorean Triangle side as an exponent gives an Eigenvector, that is the impulse force from a particle vector. More will be explained on this in quantum mechanics.

Inverse square rule

The e𝕒 altitudes and e𝕙 heights, from the +𝕠d and e𝕒 Pythagorean Triangle and +𝕚d and e𝕙 Pythagorean Triangle respectively, can be written as inverses of integer square roots such as 1, 1/√2, 1/√3, … When these are observed with the E𝔸/+𝕠d potential impulse and the Eℍ/+𝕚d gravitational impulse they become the inverses of the integers. As these vary they would act as a displacement from an initial to a final position e𝕒 or e𝕙. Because the -𝕠d kinetic magnetic field has its d value proportional to e in e𝕒, this also gives the -𝕆D values as the inverses of the integers E𝔸. With a -Od kinetic probability the electrons obey an inverse square rule, they are less likely to be found in higher orbitals.

Euler Mascheroni constant

As this series is continued these probabilities as areas can be subtracted from the area of the hyperbola, this difference gives γ as the Euler Mascheroni constant. That makes the hyperbola inside this series of inverses, that would allow a hyperbolic trajectory to be captured by it. In Roy electromagnetism the inverse integers end at the ionization level where the electron orbitals end, then they jump to hyperbolic geometry where the electron leaves the atom. This ionization level comes from γ in this model, instead of there being an infinite number of energy levels there is a jump to a hyperbolic trajectory.

Two different constant area Pythagorean Triangles

In this model the two are different, the inverses of the integers comes from circular geometry and the +𝕠d and e𝕒 Pythagorean Triangle as the proton. This is formed by a Pythagorean Triangle with a constant area, as e𝕒 dilates then +𝕠d as the potential magnetic field contracts above a proton. An electron is in hyperbolic geometry, its constant area Pythagorean Triangle is under this hyperbola and changes in a different way to the +𝕠d and e𝕒 Pythagorean Triangle.

Biv space-time and γ

This would also occur in Biv space-time, as asteroid might pass a planet with its hyperbolic trajectory. This is defined by its -𝕚d and e𝕧 Pythagorean Triangle with inertia, a constant Pythagorean Triangle area under the hyperbola. The +𝕚d and e𝕙 Pythagorean Triangle has gravity reaching up as squared square root integer in +𝕀D×e𝕙 gravitational work. For this hyperbolic trajectory there is a limit as γ, it does not become infinitely small.

Quantum leaps

The same constant can appear in many situations, the -𝕠d and e𝕪 Pythagorean Triangle as the electron would also have this hyperbolic Pythagorean Triangle in the ground state. It then allows for the circular and hyperbolic geometries in this model to approach each other but not become equal at a value. From this then can come a quantum leap, the electron would jump to a higher orbital in hyperbolic geometry rather than there being a continuous change.

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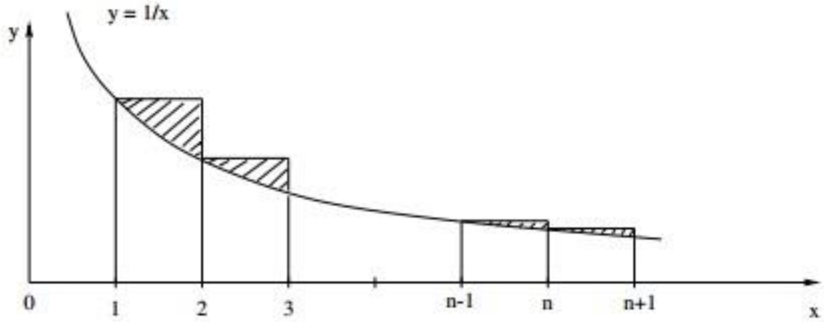
Proof. Examining the area under the graph of $y = \frac{1}{x}$, $1 \le x \le n+1$,



we see that

$$1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{n} > \int_1^{n+1} \frac{1}{x}\, dx = \log(n+1),$$

that is, $a_n = h_n - \log(n+1) > 0$ for all $n \ge 1$.

The CMB as a limit

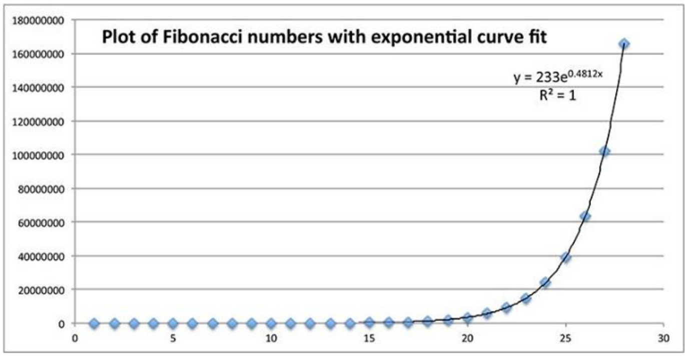
In Biv space-time this e𝕙 height extends out to the CMB, beyond there is another jump past this sum of -𝕀D inertial probabilities, or the sum of Eℍ values with the Eℍ/+𝕚d gravitational impulse. This means that e𝕪×-𝕘d photons cannot be measured past this boundary, it acts as the limit of +𝕀D×e𝕙 gravitational work. Their -𝕘d rotational frequency drops too low, to below the ground state. This can also be viewed as an event horizon, beyond this nothing can be measured by a stationary measurer.

ϕ as an exponential curve or spiral

In this model ϕ as the golden ratio comes as a limit of Fibonacci numbers, it has been shown that the solar system planets and moons approach a Fibonacci number resonance. This allows them to do +𝕀D×e𝕙 gravitational work in stable orbits where +𝕀D acts as a gravitational probability of where they can move and -𝕀D is their inertial probability from their velocity.

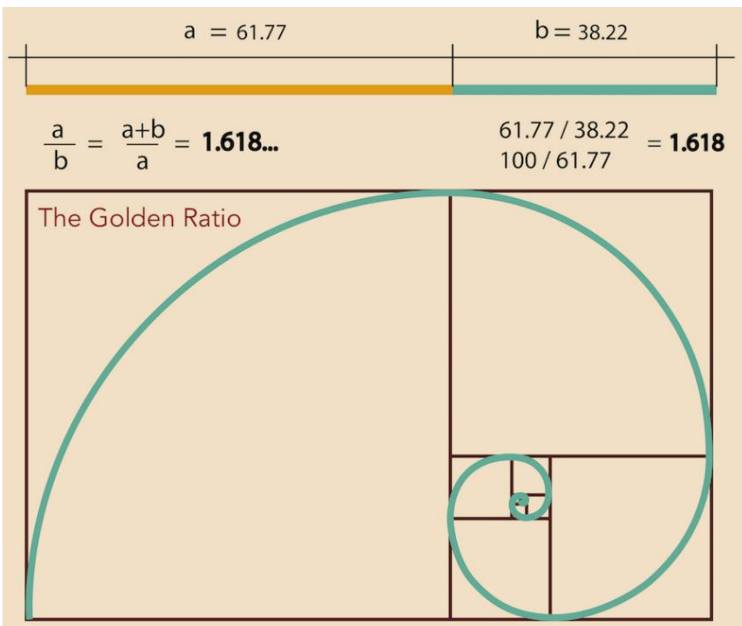
A balance between work and impulse

Because this is an exponential spiral it connects to the constant Pythagorean Triangle areas with work, when it is expressed as an exponential curve this is from impulse. The planets and moon then approach a ratio where the Eℍ/+𝕚d gravitational impulse and the +𝕀D×e𝕙 gravitational work reach a balance. This is because the golden ratio can be formed by integral areas in work, it can also be formed by adding vectors in impulse. In the diagram below the Fibonacci numbers are mapped onto an exponential curve.



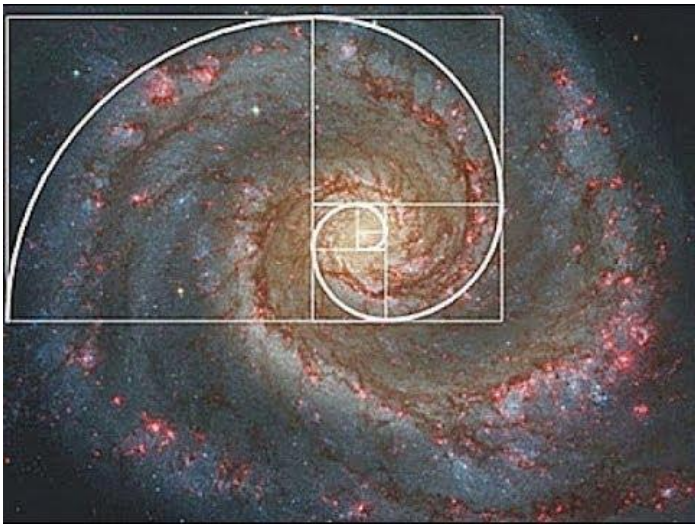
Adding areas in a Fibonacci spiral

In the diagram the golden ratio is formed from adding areas, in this model this is from integrals and work forming an exponential. This need not be with the golden ratio, that represents a limit of work and impulse converging.



Galaxies as exponential spirals

This allows for the limits of both e and ϕ to be compatible with the constant Pythagorean Triangle areas, the exponential spiral of galaxies in this model comes from this Eℍ/+𝕚d gravitational impulse and +𝕀D×eℍ gravitational work forming exponentials. It also comes from the Fibonacci exponential spiral because of these connections between work and impulse. In this model the exponential spiral of a galaxy is formed from the constant area of the +𝕚d and eℍ Pythagorean Triangle as gravity, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia.



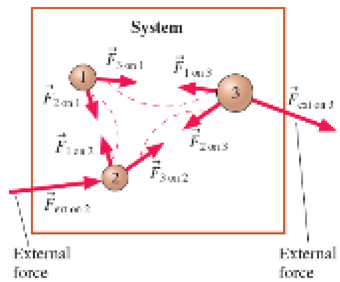
Our study of energy in the last two chapters has emphasized the importance of having a clearly defined system. The same is true for momentum. Consider a system consisting of N particles. **FIGURE 11.11** shows a simple case where $N = 3$, but N could be anything. The particles might be large entities (cars, baseballs, etc.), or they might be the microscopic atoms in a gas. We can identify each particle by an identification number k. Every particle in the system *interacts* with every other particle via action/reaction pairs of forces $\vec{F}_{j\text{ on }k}$ and $\vec{F}_{k\text{ on }j}$. In addition, every particle is subjected to possible *external forces* $\vec{F}_{\text{ext on }k}$ from agents outside the system.

If particle k has velocity $\vec{v}_k$, its momentum is $\vec{p}_k = m_k\vec{v}_k$. We define the **total momentum** $\vec{P}$ of the system as the vector sum

$$\vec{P} = \text{total momentum} = \vec{p}_1 + \vec{p}_2 + \vec{p}_3 + \cdots + \vec{p}_N = \sum_{k=1}^{N} \vec{p}_k \qquad (11.17)$$

That is the total momentum *of the system* is the vector sum of the individual momenta.

FIGURE 11.11 A system of particles.



Adding vectors or areas

Here a time derivative is impulse, this is shown as a sum of different time derivatives. With the clockwork universe collisions can be a sum Σ of vectors from the E𝕍/-𝕚d inertial impulse for example. In calculus an integral is portrayed as a sum of many rectangles with an infinitesimal width, or of fluxions as instants. These would be -𝕀D×e𝕧 inertial work for example.

Lines of force

A field is sometimes portrayed as lines of force, for example with an electric or magnetic flux. This can act like a flow with straight Pythagorean Triangle sides, a Gaussian flux can then have an equal amount going in and out of an object. In this model the electric flux can be straight Pythagorean Triangle sides such as a E𝕐/-𝕠d kinetic impulse, the magnetic flux would be an integral area from -𝕆D×e𝕪 kinetic work.

A flux flow

The flow of the flux would be according to the potential speed e𝕒/+𝕠d and the kinetic velocity e𝕪/-𝕠d, these might be electrons as -𝕠d and e𝕪 Pythagorean Triangles moving towards protons as +𝕠d and e𝕒 Pythagorean Triangles.

Integrals as summed vectors

A sum symbols as Σ would be of lines as vectors adding to an area, an integral ∫ would be adding areas together. The vector can be squared, then its magnitude such as E𝕍 is a displacement force.

An area can also be squared such as -𝕆D, this acts as a temporal duration or history. With calculus then these areas can also be regarded as lines of vectors with an infinitesimal width, a field might then be classically approximated by a vector space of particles. A gravitational field can be approximated with the Eℍ/+𝕚d gravitational impulse, the Eℍ height displacement acts like an integral composed of Eℍ vectors.

Vectors as curl

In Roy electromagnetism an electric field would be a classical approximation from the E𝕐/-𝕠d kinetic impulse, the E𝕐 kinetic displacement vectors would be infinitesimals pointing in the directions of forces. The -𝕠d kinetic magnetic field is also portrayed this way sometimes with curl, small vectors spin and create the magnetic forces in conventional physics.

Lines and areas

This becomes a paradox similar to what Zeno discussed with points and lines. A line such as e𝕧 can be a vector as a series of points on a scale. A e𝕧 length in the -𝕚d and e𝕧 Pythagorean Triangle acts as a series of e𝕧 points or positions on a scale. When this is observed it is an E𝕍 displacement, then it becomes a history as a line. An integral then has a straight Pythagorean Triangle side with Zeno's paradox, these e𝕧 points on a line can be the beginnings of vectors with an infinitesimal width.

Field lines

In this model that would be a classical approximation, it allows for modeling -𝕆D×e𝕪 kinetic work as a kinetic magnetic field with vectors and field lines. The e𝕧 points or positions are on a scale of work, but for this to be field lines the vectors must each have an E𝕍 displacement with here.

Past, present and future

In terms of Zeno's arrow it does not actually move in the present, its E𝕍 inertial history can end in the present showing its displacement history from an initial to final position e𝕧. A straight Pythagorean Triangle side squared becomes a displacement, a spin Pythagorean Triangle side squared becomes a duration. Because these are defined by the final e𝕧 position and -𝕚d inertial moment respectively, these cannot happen in the present. In this model then the present is not observable or measurable, it is where forces end in moving towards the future, or in moving from the future.

An integral as a sum of vectors

An integral under a curve can approximately be summing an E𝕍/-𝕚d inertial impulse by a series of parallel E𝕍 vectors. There is then no -𝕆D×e𝕪 kinetic work, the E𝕐/-𝕠d kinetic impulse is however composed of straight-line forces to describe a curved field. In conventional physics these straight-line vectors might be spun with a -𝕆D kinetic torque, then the vectors would represent the e𝕪 kinetic electric charge as positions. For example the initial position e𝕪 would have this -𝕆D kinetic torque on it, when the vectors are presumed to be infinitesimals this is the same as a point.

Observer measurement and electromagnetism

In this model electromagnetism is not a dual force, it can be observed as a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. This is the potential electric charge and kinetic electric charge respectively. It can also be measured as +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. To say an observer of impulse measures work can assume these two forces acts simultaneously in the same moment, and in the same position. Here this cannot happen, first there is a measurement and then this is observed.

Using work to model impulse

When a field is modeled as a sum of field lines, this is using impulse to model all work. Conversely work can be used to model all impulse, in this model that is the basis of quantum field theory. This is where constructive and destructive interference cancels out the spin probabilities except for where a particle is observed.

Summing histories as interference

In the -𝕠d and e𝕪 Pythagorean Triangle for example there is -𝕆D×e𝕪 kinetic work, this can also be regarded as a sum of kinetic temporal histories like a path integral. The conventional model proposes that the different -𝕆D kinetic probabilities interfere so that only the particle with the E𝕐/-𝕠d kinetic impulse remains.

Path integrals and field lines

A path integral then models particles as a sum of possible displacement histories that interfere, for example a e𝕪×-𝕘d photon in a double slit experiment has many probable path histories. Field lines take the opposite approach, that the wave like nature of the photons is composed in field lines, that these paths would be like vectors that leave on history at the end.

An observation measurement problem

This reverses the measurement observer problem, whether an observer is needed to create a measurement. That is not true in this model, work is a measurement so that impulse can follow it. But work can also be a series of measurement over a scale of straight Pythagorean Triangle sides without observing a particle with impulse.

A wave function spreads out

When an observation occurs with impulse, the converse is whether this can be measured by a measurer. That is like taking a particle and collapsing it back into a wave function. In this model that would be done by measuring its positions, an electron in quantum mechanics turns back into a wave as this localized observation spreads out. This is referred to as changing over time, in this model that would be spreading out over an increasing distance. The difference is the spreading out refers to a distance, whether this happens over a long or short time can refer to a temporal duration probability.

A curve composed of slopes

In calculus a curve is composed of tangent slopes from a Pythagorean Triangle, defining a curve from integration would say this curve is composed of the areas of those Pythagorean Triangles. In conventional calculus these two are interchangeable, instead of a derivative slope the integral area is taken. Each has a squared force when taken as a double derivative or double integral. In this model that is why a second derivative is only used with impulse, a slope is a particle. A second integral is only used with work, this gives an area which acts as a field not a particle.

Uncertainty between field lines and path integrals

When a field is regarded as composed of vectors, or a particle with its vector path is composed of fields, this implies the two are directly convertible into each other. That needs a calculus

Pythagorean Triangle with sides that are infinitesimals or fluxions as instants. When the Pythagorean Triangle cannot be made small enough this creates uncertainty from one viewpoint to the other, that becomes the uncertainty principle.

Changing from field lines to path integrals

When field lines are used this implies a position with these vectors can be known precisely. When path integrals are used this implies that a vector is a precise probability, a history that was the only possible one. The limit of these two is the area of the e𝕪 and -𝕘d Pythagorean Triangle as a photon, its e𝕪 kinetic electric charge or e𝕧 wavelength is not an infinitesimal and the -𝕘d rotational frequency is not a fluxion or instant. If both Pythagorean Triangle sides could be observed and measured together this is the same as saying it is infinitely small. Because of this only one Pythagorean Triangle side can be observed or measured at a moment or position.

The uncertainty principle from vectors

Using observation and particles then fields can be modeled as vectors and particles, but this creates the uncertainty principle when the position e𝕧 of a particle is observed too closely. In this model that causes the -𝕚d and e𝕧 Pythagorean Triangle, with a constant area, to have -𝕀D dilate as -𝕀D×e𝕧 inertial work. A wave function appears from trying to observe fields as a sum of vectors.

Changing from displacement to history

There was a change from a vector having a displacement history to becoming a position, that turned it from impulse to work. If a probability in a path integral is measured too precisely this turns it into a moment in time instead of a temporal duration, that creates impulse so the particle moves faster.

General Relativity and basis vectors

It also leads to General Relativity where these summed integral areas no longer have straight-line sides, the +𝕀D gravitational durations are modeled with curved coordinates though these are still called basis vectors. These curved forces in a geodesic can be regarded as a +𝕀D gravitational torque at different e𝕙 heights above a planet. They are not the vectors but the spin on the vectors as points on a scale like a ruler.

Gravitational torque

In this model the changes in the +𝕀D gravitational torque, or gravitational probabilities like a path integral, are not vectors but are a series of positions as points making a path not a displacement. The change in the +𝕀D gravitational field force would then be a change in integral areas summed together as torque or probabilities interfering with each other. The slope of the particle's trajectory is then directed by the forces of the geodesic, the amount of +𝕀D gravitational torque or probability would cause a satellite to orbit around a planet for example.

The particle is not the geodesic

This creates a wave equation for gravity but now there are no particles in it, that makes it impossible to observe a quantization. A particle is assumed to have no forces so there is no Eℍ/+𝕚d gravitational impulse, instead it moves with free fall on a curved geodesic. The particle is not part of the geodesic itself, a position or series of points on a path is measured by the geodesic with +𝕀D×e𝕙 gravitational work.

The geodesic does not change

This geodesic does not change for different particles in this model, it is like different sized balls rolling in and around a depression. This is a common model for a geodesic, here the -𝕀D×e𝕧 inertial work of the ball is subtracted from the +𝕀D×e𝕙 gravitational work or geodesic to measure its positions. This is because a geodesic does not have +𝕚d gravitational moments on a timeline, it represents a fixed gravitational temporal duration as a history.

History does not change, it ends

This history then cannot change unless it becomes impulse, for example a rocket might be gravitationally weightless moving in a geodesic conforming to this history. If it fires its rocket with a E𝕐/-𝕠d kinetic impulse then this changes that history, the rocket measures the +𝕀D×e𝕙 gravitational work done by the geodesic actively trying to keep gravitationally weightless.

The total momentum of the rocket + gases system is conserved, so the rocket accelerates forward as the gases are expelled backward.

The time derivative of $\vec{P}$ tells us how the total momentum of the system changes with time:

$$\frac{d\vec{P}}{dt} = \sum_k \frac{d\vec{p}_k}{dt} = \sum_k \vec{F}_k \tag{11.18}$$

where we used Newton's second law for each particle in the form $\vec{F}_k = d\vec{p}_k/dt$, which was Equation 11.4.

The net force acting on particle k can be divided into *external forces*, from outside the system, and *interaction forces* due to all the other particles in the system:

$$\vec{F}_k = \sum_{j \neq k} \vec{F}_{j \text{ on } k} + \vec{F}_{\text{ext on } k} \tag{11.19}$$

The restriction $j \neq k$ expresses the fact that particle k does not exert a force on itself. Using this in Equation 11.18 gives the rate of change of the total momentum $\vec{P}$ of the system:

$$\frac{d\vec{P}}{dt} = \sum_k \sum_{j \neq k} \vec{F}_{j \text{ on } k} + \sum_k \vec{F}_{\text{ext on } k} \tag{11.20}$$

The double sum on $\vec{F}_{j \text{ on } k}$ adds *every* interaction force within the system. But the interaction forces come in action/reaction pairs, with $\vec{F}_{k \text{ on } j} = -\vec{F}_{j \text{ on } k}$, so $\vec{F}_{k \text{ on } j} + \vec{F}_{j \text{ on } k} = \vec{0}$. Consequently, **the sum of all the interaction forces is zero.** As a result, Equation 11.20 becomes

$$\frac{d\vec{P}}{dt} = \sum_k \vec{F}_{\text{ext on } k} = \vec{F}_{\text{net}} \tag{11.21}$$

where $\vec{F}_{\text{net}}$ is the net force exerted on the system by agents outside the system. But this is just Newton's second law written for the system as a whole! That is, **the rate of change of the total momentum of the system is equal to the net force applied to the system.**

All momentum as vectors

An isolated system in this model is a number of Pythagorean Triangles, the -𝕚d×e𝕧/-𝕚d inertial momentum is conserved throughout because of the constant Pythagorean Triangle area of the -𝕚d and e𝕧 Pythagorean Triangle. This applies to all the Pythagorean Triangles and so the overall momentum is also conserved. This is modeled below as a vector addition, that is like the sums of derivatives slopes in a clockwork universe.

Fields as virtual particles

When subatomic particles are also modeled as vectors this way all fields become composed of virtual particles. Biv space-time contains fields of different virtual particles in quantum field theory. This is referred to as vacuum energy.

Borrowing energy for a short time

They cannot be observed or measured, but can appear for a short time by seeming to borrow energy. This energy comes from impulse, the E𝕐/-𝕠d kinetic impulse for example is part of the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy formula. The greater this energy as E𝕐 for example the shorter the -𝕠d kinetic time it is observed for. This refers to impulse because they are being observed.

Muon lifespan

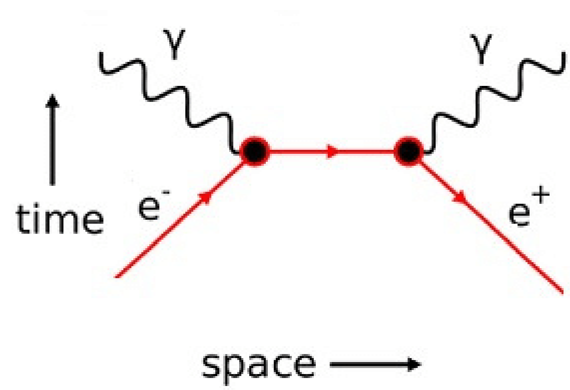
That might be from a particle collision where the particle receives enough e𝕧/-𝕚d velocity to slow its clock gauge according to Special Relativity. A muon electron for example might be created as the byproduct of a collision, when moving fast enough its -𝕠d time on a clock gauge is slowed enough to detect it before it decays.

Exponential decay curve

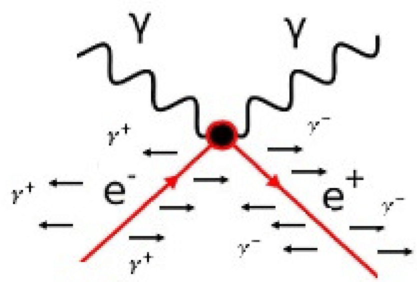
This is on the Pythagorean Triangle exponential decay curve, that would be where the E𝕐 kinetic displacement history and the -𝕠d kinetic time diverge to form the exponential curve. This comes from the E𝕐/-𝕠d kinetic impulse because its clock is slowed, if this came from -𝕆D×e𝕪 kinetic work then its lifespan would not be extended. Instead, its e𝕧 length would be contracted.

Electron positron probabilities

Electron positron pairs might appear for a short time in a vacuum, this comes from e𝕪×-𝕘d photons where the +𝕆D positron probability and -𝕆D kinetic probability is large enough to spontaneously appear then disappear in an annihilation as other photons. It is large enough to appear to be measured, but the probabilities are small enough for this to be rare. With a small enough +𝕆D positronic difference and a -𝕆D kinetic difference, as a temporal history, the e𝕪 kinetic electric charge can be large enough to temporarily form the electron and positron.



Feynman diagram of electron/positron annihilation



Attraction by virtual photons

Summing probabilities

Because this rarely happens in a large section of Biv space-time the over probabilities are low enough when summed like a path integral. That allows for an occasional higher probability with constructive and destructive interference of the overall probabilities. For example, in poker a straight flush might be rare, but this allows for an occasionally improbable event to occur.

Separating probabilities

If these are separated, for example by being near a +ⅈd gravitational mass then they might move off in different directions. The +𝕆D positronic and -𝕆D kinetic probabilities then no longer destructively interfere because their e𝕪 and e𝕧 positions are no longer correlated.

Energy/time uncertainty

The E𝔸 potential and E𝕐 kinetic history also come from the uncertainty principle, this is referred to conventionally an energy/time uncertainty. They can also be measured as a temporal duration, then an improbable observation of a particle is unpredictable. Uncertainty in this model then refers to probability and predictability.

Predicting impulse

Impulse can be deterministic, but without being able to measure a temporal duration then it is a series of unpredictable moments on a clock gauge. To predict where a particle will be at a future time that needs a measurement of the temporal duration, that is from work only.

Start to final positions

These displacement histories are not temporal in the sense of going forward and backwards in time, instead they are displacements from a start to a final position. With a E𝕐/-𝕠d kinetic impulse there is a starting and final e𝕪 position over a -𝕠d kinetic time going forwards, with a E𝔸/+𝕠d potential impulse there is a final to starting position over a +𝕠d potential time going backwards.

A displacement is not the time taken

When a car makes a journey for example, this can be impulse from its starting point to its destination. It can also be referred to as being the displacement from its destination to its starting position. Starting and final do not refer to time in this model, instead they are where a force begins and ends on a clock gauge. The displacement of the journey is not the time, it is defined in meters not seconds. This displacement remains when the time taken varies.

Electron repulsion

Two electrons are proposed in conventional physics to repel each other, this happens because of virtual photons that cannot be detected. In this model the probabilities of different particles being formed by this interaction comes from α as a probability, this not from impulse as vectors but from work.

Electrons interfere destructively

It also comes from the -𝕆D×e𝕪 kinetic work with destructive interference, when they approach each other the -𝕆D kinetic probabilities decrease destructively. This causes them to be less likely to be closer together on a e𝕪 scale of positions, they then move apart with a -𝕆D kinetic torque in a hyperbolic trajectory.

Probability of being in a higher orbital

When two electrons are in a Helium atom they form a boson pair, then this -𝕆D kinetic torque is also interfering destructively, this makes it less likely they are found in a higher orbital. As an electron moves to a higher orbital its -𝕆D kinetic torque and probability increases, when this is lower then the electron is more probably found in a lower orbital. When the spins are opposed this also lowers the -𝕆D kinetic probability, that makes it more likely they will be found in the lowest orbital.

Cooper pairs

In this model a Cooper pair forms a boson with two electrons, this is like in an orbital except the electrons are outside atoms. The repulsion from other electron in a lattice causes them to oppose their spins and become a boson pair. Because of this their mutual repulsion is removed, then more electrons can fit into this lattice in a current like in a lower orbital or energy level. When in this state the Cooper pairs have no overall -𝕆D kinetic probability, this removes the kinetic friction that would dissipate a current.

Meissner effect

This repels an outside magnetic field because of this lower energy state, that is called the Meissner effect. The process is the same as a boson pair in the ground state repelling a fermion from joining them in a lower orbital in an atom. Their -𝕆D kinetic torque is lower as a pair, this enables them to move through the lattice instead of being repelled from each atom forming a more turbulent current. This turbulence comes from β^2 approaching but not equaling ½π, the electrons would lose energy with a chaotic motion.

A magnetic field from fermions

The external magnetic field is composed of fermions spinning in the same direction. This cannot affect the Cooper pairs because their spins are opposed and canceled, the external magnetic field experiences the same repulsion that caused the Cooper pairs to form with opposing spins. If the lattice warmed, then the Cooper pairs would break up with chaotic motions acting like friction and turbulence. Then they would act like fermions the same as the external magnetic field which would not longer be repelled differently than the electron pairs.

Inertial probability and torque

This is like two tops with a clockwise spin meeting, in between the -𝕀D inertial torque pushes them away from each other. In this model that is the -𝕀D inertial probability being canceled between them so they have a lower inertial probability of remaining together. The tops could be placed with one on top of the other, then the probabilities interfere constructively and they no longer repel each other.

Quantum electrodynamics

In this model α is the -𝕆D×e𝕪 kinetic work done by an electron in the ground state as $e^{-𝕆D}$, because this is quantized then as D increases it gives the quantum orbital numbers n. Because this is set as 1 in the ground state as a wave, this means the probabilities of what electrons do are also in increments of 1 as -𝕆D kinetic probabilities. It also means that the repulsion between electrons can be measured as -𝔾D×e𝕪 light work with increments of 1 as a light probability. The -𝕆D×e𝕪 kinetic work squares d values which are the square roots of integers only, this is because a fraction would be a derivative as impulse.

Electrons with a quantized interaction

In the ground state α comes from δ and β as the two Fiegenbaum constants in chaos. When this is measured in the ground state as e^{-0d} that gives an increment of constructive and destructive probability in between electrons as they are attracted or repelled. This happens because when electrons approach each other they act like they are in orbitals in relation to each other, they do -𝕆D×e𝕪 kinetic work on each other.

Fermions

Some electrons then repel each other in an atom as fermions, a constructive -𝕆D kinetic interference occurs because their e𝕪 positions in -𝕆D×e𝕪 kinetic work are not correlated together like a boson pair. This constructive interference adds their -𝕆D kinetic torques to each other, that makes them more likely to spin each other up to a higher orbital. This is like when they approach each other outside an atom, then the direction is opposed so the destructive interference makes them less likely to be close together which acts as a repulsion.

Path integrals of electrons

These different paths form the different orbital probabilities of electrons, in some cases they form constructive interference in an orbital such as a filled shell. In others they are repelled to a different orbital. When an orbital is full the -𝕆D kinetic probability is an integer, to fit in more electrons the -𝕆D kinetic torque must increase but then the e𝕪 kinetic electric charge decreases along with the e𝕧 length.

Number of electrons in an orbital

The value of the +𝕆D potential probability gives the number of electrons that can fit in that orbital for an altitude e𝕒. These probabilities come from the strength of the electric charge to the magnetic field, also the relative +𝕚d gravitational mass of the proton to the -𝕚d inertial mass of the electron. These values will be covered later.

A single fermion to a higher orbital

When an orbital is full this causes the e𝕧/-𝕚d velocity and e𝕪/-𝕠d kinetic velocity of the electron to decrease, it then moves to a higher orbital. This only happens with the single electron, the others can remain in the lower orbital.

The electron actively moves upwards

That happens because of the constant area of the active -𝕠d and e𝕪 Pythagorean Triangle, when -𝕠d is dilated then e𝕪 is contracted. The -𝕆D×e𝕪 kinetic work of the electron has a higher probability of occurring with a smaller e𝕪 kinetic electric charge, it then has an active force trying to move to higher orbitals with a slower e𝕪/-𝕠d kinetic velocity and possibly escaping the atom.

Potential work adds to kinetic work probabilities

The +𝕆D×e𝕒 potential work of the proton reacts against this, it adds to the -𝕆D×e𝕪 kinetic work of the electrons. In an orbital 4 electrons might fit there, the +𝕆D×e𝕒 potential work sums to four of them to fit into that orbital.

An odd electron interferes destructively

The fifth electron does not have enough +𝕆D×e𝕒 potential work summed to it to also keep it in that orbital, its -𝕆D kinetic probability allows it to escape to the higher orbital. The boson pairs have a lower -𝕆D kinetic torque then than fifth electron, this makes it more likely to be found in a higher orbital.

Gravitational probability and height

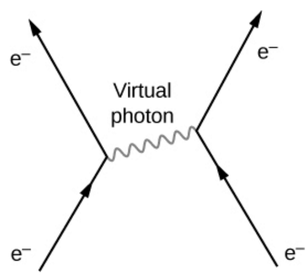
The active -𝕆D×e𝕪 kinetic work is like the +𝕀D×e𝕙 gravitational work, there is a higher +𝕀D gravitational probability at a lower e𝕙 height. This acts like an attraction of objects to where they are most probably measured unless there is enough -𝕀D×e𝕧 inertial work for example with a satellite. The electron moves outwards with a higher -𝕆D kinetic probability, this is reacted against by the proton and its +𝕆D potential probability otherwise the electron would leave. This makes the electron and gravity both have an increased probability towards a position, that creates an active work force.

Quantized repulsion

This makes the electron repulsion act as if quantized in orbitals, even in free space. As the electrons approach each other the -𝕆D kinetic probabilities can value between them, these are quantized in increments of α. This also gives the virtual photons between the electrons, in between quantized orbitals e𝕪×-𝕘d photons are emitted and absorbed as increments of α. The -𝕘d rotational frequencies of these photons depends on the orbital number, in between electrons it depends on how closer they are as a position e𝕪 with their -𝕆D×e𝕪 kinetic work.

Feynman diagrams

The different probabilities are shown in Feynman diagrams, these are increments of α as a probability of different particles forming in between the electrons. Because α is a probability this also gives the relative probabilities of different particles being observed.



Momentum is not observed or measured

In this model momentum is conserved because there are no forces, with no change of the angle θ in a Pythagorean Triangle they are the same as if they do not interact at all.

Law of conservation of momentum The total momentum $\vec{P}$ of an isolated system is a constant. Interactions within the system do not change the system's total momentum. Mathematically, the law of conservation of momentum is

$$\vec{P}_f = \vec{P}_i \qquad (11.23)$$

The total momentum *after* an interaction is equal to the total momentum *before* the interaction. Because Equation 11.23 is a vector equation, the equality is true for each of the components of the momentum vector. That is,

$$\begin{aligned}(p_{fx})_1 + (p_{fx})_2 + (p_{fx})_3 + \cdots &= (p_{ix})_1 + (p_{ix})_2 + (p_{ix})_3 + \cdots \\ (p_{fy})_1 + (p_{fy})_2 + (p_{fy})_3 + \cdots &= (p_{iy})_1 + (p_{iy})_2 + (p_{iy})_3 + \cdots\end{aligned} \qquad (11.24)$$

The x-equation is an extension of Equation 11.16 to N interacting particles.

NOTE It is worth emphasizing the critical role of Newton's third law. The law of conservation of momentum is a direct consequence of the fact that interactions within an isolated system are action/reaction pairs.

Active and reactive forces

In the diagram there is the -ⅈd×e𝕧/-ⅈd inertial momentum of the planet and ball, also the +ⅈd×e𝕙/+ⅈd gravitational momentum for the planet and the ball. This is conserved from the constant Pythagorean Triangle areas. With the E ℍ/+ⅈd gravitational impulse of the planet and ball these attract each other, that causes a change over +ⅈd gravitational time. Subtracted from each is the E𝕍/-ⅈd inertial impulse of the other, they may have a velocity relative to each other. They also need an active force to move them, they react against this.

Momentum as a superposition of a field and particle

The momentum needs to balance the +𝕀D×e𝕙 gravitational work with the Eℍ/+ⅈd gravitational impulse, this is because both +ⅈd×e𝕙 as a field and e𝕙/+ⅈd as a particle appear as a superposition in +ⅈd×e𝕙/+ⅈd.

Freefall and weightlessness

If the gravitational and inertial momentum was not conserved with the Eℍ/+ⅈd gravitational impulse and E𝕍/-ⅈd inertial impulse then each would not experience free fall in relation to the other. Also, the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work cause weightlessness. The ball and the planet experience no forces while falling, they remain weightless from work and in free fall from impulse. Because of this their momentum is conserved, it has not changed from being motionless in space.

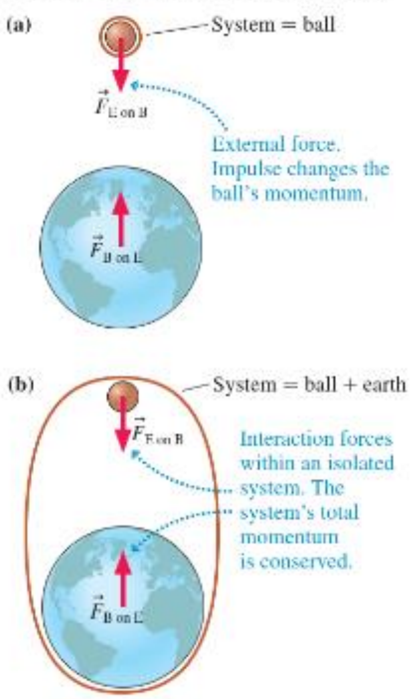
Inverted forces

In this model the inertial and gravitational momentum do change, but so that these changes chancel out. With the +𝕀D×e𝕙 gravitational work there is a +𝕀D gravitational probability or difference, from this is subtracted the -𝕀D reactionary inertial probability or difference. The -ⅈd×e𝕧/-ⅈd inertial momentum has -ⅈd as the inertial mass decreasing as each falls towards the other, the ball's inertial mass then decreases as does the planet's inertial mass. As they get to a lower e𝕙 height in relation to each other the +ⅈd gravitational mass in +ⅈd×e𝕙/+ⅈd increases, because +ⅈd and -ⅈd are inverses of each other then the changes in the inertial and gravitational momentum sum to a constant.

Balance of forces

Taking this as the Eℍ/+𝕚d gravitational impulse and the E𝕍/-𝕚d inertial impulse the E𝕍 displacement length increases from its initial e𝕧 position, this is an inverse to the Eℍ height displacement decreasing from the initial height. So these are also inverses, when observed with impulse these are also conserved. Because both impulse and work are conserved the overall momentum is also conserved. The balance of +𝕀D and -𝕀D probabilities give weightlessness and the balance of E𝕍 displacement length and the Eℍ displacement height give free fall.

FIGURE 11.15 Whether or not momentum is conserved as a ball falls to earth depends on your choice of the system.



The normal force

In this model there is a -𝕚d×e𝕧/-𝕚d inertial momentum as the ball moves to a lower e𝕙 height, this is reacting against the +𝕚d×e𝕙/+𝕚d gravitational momentum. When the balls hits the ground it rebounds with the normal force, that comes from the +𝕠d×e𝕒/+𝕠d potential momentum. The ball may have been moved to its initial e𝕙 height by a kinetic momentum -𝕠d×e𝕪/+𝕠d, the ball and the planet's motion are then from the four Pythagorean Triangles.

Positive and negative momentum

When the ball bounces this down to up motion is not a positive to negative momentum in this model, they reverse but this is from the change in direction of the angle θ opposite the spin Pythagorean Triangle side. As a convention this can be clockwise when the angle contracts as the spin Pythagorean Triangle side contracts, and counterclockwise when it expands as the spin Pythagorean Triangle side expands. A Pythagorean Triangle can also be flipped over so that clockwise and counterclockwise is reversed, by convention here θ is on the left.

Summing probabilities

The positive and negative sign can be used when one of an action/reaction pair dominates, with the ball falling the +𝕀D×e𝕙 gravitational work is stronger than the -𝕀D×e𝕧 inertial work. This is because when they are summed +𝕀D as the gravitational probability or difference is larger than the -𝕀D inertial probability or difference. The ball is then attracted, similar to with a magnet, towards where it is most probable to be found.

Inertial probability

If the ball bounced so high that it achieved escape velocity then its -𝕀D×e𝕧 inertial work would become larger than the +𝕀D×e𝕙 gravitational work, this could be regarded as negative overall. The ball would move with a reactionary inertia to where it is most likely to be found, its -𝕀D inertial probability acts like an attractive force. This is not accelerating towards this most probable e𝕧 position, instead it is a reaction that would be subtracted from other +𝕀D×e𝕙 gravitational work such as a moon.

Impulse and escape velocity

In this model if the ball bounced directly upwards then its escape velocity would be at the CMB. This is because with the Eℍ/+𝕚d gravitational impulse it is a straight-line force only, subtracting the E𝕍/-𝕚d inertial impulse from this the inertia would only be stronger once it was able to climb out of this gravitational well with a e𝕙 height. In practice a ball also does -𝕀D×e𝕧 inertial work, there would be a minimum amount of motion to the side creating a hyperbolic trajectory or an orbit.

Photons and gravitational wells

A e𝕪×-𝕘d photon changes its -𝕘d rotational frequency in a similar way, as it climbs out of a gravitational well of e𝕙 height then -𝕘d is subtracted from the +𝕚d gravitational field. Because +𝕚d decreases with a greater e𝕙 height this change is linear, the e𝕙 height of the +𝕚d and e𝕙 Pythagorean Triangle is much larger than the proton’s +𝕠d and e𝕒 Pythagorean Triangle and extends to the CMB. So the photon would have its redshift grow until it reached the ground state, then it would be unable to be measured because this frequency would be too low to move an electron.

As an example, consider what happens if you drop a rubber ball and let it bounce off a hard floor. Is momentum conserved? You might be tempted to answer yes because the ball's rebound speed is very nearly equal to its impact speed. But there are two errors in this reasoning.

First, momentum depends on *velocity*, not speed. The ball's velocity and momentum change sign during the collision. Even if their magnitudes are equal, the ball's momentum after the collision is *not* equal to its momentum before the collision.

But more important, we haven't defined the system. The momentum of what? Whether or not momentum is conserved depends on the system. **FIGURE 11.15** shows two different choices of systems. In Figure 11.15a, where the ball itself is chosen as the system, the gravitational force of the earth on the ball is an external force. This force causes the ball to accelerate toward the earth, changing the ball's momentum. When the ball hits, the force of the floor on the ball is also an external force. The impulse of $\vec{F}_{\text{floor on ball}}$ changes the ball's momentum from "down" to "up" as the ball bounces. The momentum of this system is most definitely *not* conserved.

Figure 11.15b shows a different choice. Here the system is ball + earth. Now the gravitational forces and the impulsive forces of the collision are interactions *within* the system. This is an isolated system, so the *total* momentum $\vec{P} = \vec{p}_{\text{ball}} + \vec{p}_{\text{earth}}$ is conserved.

In fact, the total momentum (in this reference frame) is $\vec{P} = \vec{0}$ because both the ball and the earth are initially at rest. The ball accelerates toward the earth after you release it, while the earth—due to Newton's third law—accelerates toward the ball in such a way that their individual momenta are always equal but opposite.

Inelastic collisions and torque

With an inelastic collision work is done, in a particle accelerator an inelastic collision causes two iotas to form new iotas. With an elastic collision this is like a spring, the displacement history causes the iotas to be compressed then expand. They cannot be inelastic because the displacement force is directed to the sides with torque.

Pressure and work

For example, pressing down on a bike pump with a E𝕐/-𝕠d kinetic impulse causes a reaction with an E𝕍/-𝕚d inertial impulse. It also increases the -𝕆D×e𝕪 kinetic work done when the pump is pushed downward to a new position e𝕪. The reaction of the -𝕀D×e𝕧 inertial work gives a position corresponding to e𝕪 as a e𝕧 length.

Work and heat

Because this is work there is a -𝕆D kinetic torque and a -𝕀D inertial torque, that causes some of the impulse force to be spread inelastically through the air in the pump. That causes the e𝕪 temperature to increase as a scale for the -𝕆D×e𝕪 kinetic work, this heat is then lost through the sides of the pump. This is referred to below as thermal energy, in this model the E𝕐/-𝕠d kinetic impulse would have E𝕐 as a displacement history.

Thermal energy

That would be thermal energy because it is being observed. Temperature as e𝕪 acts like a scale, it is a series of points or positions like on a ruler. A mercury thermometer would give these on a linear scale. When released this lost E𝕐/-𝕠d kinetic impulse energy would mean it does not rebound with the same E𝕍/-𝕚d inertial impulse.

Inelastic collisions and randomness

An inelastic collision gives a higher -𝕆D kinetic probability of the impact being spread randomly through both objects. This is reacted against by the +𝕆D potential probability as a normal force, there is a -𝕀D inertial probability also from -𝕀D×𝕖𝕧 inertial work acting as a randomizing -𝕀D inertial probability. Because the objects have a +𝕚d gravitational mass they also do +𝕀D×𝕖𝕙 gravitational work, the +𝕀D gravitational probability actively randomizes the object molecules with a +𝕀D gravitational torque. This would also be seen with an inelastic object falling into a planet.

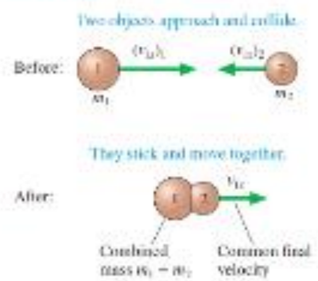
Work and mass

Because of this inelastic collision the -𝕀D×𝕖𝕧 inertial work has a -𝕀D inertial temporal duration or history, this can form into other iotas with a collision in a particle accelerator. That originally comes from the -𝕆D×𝕖𝕪 kinetic work and the -𝕆D kinetic temporal duration of being accelerated.

11.3 Collisions

Collisions can have different possible outcomes. A rubber ball dropped on the floor bounces, but a ball of clay sticks to the floor without bouncing. A golf club hitting a golf ball causes the ball to rebound away from the club, but a bullet striking a block of wood embeds itself in the block.

FIGURE 11.16 An inelastic collision.



Inelastic Collisions

A collision in which the two objects stick together and move with a common final velocity is called a **perfectly inelastic collision.** The clay hitting the floor and the bullet embedding itself in the wood are examples of perfectly inelastic collisions. Other examples include railroad cars coupling together upon impact and darts hitting a dart board. As FIGURE 11.16 shows, the key to analyzing a perfectly inelastic collision is the fact that **the two objects have a common final velocity.**

A system consisting of the two colliding objects is isolated, so its total momentum is conserved. However, mechanical energy is *not* conserved because some of the initial kinetic energy is transformed into thermal energy during the collision.

Perfectly elastic collisions

In this model a perfectly elastic collision is not possible, there would be some -𝕆D kinetic torque on the molecular bonds. The E𝕐/-𝕠d kinetic impulse would compress and expand in a straight-line as the balls collided, but a displacement history also needs a temporal history. A past in this model represents an initial and final position with impulse, such as E𝕍 in the E𝕍/-𝕚d inertial impulse. This is observed on an inertial timeline as a series of -𝕚d moments.

Uncertainty and history

The past also has a temporal history, this is from an initial inertial moment -𝕚d to a final inertial moment. The displacement and temporal histories cannot occur together, that would mean a position and time were known from the displacement history and temporal history with perfect precision. But this runs into the uncertainty principle, knowing both the initial and final positions and times is impossible.

Zeno's arrow and history

It is also a problem with Zeno's arrow, a force describes a history which has ended. That implies the arrow has stopped, because of this there would be no present and nothing can move. The arrow cannot be observed and measured together in the present, a measurement takes time and a displacement needs a distance so they are no longer in the present.

An uncertain temporal history

To have a sense of a past history in the macro world, the balls would have to have measurements of work to give this temporal history. But that adds a probability to where positions are measured on a scale, this would cause some losses of impulse energy through randomness such as with heat and friction. A temporal history is uncertain because of this probability, the past appears to be certain because in the macro world deterministic impulse is much stronger.

Gravitational probabilities

The past can only be measured with probability using work, this is seen in history where earlier events become increasingly uncertain. With the -𝕚d and e𝕧 Pythagorean Triangle this increases with a greater e𝕙 height in a gravitational well towards the CMB. The measurements of +𝕀D×e𝕙 gravitational work with redshifts may show a past that does not exist, instead the gravitational probabilities themselves might portray an illusion.

Inertial probabilities

As the e𝕙 height approaches a maximum the +𝕀D gravitational probabilities approach a minimum. The -𝕚d and e𝕧 Pythagorean Triangles with inertia are an inverse of this, so with their contracted e𝕧 length the -𝕀D inertial probabilities approach a maximum. This is also approaching a maximum of inertial entropy, stars and galaxies would be measured as becoming a random surface such as the CMB.

A limit of randomness

The CMB then may be a limit of randomness with only small deterministic fluctuations that appear as power laws from the Eℍ/+𝕚d gravitational impulse. The hiss on old TVs is regarded as being completely random, this comes from the CMB. If this randomness slowly reduced as -𝕀D×e𝕧 inertial work then it would form into iotas, creating atoms, then stars, the inertial entropy would decrease from the CMB to form stars and galaxies close to the measurer.

Noise in a wire

It would be like noise masking signals in a wire, eventually the random noise from work is all that is measured. Then as measurements were made of this signal with decreasing noise, the signals may appear as if they were evolving from this random noise. They would appear first as random bits and then become more deterministic as the E𝕐/-𝕠d kinetic impulse of electrons in a wire overcame the -𝕆D×e𝕪 kinetic work.

Evolving from the CMB

In this model the stars and galaxies would appear to evolve from this CMB noise as if there was a Big Bang that exploded. The Shannon Hartley theorem changes with a logarithm, here the exponential curve would be formed by the increasing -𝕀D inertial probabilities.

$$C = B\log_2\left(1 + \frac{S}{N}\right)$$

The CMB and the cosmic web

In the CMB there are patterns like sound waves, in conventional cosmology these formed the cosmic web of galaxies. In this model they already are galaxies just before the CMB, the increased -𝕀D×e𝕧 inertial work makes the signal so randomized that it only remains as these sound waves.

Probability becoming the past

The increasing gravitational probability may then show a past that has little relation to the deterministic Eℍ/+𝕚d gravitational impulse. This impulse would cause the +𝕚d gravitational time to slow approaching the CMB as an event horizon, but this would not change the e𝕙 heights of the galaxies there. The -𝕀D×e𝕧 inertial work would have +𝕀D approaching a maximum, this would be measured as a highly random emitter of e𝕪×-𝕘d photons with a e𝕧 length contraction.

The CMB as waves

The cosmic web would appear as waves from the increased -𝕀D×e𝕧 inertial work, narrow waves as e𝕧 would be contracted, further from the CMB these would appear to dilate with e𝕧 as the -𝕀D inertial probabilities contracted in an exponential decay curve.

Waves becoming particles

This would cause them to be measured as increasingly deterministic like particles instead of a wavelike CMB surface. These particles would act less like waves in the CMB, more like waves composed of particles forming stars and galaxies. With an increased E𝕍/-𝕚d inertial impulse the atoms would be observed as colliding in these stars and galaxies and appear more like normal matter.

The limit of gravitational probability

With close to the maximum e𝕙 height the +𝕀D gravitational probability is contracted, this makes it less likely for there to be a measurement. Beyond the limit of the angle θ in the -𝕚d and e𝕧 Pythagorean Triangle this gravitational probability reaches its limit and the gravitational probability of a measurement ends.

Impulse and a timeline

The concept of a past and future is part of the problem of consciousness. In this model impulse is on a timeline as a series of moments. With a clockwork universe this enables the past to evolve into the future through a series of particle collisions, the clock gauge acts as a linear or constant scale to observe the displacement forces.

Time travel paradoxes

This leads to the paradoxes of time travel, if the timeline is assumed to be linear and impulse is deterministic, then like a movie it can be rewound to an earlier moment or into the future. In the Time Machine movie for example, it moves forwards in time like a movie in fast forward around the machine.

Determinism and free will

With determinism there can be two ideas, one is the time traveler cannot change anything because their deterministic travels are part of the overall series of particle collisions. They go back in time for example and change something, this propagates forward and, in some cases, might affect the traveler's existence in the future. The other is that the traveler has free will and that the timeline is the result of free choices, it might then depend on their going back in time and changing something.

Positrons and electrons

This is similar to how quantum mechanics describes some antiparticles, a positron goes backwards in time and an electron forward in time. They can meet and annihilate each other in the present, then their timelines end with the emission of photons.

Impulse going forwards and backwards in time

In this model there are two Pythagorean Triangles going forward in time, this gives the active E𝕐/-𝕠d kinetic impulse often described as kinetic energy. There is also the E𝕍/-𝕚d inertial impulse where objects are observed to move forward in time with a reactive inertia. Gravity with the active Eℍ/+𝕚d gravitational impulse moves backwards in time, the E𝔸/+𝕠d potential impulse from the protons moves reactively backwards as well.

The timelines can coexist

Events then happen as the two impulse displacement forces create a kinetic and inertial history moving forward in time. They also have two impulse displacement histories moving from the present to the past. These do not need to collide and annihilate each other like the electron and positron, in this model they are summed together at various moments on the clock gauge of the timeline. An electron can move forward in time, the positron can move backwards in time as long as it does not meet the electron.

Conservation of time

This allows for conservation laws, the electron with the E𝕐/-𝕠d kinetic impulse can move forward in +𝕠d kinetic time without conflicting with the E𝔸/+𝕠d potential impulse of the proton moving backwards in +𝕠d potential time.

Neutral time

If they meet in some cases they can combine to form a neutron, the forward and backward motion of time becomes neutralized. The neutron can also decay into the proton going backwards in time and the electron going forwards in time. The E𝕍/-𝕚d inertial impulse moves forward in -𝕚d inertial time, this does not conflict with the Eℍ/+𝕚d gravitational impulse moving backwards in +𝕚d gravitational time. When the neutron is formed the -𝕚d inertial time also becomes combined with the +𝕚d gravitational time to become neutral in the present.

Temporal inverses

These Pythagorean Triangles balance because the -𝕠d and -𝕚d negative impulse timelines are the inverses of the +𝕠d and +𝕚d positive timelines. In Roy electromagnetism the E𝔸/+𝕠d potential impulse has protons with a potential displacement history moving backwards, this reacts against the E𝕐/-𝕠d kinetic impulse where the electrons have a kinetic displacement history moving forward in time.

Temporal changes and photons

At various moments in the timeline they interact, with the changes being mediated by e𝕪×-𝕘d photons moving forward in time, and +𝕘d×e𝕒 virtual photons moving backwards in time. With impulse this happens with the e𝕐/-𝕘d light impulse, the photon acts as an observable particle. With work this happens with -𝔾D×e𝕪 light work, the photon is measurable as a wave.

Gravis and Iners

In Biv space-time they also balance, the E𝕍/-𝕚d inertial impulse moves forward with an inertial displacement history. The Eℍ/+𝕚d gravitational impulse moves backwards with a gravitational displacement history, the two meet at various moments in the timeline as inverses. The changes are mediated by the e𝔹/+𝕘d Gravi impulse which actively propagates them backward in time, and the virtual E𝕍/-𝕘d 𝕚d Iner impulse forward in time. Gravity and inertia are inverses and cannot conflict with each other but only sum together, instead at moments in the timeline one might be stronger than the other.

Time travel and probability

In this model the determinism of time travel is not possible because of work, the force here is a temporal duration between moments. So with impulse the moments on timelines extend into the past and future, with work the durations between these moments also extend into the past and future.

Laplace’s demon

Because the temporal duration is probabilistic this makes the past and future uncertain. Instead of a clockwork universe that Laplace’s demon might predict from the present, this duration between the moments is like that in the uncertainty principle.

Time as a gauge or a force

The idea of a clockwork universe is that time itself acts like a clock gauge, that there are no temporal forces. In this model when the spin Pythagorean Triangle sides are squared these give probabilities of where the Pythagorean Triangles will be as a position on a scale. These are like tossing a coin, there seems to be a force that causes the heads and tails to even out over many tosses. Here the probabilities act as an attraction with constructive interference, and a repulsion with destructive interference.

Probability and torque

When a coin is tossed there is a -𝕀D inertial torque and a +𝕀D gravitational torque, these interfere destructively to average out as heads and tails. The -𝕀D inertial probability also interferes constructively, there can then be runs of heads or tails. The there can also be runs of +𝕀D gravitational probability where the coin might be pulled down to give similar runs.

Interference and the probabilities of events

The past and future in this model measure a destructive interference as a repulsion, so that causes some positions or events to occur less often. With a constructive interference this is like an attraction, some positions or events happen more often.

Fate and destiny

These attractions and repulsions cause the future to seem to hold forces, a measurer would experience these as moving forward in time along with these forces. They would also measure other forces moving towards them from the future then recede into the past. This can appear like a fate or destiny, how some events seem to average out.

The measurer also remembers the past from this +𝕆D×e𝕒 potential work and +𝕀D×eℍ gravitational work, they would be the potential and gravitational probabilities that cannot change. For example if the rocket was unable to lift off again, the moon mission would remain as a past event. It appears is if these events also happened with attractions and repulsions from the constructive and destructive interferences. With tossing coins, the past would appear to have a more balanced probability between heads and tails.

Constructive interference and gravity

In Roy electromagnetism this interference forms a magnetic torque, the constructive interference acts as an attraction and destructive interference as repulsion. In Biv space-time, gravity can act with a constructive interference attracting asteroids to a planet. This is because, with +𝕀D×eℍ gravitational work, there is a higher +𝕀D gravitational probability at a lower eℍ height. That causes the planet and asteroid to interfere constructively, their +𝕀D gravitational probabilities sum and act to attract each other.

Inertial destructive interference

The -𝕀D×e𝕧 inertial work of each can interfere destructively, the asteroid and planet may have higher -𝕀D inertial probabilities interfering destructively by going in opposite directions. This acts as a reactive repulsive force which reduces their constructive +𝕀D gravitational probabilities towards each other.

Displacement does not attract and repel

The clockwork universe then has displacement histories from the straight Pythagorean Triangle sides, but there are no attractive and repulsive forces from probability. Instead the displacement forces sum as vector addition with the dot product.

No probability in impulse, only possibility

It would seem that a coin toss could produce heads forever as long as the deterministic collisions made it possible. Adding temporal durations to this allows a field to attract or repel, the heads are equally attracted as tails and so they occur evenly over time. It remains possible for the E𝕍/-𝕚d inertial impulse to cause runs away from probability, the coin can fluctuate chaotically then return to -𝕀D×e𝕧 inertial work and an average.

A Galton box and torque

A Galton box acts as Pascal’s triangle, a ball can fall to the left and right according to the -𝕀D×e𝕧 inertial work the -Id inertial torque does in spinning the ball. This also acts as a -Id inertial probability appearing to attract the ball to fall to the left and right, with a higher probability in the middle.

A Gaussian from an exponential

This forms a Gaussian curve at the bottom with a squared spin Pythagorean Triangle side as -𝕀D and a linear scale as e𝕧. This comes from an exponential spiral, impulse comes from an exponential curve where the straight Pythagorean Triangle side is squared and the spin Pythagorean Triangle side is linear.

Chaos and randomness in the Galton box

From the formula for the Gaussian there is 1/√2π, this is approached by β in this model as the second Fiegenbaum number. The tines of the chaotic graph doublings are like the spacings in the Galton box, when these are less than 1/√2π then the balls move chaotically with an E𝕍/-𝕚d inertial impulse. That allows them to move to the left and right more instead of all falling towards the average. When this is ½π that gives the -𝕆D×e𝕪 kinetic work because this is from probability, the changes between β and ½π allow for the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work.

Approaching e

As e is approached with logarithms then the exponents of -1/𝕀D as the inverse of squares give the Gaussian. When this is not exactly e that comes from δ as the first Fiegenbaum number, it allows for chaotic motions of the balls in falling downwards like a turbulence. When e is reached this acts like a regular doubling in the E𝕍/-𝕚d inertial impulse. The balls are then able to move chaotically to the side with β and downwards with δ. This is an iterative process because the balls can be moving in different directions and with different velocities, but they hit the pins in the Galton box over and over.

Chaos and turbulence in the past and future

With the future then this allows for some chaos to occur, the probabilities of -𝕀D×e𝕧 inertial work in tossing a coin also balance against the E𝕍/-𝕚d inertial impulse with runs of heads or tails. When β appears this allows for chaotic random walks between heads and tails. When δ appears it allows for turbulent events where the coins have uneven numbers of heads followed by tails and vice versa. This is an iterative process like a formula for fractals, the tossing of the coin is done over and over.

Riding a wave of luck

The temporal probabilities can then allow a measurer to ride the wave of a lucky streak, for example in a casino. It appears good luck is sometimes attracted to the measurer, even when their bets are widely spaced in time.

Durations between bets

This is because in work the measuring scale is positions not moments, the timeline is not used and so it makes no difference whether the temporal durations are close together or widely spaced. A person might get the same probabilities in a casino betting once a minute or once a week. This moving forward in a wave comes from the -𝕆D×e𝕪 kinetic work and the -𝕀D×e𝕧 inertial work, both have negative signs.

Encountering waves of luck

The measurer also senses that the future seems to come towards them, for example they might feel an appointment is coming closer to them rather than their moving towards it. Sometimes this also appears to be waves of good or bad luck directed at them from the +𝕆D potential probabilities and the +𝕀D gravitational probabilities.

Acting and reacting to luck

The measurer might also feel they go out to meet the future such as by going to work, the difference is they actively have this -𝕆D kinetic temporal probability moving them forward. There is also a reactive -𝕀D inertial temporal probability moving them forward, sometimes people resist how probability seems to be pushing them in a direction. Gamblers for example often feel a compulsion to use slot machines, sometimes feeling these waves of good or bad luck. The future coming to the measurer has an active $+\mathbb{I}D$ gravitational temporal probability, also the reactive $+\mathbb{O}D$ potential temporal probability.

Moving towards and away from objects

This is similar to impulse in the clockwork universe, an observer might see objects moving towards them while they also observe themselves moving towards objects. This occurs through displacement histories on a timescale of moments, in this model that is like a temporal future because it can become the present. An observer moving towards a ball, or a ball is thrown to them, can touch it, then it is in their present. A ball moving away from them is not a part of their future, it is in their past only.

Past and future displacements

The forces of moving towards objects, or objects moving towards the measurer on a timeline comes from the straight Pythagorean Triangle sides. Conversely when the observer is moving away from objects, or the objects are moving away from them, then this is the past in this model. That is because the observer can never meet them in the present.

Destiny and fate

In work, the temporal forces also allow a measurer to move forward but to positions on a scale not to moments on a clock gauge with a timeline. Other temporal forces move towards the observer, also on a scale of positions not on a clock gauge with impulse. When the measurer moves to positions with this temporal duration this is called moving to their future, or destiny as a destination. When positions move to the measurer this is more like fate, the measurer might try and fail to escape this meeting with those temporal forces. When these positions have temporal forces moving further away from the measurer this is called the past, when the measurer moves further away from these positions it is also the past.

Past and future alternating

With impulse some objects might move towards the observer and then move further away by themselves, for example being on a planet and observing other planets move closer then recede. In this model that is the interplay of the timelines moving forwards and backwards. When the planets move closer they are approaching the present as a collision, this is like a displacement future possibility because it can become the present. When the planets move away again this is like a displacement past possibility, if they continue to do this they can never meet as an impossibility.

Moving towards and away from a future event

If the observer is in a rocket they might move towards a planet, this is like moving into a displacement future that could possibly not probably become the present. If their trajectory takes them away from a planet this is like the displacement past, if this continues then they will never reach the planet in their present.

Time flows combine

In this model then time does not flow in one direction, nor does it represent a flow from the future to the past and vice versa. Instead the two time flows are summed together as possibilities in impulse and probabilities in work. If the negative timelines are larger then the observer is moving towards an object or it is moving towards the observer, it becomes increasingly possible not probable for them to connect to the object.

Kinetic and potential possibilities

For example the observer is in a rocket that blasts off from a planet towards their goal of a possible not probable moon landing, their E𝕐/-𝕠d kinetic impulse is moving them forward in -𝕠d kinetic time. If their rocket is not strong enough they might fall back onto the planet in +𝕠d potential time from the E𝔸/+𝕠d potential impulse. This is where the fuel in the rocket was not explosive enough with its E𝕐/-𝕠d kinetic impulse compared to the E𝔸/+𝕠d potential impulse of the molecular bonds. Then the mission to the moon is in the past, there is no possible future where they get to the moon.

Gravitational and inertial possibilities

In Biv space-time it is the same, they move upwards towards the moon with an E𝕍/-𝕚d inertial impulse forward in -𝕚d inertial time. If they succeed then this future of possibly reaching the moon can become the present. If the rocket is not strong enough then the Eℍ/+𝕚d gravitational impulse of the planet pulls them down with its +𝕚d gravitational time, the possibility increases that they will not reach the moon. Then the mission is again in the impossible past, there is no possible future where they get to the moon. If they try again then the moon mission may again be in the future as a possibility with both their E𝕐/-𝕠d kinetic impulse and the E𝕍/-𝕚d inertial impulse.

Observing the past and future possibilities

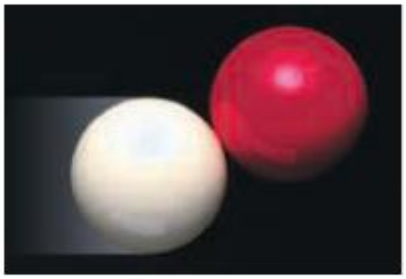
This is how observers typically experience time, if they can get to a goal or the goal comes to them then this is observed as a possible future. If they cannot get to this goal, or the goal come to them, then this is in the past as an impossibility. At some stage an event may have seemed possible to occur in the future, if this won't happen then it remains as a past remembrance of a possibility.

Measuring the past and future probabilities

With work there is the same past and future, the difference is that the future represents the probability of going to a position or the position coming to the measurer. These are also summed, with the +𝕆D potential probability having the -𝕆D kinetic probability subtracted, the +𝕀D gravitational probability having the -𝕀D inertial probability subtracted.

Changing probabilities and improbabilities

With the moon mission the -𝕆D×e𝕪 kinetic work has a probability this time, not a possibility of the measurer succeeding in their future. If the rocket will probably fail to reach escape velocity the +𝕆D×e𝕒 potential work will probably pull them down, this becomes a failure in their past. With -𝕀D×e𝕧 inertial work this is in their probable or improbable future, with +𝕀D×e𝕙 gravitational work in their probable or improbable past, and if they try again there are probabilities landing on the moon will be in their future. If probably not, then failed attempts will probably be their only past.



A perfectly elastic collision conserves both momentum and mechanical energy.

FIGURE 11.19 A perfectly elastic collision.

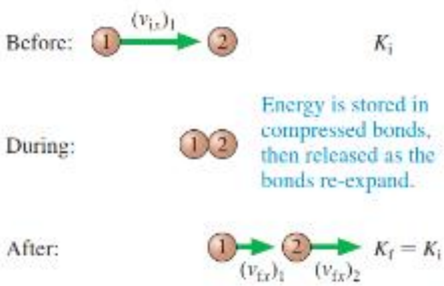
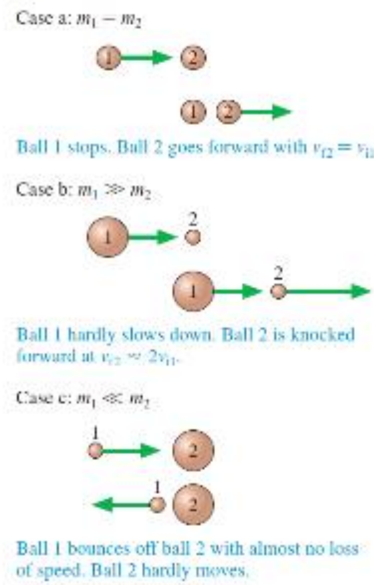


FIGURE 11.20 Three special elastic collisions.



Moving between reference frames

In this model moving from one reference frame to another requires a force. In between the two balls each has a velocity e𝕍/-𝕚d, they also have an E𝕍/-𝕚d inertial impulse. That has an E𝕍 inertial displacement history from when it was at rest to its current velocity, because this is an inertial acceleration then the -𝕚d inertial time on a clock gauge will be slower. With their -𝕀D×e𝕍 inertial work the -𝕀D inertial probability is also an increased final -𝕚d final inertial mass, this acts like an inertial temporal history. That causes the balls to each have a e𝕍 length contraction.

Four reference frames

In this model each Pythagorean Triangle also acts as a reference frame, one axis of the frame is a straight Pythagorean Triangle side and the other is a spin Pythagorean Triangle side. When the observation time is moved, on a clock gauge, this changes the impulse in all four reference frames.

A change in displacement history

In the diagram, moving from a kinetic reference frame in the middle to on the left ball needs a E𝕐/-𝕠d kinetic impulse. That means the E𝕐 kinetic displacement history has changed for the kinetic observer, because they moved with an E𝕐 kinetic acceleration to the left ball then the -𝕠d kinetic time appears slower on the right ball. This slowing of the -𝕠d kinetic time occurs whether the right ball is moving towards or away from the observer, this is because it is the E𝕐 displacement which is the same in either direction.

Photons as particles and time slowing

The kinetic time would be observed with the e𝕐/-𝕘d light impulse of photons acting as particles. This also happens in the double slit experiment when the observer tries to detect which slit a photon went through. When the E𝕐 displacement history is observed then photons act as particles, the e𝕧 length of a ball cannot be observed because the straight Pythagorean Triangle side is being used as a square. That only leaves the -𝕠d kinetic time which slows.

Synchronizing kinetic time

As the kinetic observer moves to the left ball, they would have observed an additional -𝕠d time slowing during their journey to the left ball, this synchronizes their kinetic clocks for when they arrive there. Kinetically observing the right ball in this journey would show less -𝕠d kinetic time slowing, this is because the observer is moving closer to the velocity or e𝕪/-𝕠d kinetic velocity of the right ball. When they reach the left ball this kinetic time from the right ball will again slow down.

Kinetic proper time

The kinetic observer would then have a kinetic proper time between them and a clock gauge on the left ball. Before the observer moved the two balls each had an E𝕐 kinetic displacement history, so each would have had their -𝕠d kinetic times on their clock gauges slowed compared to the stationary observer. Now the kinetic observer has the same relative kinetic displacement history as the left ball, they would share the same proper time.

Potential reference frame

The potential reference frame refers to the protons and nuclei, there is a +𝕠d potential time slowed on a clock gauge with the E𝔸/+𝕠d potential impulse. The clock gauges would then have their electrons slowed in -𝕠d kinetic time, to maintain the same proportions then the +𝕠d potential time also slows by the same amount. If not then the e𝕧 length contraction of a ball would be wrong. The protons would have a e𝕒 altitude contraction from the +𝕆D×e𝕒 potential work, the electrons would have a different e𝕪 contraction from -𝕆D×e𝕪 kinetic work. As an extreme, this would cause a ball moving at near c to either collapse into neutrons or explode.

Potential reference frame and General Relativity

In General Relativity this potential reference frame can have a greater slowing of +𝕠d potential time, for example in a neutron star. That causes the +𝕆D×e𝕒 potential work to increase, it adds more to the -𝕆D×e𝕪 kinetic work of the electrons and causes them to move to lower orbitals. This is because their -𝕆D kinetic torque is less after this addition, also the -𝕆D kinetic probability is higher at a lower e𝕒 altitude. This can cause electrons to rejoin with protons to become neutrons.

Gravitational reference frame

The gravitational reference frame would also have the +𝕚d gravitational time slowed for both balls, this is from the Eℍ/+𝕚d gravitational impulse. They were formed from matter that coalesced on the planet's surface from a greater initial e𝕙 height, because of this the matter on a planet has a slower +𝕚d gravitational time from this Eℍ gravitational displacement history. When the gravitational observer moves to the left ball their Eℍ/+𝕚d gravitational impulse also changes, they had an initial e𝕙 height and a final e𝕙 height associated with this Eℍ gravitational displacement history.

Gravitational and inertial time

Because this changes with the E𝕍 inertial displacement history, the ball on the right is slowed in both +𝕚d gravitational time and -𝕚d inertial time. If the gravitational observer for example was initially below the balls looking up, then the balls would have had a lower Eℍ/+𝕚d gravitational impulse because their Eℍ displacement history was smaller. That is because their initial e𝕙 height when the planet coalesced gives the Eℍ force to a higher e𝕙 final height.

Subtracting inertial time from gravitational time

From this is subtracted the -𝕚d inertial time slowed in between the two balls, then the inertial observer moves with an E𝕍/-𝕚d inertial impulse to the left ball. The right ball has a different E𝕍 inertial displacement history to the observer than before, their -𝕚d inertial time has slowed. Because the e𝕙 height may have changed then the +𝕚d gravitational time difference would be added to this.

Relative displacement history

Moving to the ball on the left also has an E𝕍/-𝕚d inertial impulse, the inertial observer will then have a relative E𝕍 inertial displacement history the same as the left ball. This is because the inertial observer would have started from rest and accelerated to the same velocity the left ball is moving at, that E𝕍 inertial displacement history is added to the left ball's E𝕍 value with a vector addition using the dot product. Then after reaching the left ball it would have no -𝕚d inertial time slowing on a clock gauge, the $E\mathbb{V}_{l}$ value is the same for the observer as for the left ball. This is called the inertial proper time.

Changing the relative displacement history

Observing the right ball would now see an increased $E\mathbb{V}_{r}$ inertial displacement history, when the inertial observer was at rest between the balls the right ball had a slower relative velocity to them. With this increase in the E𝕍 inertial displacement history, this causes the right ball's -𝕚d inertial time to be slower on a clock gauge than from inertially observing in the middle.

All four Pythagorean Triangles change their displacement history

The change in the kinetic, potential, gravitational and inertial displacement histories occur with each moment the observer changes their displacement history. In Roy electromagnetism this is observed with photons, in Biv space-time it is observed with Gravis.

Four Pythagorean Triangles and work

The force of moving to the left ball is also associated with work, there is a changed temporal history from an initial moment to a final moment of arriving at the left ball. This causes a change in the measured contraction of the straight Pythagorean Triangle sides compared to being at rest between the balls initially.

Attracted to a greater kinetic probability

The force of moving to the ball is a probability with work, the measurer now has a greater probability of being at the left ball, and so they are attracted to that position. For example, with the kinetic reference frame, the measurer does -𝕆D×e𝕪 kinetic work in moving to the left ball. Initially they would have measured a e𝕪 kinetic electric charge contraction in each ball from their -𝕆D kinetic temporal history, then their increased -𝕆D kinetic probability attracted them to the left ball.

Changing the kinetic probability as a force

This change in the -𝕆D kinetic probability is the force they used to get to the left ball, for example in burning kinetic fuel. That synchronizes their kinetic temporal history as -𝕆D, the left ball now has no e𝕪 distance contraction and the right ball has an increased e𝕪 distance contraction. This is because its -𝕆D kinetic temporal history is now larger than when the kinetic measurer was at rest between the balls.

Rearranging the relativity equation

The changes in the e𝕧 length contraction, using the -𝕚d and e𝕧 Pythagorean Triangle, are calculated as γ or gamma in the conventional relativity equation below. In this relativity equation γ=√(c²-E𝕍/-𝕀D), in this model the terms in the brackets are now multiplied by c² so that the hypotenuse ζ² is no longer 1. Before this the equation had 1, from this was subtracted the ratio of the velocity squared to c squared. This 1 is removed because the model does not use the hypotenuse, only the Pythagorean Triangle sides.

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}}$$

Uncertainty and history

E𝕍/-𝕀D, as for example the squared velocity of a rocket, is the inertial displacement history divided by the inertial temporal history. That is not allowed in this model to be done simultaneously or at the same -𝕚d inertial moment as well as at the same e𝕧 position. This is because of the uncertainty principle, it would be observing the E𝕍/-𝕚d inertial impulse at the same time as the -𝕀D×e𝕧 inertial work is measured at the same position. If this position was measured too closely then the -𝕀D×e𝕧 inertial work would have -𝕀D dilate as the inertial probability. This would make the position less certain.

A history and a scale

Also the E𝕍 inertial displacement history would be acting as a force, but also as a scale e𝕧, the -𝕀D inertial temporal history would be acting as a force but also as a moment -𝕚d on a clock gauge. They would then have to be both a force and not a force with no uncertainty. This relates to Zeno's paradox with points on a line, a e𝕧 position and a -𝕚d inertial moment act like points. A line is a displacement or duration in between points, moving from one point to another. This motion in between points cannot also be a point, then it has no size.

Changing the relativity Pythagorean Triangle

This model uses a different Pythagorean Triangle to the relativity equation, but the answers are the same. The Pythagorean Triangle area here is constant, in the relativity equation the hypotenuse ζ is constant and set as 1. The angle θ in the Pythagorean Triangle opposite the spin Pythagorean Triangle side defines γ in both cases so they are equivalent.

Light speed as an angle not a limit

To convert from the conventional relativity equation to this model's equation, first each term in the denominator below is multiplied by c². This becomes √(c²-E𝕍/-𝕀D) because the rocket's velocity is squared as E𝕍/-𝕀D. In this model c is not the hypotenuse but a limit as an angle θ on the Pythagorean Triangle, because of this it may be possible for a rocket to move faster than c. When the rocket does -𝕀D×e𝕧 inertial work in burning fuel it allows for this angle to be passed, its velocity as e𝕧/-𝕚d would then be greater than c similar to breaking the sound barrier.

Using the four Pythagorean Triangles

The same analysis would follow with the +𝕠d and e𝕒 Pythagorean Triangle as the proton, the -𝕠d and e𝕪 Pythagorean Triangle as the electron, the +𝕚d and e𝕙 Pythagorean Triangle as gravity, here the -𝕚d and e𝕧 Pythagorean Triangle is given as an example. As before with the reference frames, each of these would have a proportional γ or 1/γ value.

Special relativity and inertial reference frames

The -𝕚d and e𝕧 Pythagorean Triangle is used here because special relativity is associated with inertial reference frames. In the twin paradox one girl would travel on a rocket at close to c, she would experience inertia from this which means her rocket has an E𝕍/-𝕚d inertial impulse and does -𝕀D×e𝕧 inertial work. Her twin at home does not have this inertial impulse and work, the difference between them can be represented as inertial reference frames. When the girl arrives home her E𝕍 inertial displacement history is larger, so her -𝕚d inertial time has slowed by comparison to the girl at home.

Converting the relativity equation to impulse

Because this model does not allow the numerator and denominator to both be squared, the equation needs to be converted into first the E𝕍/-𝕚d inertial impulse to find γ. Then the -𝕀D×e𝕧 inertial work is compared to it with its γ. This factor γ needs to be the same in both cases.

Length contraction and time dilation

As the rocket approaches c its e𝕧 length contracts, in this model time dilation is not referred to as being the opposite of contraction, instead this is also contracting as time slowing. The answers are the same but they are no longer inverses of each other. Calling a slowing of a clock gauge dilation is a convention, to avoid confusion this is referred to here as slowing.

Setting the time as 1

To remove the denominator with the conventional relativity equation is easier, the time can be set as 1 to give $\sqrt{(E\mathbb{V}_c - E\mathbb{V}_f)}$. This can also be written as $\sqrt{(E_c - E_f)}$ where the values of E can be easier to work with. This represents two angles θ of the -𝕚d and e𝕧 Pythagorean Triangle, at c this angle is now small but not zero as it was when c was the hypotenuse. The velocity of c as $e\mathbb{v}_c/-\mathbb{i}d_c$ is 3×10^8 meters as e𝕧 and -𝕚d being 1 second, the angle θ can then be tanθ as c.

The rocket's velocity

The velocity of the rocket would be the inertial displacement E𝕍 from its initial position $e\mathbb{v}_I$ to its final $e\mathbb{v}_f$ position. That gives a change in the angle θ from its initial velocity, that cannot be completely at rest because then the -𝕚d and e𝕧 Pythagorean Triangle would have e𝕧 as zero and -𝕚d would have to be infinite. Instead, the iotas have some motion relative to each other, even close to absolute zero.

Observing from the initial position

As the rocket inertially accelerated there would be an e𝕧 length contraction. This would be in observing its E𝕍/-𝕚d inertial impulse as an inertial observer at the rocket's initial position $e\mathbb{v}_{I.}$ Comparing this velocity to that of c would give γ as in the conventional relativity equation, now it is comparing two angles θ. That allows it to also be used in comparing two rockets and their velocities to c, and to each other.

Setting the position to 1

Instead of the E𝕍/-𝕚d inertial impulse this could have been done with -𝕀D×e𝕧 inertial work, then the numerator would have been set as 1 meter. The denominator would be how long the rocket took to travel 1 meter compared to how long a photon at c would take to travel 1 meter. This removes the E𝕍 value so the only force is the -𝕀D inertial temporal history, that compares the rocket's history to the photon. This gives the same value of γ because the same numbers are used to convert either time or distance to 1. For example if a rocket is going 100 kilometers a second then this is the same as 1 kilometer in 1/100 of a second, the factor 100 is used for both.

The inverse of distance and moments with γ

It also shows the inverse of the distance as e𝕧 and moments as -𝕚d both give γ, in this model a Pythagorean Triangle with a constant area has this inverse relationship. With c then a velocity need not have a time as 1 second in the denominator, as the angle θ changes with a constant Pythagorean Triangle area both the numerator and denominator change. They can be converted to having 1 as the straight or spin Pythagorean Triangle side to show that γ is the same, in this model that would not be done as it can complicate the displacement and temporal histories.

Converting the denominator to 1

If neither c or the rocket's velocity have the denominator as 1, then the two denominators are multiplied together. This result is then used to multiply each of the numerators by that value. That gives the -𝕚d inertial time as 1, the Pythagorean Triangle area is no longer constant but this is to show γ is still the same. That would give $\sqrt{}$(E$𝕍_c$-E$𝕍_f$) as before, it can then be multiplied or divided by a number to give exactly the same values of E as in the conventional relativity equation.

Converting the numerator to 1

The same process can be used to give $\sqrt{}$(-𝕀D_c- -𝕀D_f) by taking both numerators, multiplying them together and then dividing both terms by that value. This removes E𝕍 as before, γ remains the same. Here both terms are negative but these are being subtracted as areas, the negative sign does not indicate one is subtracted from the other.

Subtracting with the cross and dot product

Another minus sign is used so that one is summed to the other, but in this model that does not mean one becomes +𝕀D which is different. Instead with the Pythagorean Equation two areas are subtracted to give a third area, alternatively this can use the cross product. With E𝕍 these are also not conventionally subtracted, instead this represents a vector subtraction with the dot product.

Taking c as approaching 1

This can also be shown by making c with an infinitesimally small angle θ, so now c is not represented by the hypotenuse but approaches 1 as a second angle θ to the rocket's velocity with its angle θ. Then the two velocities are converted from one to the other by changing the angle θ, the difference is γ.

γ as a velocity

In the conventional relativity equation γ is actually a velocity, c is a squared velocity and the rocket's velocity is subtracted from it then the square root is taken. This means when the e𝕧 length contraction is calculated it also includes a time component, that would violate the uncertainty principle. When the velocities all have 1 in the numerator or denominator then γ becomes a e𝕧 length which contracts or a -𝕚d inertial time that slows.

γ as a square root

When the numerator or denominator is not 1 then γ is a fraction with this contraction and dilation. In this model γ would be a square root value of e𝕧 or -𝕚d, that can be observed as E𝕍 or measured as -𝕀D.

Photon contraction and dilation

In this model the e𝕪×-𝕘d photon has its Pythagorean Triangle sides change inversely to each other, as the e𝕪 kinetic electric charge contracts, proportional to e𝕧 as the wavelength, then -𝕘d dilates. That makes the photon's clock gauge turn faster not slower, this is a higher frequency photon which can liberate electrons more with the photoelectric effect. These photons have a shorter wavelength, so if this was the same as a e𝕧 length contraction then the -𝕘d rotational frequency of the photon would have to slow as well. Instead it increases inversely to the e𝕧 wavelength. Because of this the change in time closer to c is referred to as slowing, to differentiate it from the photon.

The photon as the difference between orbitals

The difference is because the photon has its angle θ as the difference between electron orbitals. When an electron emits a e𝕪×-𝕘d photon it drops to a lower orbital, that changes its angle θ so that e𝕪 as the kinetic electric charge increases and -𝕠d as its kinetic magnetic field decrease. This is because as it moves to a higher orbital the electron must do -𝕆D×e𝕪 kinetic work. That increases its -𝕆D kinetic probability of being in a higher orbital using a -𝕆D kinetic torque.

An electron and photon change Pythagorean Triangle sides inversely

The change in the electron then is an inverse with e𝕪 and -𝕠d, that inverse is emitted as the photon. A rocket approaching c is not conserving the Pythagorean Triangle sides with a constant area as with the electron. Instead, it uses up fuel to increase its velocity, that increases both its E𝕍 inertial displacement history from rest and its -𝕀D inertial temporal history. Because both of these increased then there is both a e𝕧 length contraction on a scale and a -𝕚d inertial time slowing on a clock gauge.

Converting work and impulse into each other

If this were not true, then the rocket's increased E𝕍/-𝕚d inertial impulse would no longer be convertible into -𝕀D×e𝕧 inertial work. In this model the E𝕍/-𝕚d inertial impulse can be written as meters^2/second and -𝕀D×e𝕧 inertial work as meters/second^2, these would no longer be a classically equivalent acceleration.

Using Reference Frames

Equations 11.29 assumed that ball 2 was at rest prior to the collision. Suppose, however, you need to analyze the perfectly elastic collision that is just about to take place in FIGURE 11.21. What are the direction and speed of each ball after the collision? You could solve the simultaneous momentum and energy equations, but the mathematics becomes quite messy when both balls have an initial velocity. Fortunately, there's an easier way.

You already know the answer—Equations 11.29—when ball 2 is initially at rest. And in Chapter 4 you learned the Galilean transformation of velocity. This transformation relates an object's velocity as measured in one reference frame to its velocity in a different reference frame that moves with respect to the first. The Galilean transformation provides an elegant and straightforward way to analyze the collision of Figure 11.21.

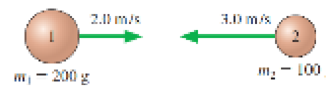


FIGURE 11.21 A perfectly elastic collision in which both balls have an initial velocity.

At rest

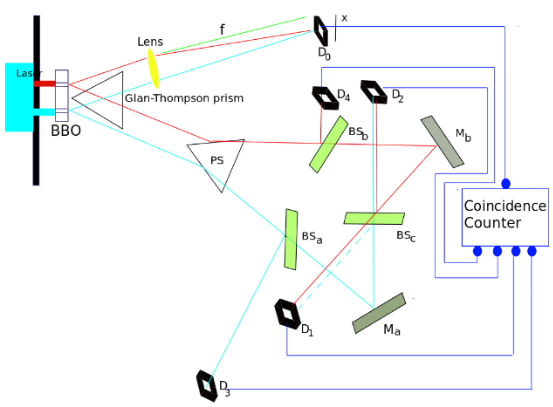
In this model a particle cannot be completely at rest, then its E𝕍 inertial displacement history would have to be zero. Instead, its history of forces gives its angle θ, this is relative to the E𝕍 inertial displacement history and the -𝕀D inertial temporal history of the observer and measurer. The ball may appear to be at rest because the inertial observer moved to that reference frame, but they both then have the same nonzero relative histories.

Histories are not erased

These histories are not erased, for example molecules in a planet may have come from a supernova. If these histories were canceled then energy would not be conserved in between stars for example. When observations of impulse or measurements of work are made, these are relative to each other. When an inertial observer is at rest with the left ball their -𝕚d inertial time is approximately proper time to both.

Quantum eraser

In a quantum eraser experiment history appears to be erased by different observations and measurements. In this model that happens by changing from an observation of the e𝕐/-𝕘d light impulse of photons to measuring -𝔾D×e𝕪 light work. More will be explained on this later, here it shows how the concept of histories is important in quantum mechanics. In this model when the e𝕐/-𝕘d light impulse of photons is observed, this makes them act as particles. Because of this they cannot form an interference pattern like waves, it then appears as if they were always particles. When the -𝔾D×e𝕪 light work is measured the photons appear as waves with an interference pattern, this happens even when the choice of what to observe or measure is delayed.



Light displacement history

When the path of a photon is observed then this gives the E𝕐 light displacement history from the light emitter to the observation. That can only be observed on a timeline as a moment -𝕘d with this model, a detector would receive this photon as a particle with a signal recorded. Because the -𝔾D temporal history cannot be measured with the same photon, that cannot also create a probability interference pattern. There is only one possible path, that makes it impossible to also have probable paths. Because the path is a squared straight Pythagorean Triangle side, in this model the -𝕘d spin Pythagorean Triangle side cannot also be measured for that photon. So it cannot be known when the photon will be observed, that would means the -𝔾D light temporal history was also known for that photon.

Light temporal history

It cannot then have a probability of going along different paths, that has been made impossible by observing its E𝕐 light displacement history. When the path is not observed then the photon can act as a wave with -𝔾D×e𝕪 light work, the -𝔾D light temporal history is now measuring the duration of the initial time -𝕘d the photon was emitted to when it is absorbed as a signal. Because the -𝔾D×e𝕪 light work is being measured for that e𝕪×-𝕘d photon, that means the path cannot also be observed. Because of this there are only probable paths in a path integral, these interfere constructively and destructively to give a wavelike interference pattern.

Forwards and backwards in time

In this model the -𝕠d and e𝕪 Pythagorean Triangles as electrons and -𝕚d and e𝕧 Pythagorean Triangles as inertia go forward in time, the +𝕠d and e𝕒 Pythagorean Triangles as protons and +𝕚d and e𝕙 Pythagorean Triangles as gravity go backwards in time. So a delayed choice can make no difference, the histories are conserved and match no matter what the experimenter does. The e𝕪×-𝕘d photon goes forward in time, the +𝕘d×e𝕒 virtual photon is not observable or measurable as it goes backwards in time.

Alternating observation and measurement

In the experiment first there is an alternating observation of the E𝕐 light displacement history of the photon's path, then the -𝔾D light temporal history is measured as to when it was emitted and absorbed. These are proportional to the -𝕚d and e𝕧 Pythagorean Triangle, so these e𝕧 positions of the photon give where the -𝕀D inertial probabilities could be measured. That requires at least two different paths, otherwise the e𝕐/-𝕘d light impulse could be observed deterministically.

Not knowing when the photon will be observed

Because -𝔾D×e𝕪 light work is a field it is measured with a path integral. When the E𝕍 inertial displacement history is observed, by looking at which detector the photon went to, this gives only one possible path that could occur in that -𝕚d inertial time allowed. Because the -𝕚d inertial time is not observable on a clock gauge as a -𝔾D temporal history, it cannot be known when the photon will be detected. If it was known then it would also be known when it was emitted, that can only come from -𝔾D×e𝕪 light work. That means its -𝔾D light temporal history is unknown and there cannot be an interference pattern.

Possibility versus probability

In this model a possibility comes from impulse, the e𝕐/-𝕘d light impulse then has only one possible path. This is from the definition of a particle, being an object it is supposed to move on one path. If there are many possible paths it can take then it cannot be a particle, that is called a wave with -𝔾D×e𝕪 light work. The possible path of a particle becomes probable paths of a wave, this can become a particle by measuring different paths to see where the particle appears.

Delayed decision

The decision of whether to observe the e𝕐/-𝕘d light impulse in one detector, or to measure the -𝔾D×e𝕪 light work with different possible paths, can be delayed until a photon has passed various points in the apparatus. But the photon can only be observed with the e𝕐/-𝕘d light impulse, if no single path is selected then there are many probable paths. That makes it impossible for the e𝕐/-𝕘d light impulse to be observed as a particle. If it can only be measured with -𝔾D×e𝕪 light work as an interference pattern, and then there is only one path, there can be no interference pattern and no -𝔾D×e𝕪 light work could be measured.

An uncertain path or time

This is the uncertainty principle where the e𝕐/-𝕘d light impulse and the -𝔾D×e𝕪 light work are attempted to be observed and measured in the same e𝕪 position and -𝕘d moment. That would need a force E𝕐/-𝔾D which is impossible in this model.

A present from adding the past and future

A displacement history is formed by vector addition, the past impulse forces are added together by the dot product on a clock gauge timeline. A temporal history is formed by adding and subtracting fields of probability, this is by a constructive and destructive interference. Locally the relative displacement and temporal histories can appear as a present, the connections to the past and future cancel out.

The limits of observation and measurement

When the vectors below are added they can sum to nearly zero between the inertial observer and the left ball, the limit of this Eℍ displacement and +𝕀D temporal history comes from the maximum and minimum angles θ in the +𝕚d and e𝕙 Pythagorean Triangles as gravity. It also comes from the maximum and minimum angles of the -𝕚d and e𝕧 Pythagorean Triangles as inertia, together these give the limit of what can be observed and measured up to the CMB.

A maximum gravitational displacement and temporal history

The e𝕙 height from a gravitational observer to the CMB gives the limit of the Eℍ/+𝕚d gravitational impulse which can be observed as vectors. This can also have a maximum +𝕚d gravitational time extending back to the CMB so that the e𝕙 height goes to a minimum. This causes the CMB to appear almost flat with small variations in e𝕙 height. It can be observed with a Eℍ/+𝕚d gravitational impulse so that the CMB appears to be made of particles, it can also be measured with the +𝕀D×e𝕙 gravitational work so there are wavelike shapes in it. These are proposed in conventional physics to be sound waves, they form a web which exploded out to become the galactic web of galaxies.

The number of protons in the universe

In this model the maximum and minimum angles of the +𝕚d and e𝕙 Pythagorean Triangles and -𝕚d and e𝕧 Pythagorean Triangles allow for the number of protons in the universe, if there was more then the +𝕚d and e𝕙 Pythagorean Triangles would be smaller. Because the protons are proportional to the +𝕚d and e𝕙 Pythagorean Triangles as gravity, this allows for them to extend outwards to form a maximum e𝕙 height.

Collapse and expansion

The -𝕚d and e𝕧 Pythagorean Triangles as inertia are the inverse of the +𝕚d and e𝕙 Pythagorean Triangles, this allows for electrons to have a -𝕚d inertial mass that fits into this CMB limit of e𝕙 height. These Pythagorean Triangles allow for matter to have enough of a velocity, so the visible universe does not collapse. In this model it could not collapse because the Pythagorean Triangles are unending in number, the CMB is not related to a Big Bang but is a limit of the e𝕙 height which is observable. Because of this there is no actual collapsing or expansion happening.

Gravitational light impulse cones

The Pythagorean Triangles can also be modeled as light cones, the +𝕚d and e𝕙 Pythagorean Triangle can be rotated around its +𝕚d spin Pythagorean Triangle side to give a cone with a height e𝕙 and a base with a radius of +𝕚d. This can extend out to the CMB where +𝕚d goes to a minimum, the height of the cone goes to a maximum. The gravitational cone can represent where photons can go, at the limit of the cone at the CMB photons can no longer be observed as particles with a e𝕐/-𝕘d light impulse.

Gravitational light work cones

Alternatively, the cone can be represented as the base going to the CMB, then the e𝕙 height goes to a minimum as the variations in height at the CMB. This draws the cone with a height as the +𝕚d gravitational time, the radius of the base becomes e𝕙. This is another light cone, here there is a limit where the photons can be measured with -𝔾D×e𝕪 light work.

Spacelike and timelike light cones

This is similar to the concept of spacelike and timelike with Special Relativity light cones. When photons are outside this spacelike cone with e𝕐/-𝕘d light impulse they cannot be observed, when outside this timelike cone with -𝔾D×e𝕪 light work they cannot be measured.

Black holes and the photosphere

These can also be modeled coming from a black hole, the event horizon acts like the CMB. Photons might go straight upwards with a e𝕙 height, the black hole can form a photosphere where the photons cannot be measured or observed above this height. Photons with a trajectory outside the angle θ of the +𝕚d and e𝕙 Pythagorean Triangle light cone also cannot be measured, this is because their e𝕙 height would be lower than this photosphere.

Height contraction and the photosphere

This is because the photosphere is measured to have a e𝕙 height contraction from the -𝔾D×e𝕪 light work, below this the contraction is too great and acts as an event horizon like the CMB.

Temporal history and the photosphere

The +𝕀D×e𝕙 gravitational work of the black hole has +𝕀D as the gravitational temporal history adding to the -𝔾D light temporal history, when +𝕀D is greater the photons can have no light temporal history and so cannot be measured. This is because their -𝔾D light probability drops to zero with the +𝕀D gravitational probability canceling it out.

Redshift and the photosphere

With e𝕐/-𝕘d light impulse the Eℍ gravitational displacement history is subtracted as a vector, from E𝕐 with the dot product. This causes the +𝕚d gravitational time with the Eℍ/+𝕚d gravitational impulse to go to a minimum, the e𝕐/-𝕘d light impulse has its -𝕘d rotational frequency slowed by this to give a redshift below what can be observed.

Inertial impulse light cones

The photosphere represents where the -𝕚d and e𝕧 Pythagorean Triangles as inertia reach their limit, these can be also represented as inertial impulse light cones. They are similar to the light cones in special relativity, the height of the inertial cone is a length e𝕧 and the radius of the base of -𝕚d as inertial time or mass. When the e𝕐/-𝕘d light impulse of the photons are observed this is proportional to the -𝕚d and e𝕧 Pythagorean Triangles and the E𝕍/-𝕚d inertial impulse, c is the maximum velocity e𝕧/-𝕚d in orbit while the gravitational speed downwards is also c.

Inertial work light cones

The inertial work light cone would be where the -𝕚d inertial time or mass Pythagorean Triangle side is orthogonal to e𝕙, the photons do -𝔾D×e𝕪 light work so their -𝔾D temporal light history equals the +𝕀D gravitational temporal history.

The CMB as a photosphere

This would also happen at the CMB with the limit of the +𝕚d and e𝕙 Pythagorean Triangle as gravity, photons would appear to form a photosphere where one on the upper side escape. This would be an illusion caused by the limit of the +𝕚d and e𝕙 Pythagorean Triangle.

Black holes as a photosphere

In this model black holes are also an illusion caused by the e𝕙 height above a gravitational observer or measurer. This causes photons coming from the centers of galaxies to climb a gravitational well from other stars. In the center this creates a kind of photosphere like the CMB, when the galaxy is further away from the gravitational observer or measurer the black hole can appear larger.

Special relativity and light cones

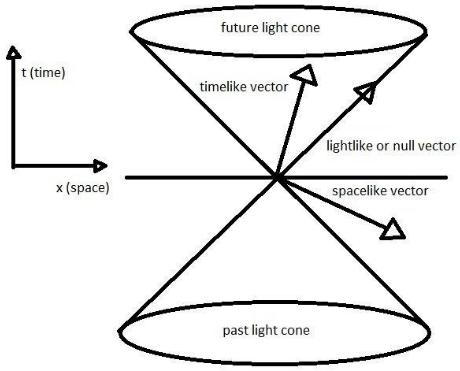
In this model the inertial light cone is bounded by the speed of light, this as $e𝕧_c/-𝕚d_c$ is an angle θ in the -𝕚d and e𝕧 Pythagorean Triangle. The same angle is also in the +𝕚d and e𝕙 Pythagorean Triangle with gravity, this gives the same c or $e𝕙_c/+𝕚d_c$ gravitational speed as a maximum at an event horizon.

The light cone formed by c

When θ is at a minimum e𝕪×-𝕘d photons cannot be measured or observed outside this inertial light cone, the photon velocity is not large enough. With an event horizon the photons also cannot be observed or measured, their kinetic velocity is not large enough.

Outside the light cone as spacelike

The light cone is formed by this angle θ where e𝕧 is $3×10^8$ meters and -𝕚d is 1 second. Taking the -𝕚d inertial time as the height of the cone and e𝕧 as the radius, this gives a wide cone where outside it is spacelike as a greater velocity than c would have θ greater than its maximum. The e𝕧 length would then be too far for light to have traveled to in that inertial time -𝕚d. Taking the light cone with a height e𝕧 and a radius of -𝕚d, outside this the light would not have had the -𝕚d inertial time to reach there.



Permittivity and permeability constants

In this model light speed is in Biv space-time, it is the ratio of the e𝕧 length and -𝕚d inertial time. It is also the gravitational speed e𝕙/+𝕚d as a limit. In Roy electromagnetism this is the permittivity constant $\epsilon_0 \times \mu_0$, the two when multiplied together give e𝕧$_c$/-𝕚d$_c$ because μ_0 is an inverse from the -𝕠d kinetic magnetic field. It comes from this magnetic field permeating in free space, ϵ_0 comes from the permittivity of free space for an electric charge.

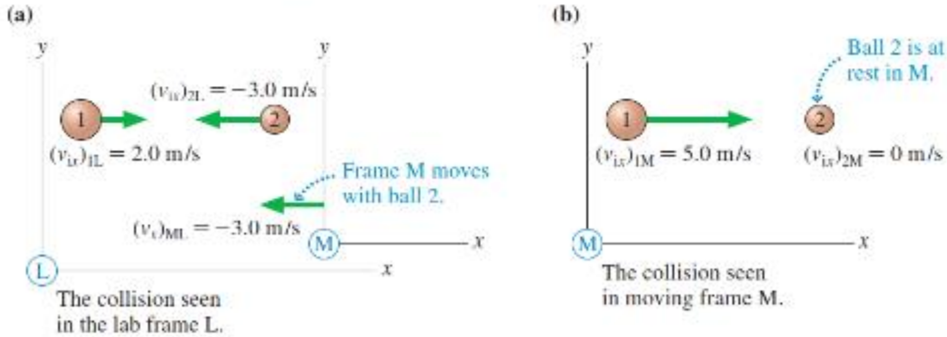
Proportional to c

When these are multiplied together and the square root is taken this gives e𝕧$_c$/-𝕚d$_c$, that is because ϵ_0 and μ_0 are squares to be observed and measured. These then change with the e𝕒 altitude of the electron above the proton, in the ground state this ratio is proportional to e𝕪/-𝕠d as the kinetic velocity. This is approximately α as 1/137 of c, the e𝕪 kinetic electric charge and the -𝕠d kinetic magnetic field then give c as a limit.

Nonrelativistic speeds in the atom

The inverse of this is where c comes from the proton with the e𝕒/+𝕠d potential speed, in both cases c is not reached in the atom. This is like with moons in orbit around a planet, the velocity is lower but there are some relativistic effects from the electron's velocity in the ground state. In this model that is automatically included with the changing angle θ with the -𝕠d and e𝕪 Pythagorean Triangle. The relationship between these constant and the speed of light was discovered by Maxwell.

FIGURE 11.22 The collision seen in two reference frames: the lab frame L and a moving frame M in which ball 2 is initially at rest.



Random motion and inelasticity

With a perfectly inelastic collision there are waves going through the two objects as they joined together, this is the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. There is some random motion from the -𝕆D kinetic and -𝕀D inertial probability, this causes a torque which makes the two objects mix together. With a perfectly elastic collision this is the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, there is no torque and so the elastic collision occurs in straight lines like a spring.

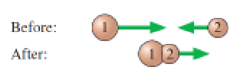
Combining masses as a force or as time

With a perfectly inelastic collision the -𝕀D inertial mass forces combine as in the equation below, this is the same as a -𝕀D constructive interference as they attract each other. In a perfectly elastic collision the masses as added together like -𝕚d inertial time, the -𝕚d inertial masses move apart with the same proportions as with the -𝕚d inertial time. This is because -𝕚d is not squared as a force, it acts like a clock gauge or timeline.

Collisions

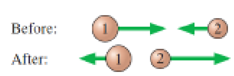
For two colliding objects.

- Represent the objects as elastic objects moving in a straight line.
- In a **perfectly inelastic collision,** the objects stick and move together. Kinetic energy is transformed into thermal energy.
  Mathematically:



$$(m_1 + m_2)v_{fx} = m_1(v_{ix})_1 + m_2(v_{ix})_2$$

- In a **perfectly elastic collision,** the objects bounce apart with no loss of energy.
  Mathematically:



  - If object 2 is initially at rest, then

$$(v_{fx})_1 = \frac{m_1 - m_2}{m_1 + m_2}(v_{ix})_1 \qquad (v_{fx})_2 = \frac{2m_1}{m_1 + m_2}(v_{ix})_1$$

  - If both objects are moving, use the Galilean transformation to transform the velocities to a reference frame in which object 2 is at rest.
- Limitations: Model fails if the collision is not head-on or cannot reasonably be approximated as a "thud" or as a "perfect bounce."

Exponential decay

In this model radioactivity occurs with an exponential decay curve. This is where the decay happens randomly, that means it is based on a Gaussian or normal curve. The nucleus does +𝕆D×e𝕒 potential work, when this decays there is a +𝕆D potential probability which declines as a square compared to an altitude away from the nucleus e𝕒. With a constant area Pythagorean

Triangle that gives an exponential decay curve. The weak force also breaks up neutrons with an exponential decay curve, the -𝕆D kinetic probability also gives a Gaussian.

Exponential chain reactions

This chain also gives a chain reaction with the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse in an atomic bomb, the byproducts of the decay cause other decays in an increasing exponential curve. This is not random so it does not come from work, there is a potential displacement force E𝔸 and a kinetic displacement force E𝕐. It is the inverse of the exponential decay curve with work, here it increases with a force over a +𝕠d potential time.

Chain reactions and the Galton box

This exponential chain reaction is like the shape of balls falling in a Galton box as Pascal's Triangle. The splitting comes from δ as the First Fiegenbaum constant, that is proportional to α in the ground state. The explosion proceeds chaotically as the Uranium increases in energy, this comes from the electron orbitals moving to higher orbitals and the nucleus breaking up. The torque from this is the +𝕆D×e𝕒 potential work, that is associated with √½π as β or the second Fiegenbaum constant. This twisting of the nucleus fragments causes them to spread like the columns of the Galton box. The result is the chain reaction using the E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work to spread to other Uranium atoms.

EXAMPLE 11.7 | Radioactivity

A ^{238}U uranium nucleus is radioactive. It spontaneously disintegrates into a small fragment that is ejected with a measured speed of 1.50×10^7 m/s and a "daughter nucleus" that recoils with a measured speed of 2.56×10^5 m/s. What are the atomic masses of the ejected fragment and the daughter nucleus?

MODEL The notation ^{238}U indicates the isotope of uranium with an atomic mass of 238 u, where u is the abbreviation for the *atomic mass unit*. The nucleus contains 92 protons (uranium is atomic number 92) and 146 neutrons. The disintegration of a nucleus is, in essence, an explosion. Only *internal* nuclear forces are involved, so the total momentum is conserved in the decay.

VISUALIZE FIGURE 11.25 shows the pictorial representation. The mass of the daughter nucleus is m_1 and that of the ejected fragment is m_2. Notice that we converted the speed information to velocity information, giving $(v_{fx})_1$ and $(v_{fx})_2$ opposite signs.

Four momentums

In this model there is a potential momentum as +𝕠d×e𝕒/+𝕠d and a kinetic momentum as -𝕠d×e𝕪/-𝕠d with Roy electromagnetism. There is also a gravitational momentum as +𝕚d×e𝕙/+𝕚d and an inertial momentum as -𝕚d×e𝕧/-𝕚d. The conservation of momentum comes from the constant Pythagorean Triangle sides, the action/reaction Pythagorean Triangle pairs are inverses of each other. Because an active change in one leads to a reactive inverse change in another the overall momentum is conserved.

Inverse reactive forces

The kinetic momentum is associated with the E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work, that causes an inverse reaction with the E𝔸/+𝕠d potential impulse and +𝕆d×e𝕣 potential work. Because they are inverses the overall change of momentum is zero. The change in the Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work comes as the rocket gains e𝕙 height, this is equal and opposite the reactive E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work.

Inverse probabilities

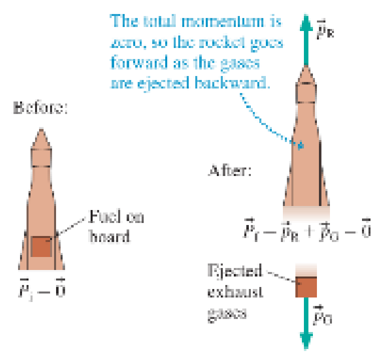
Because momentum is observed with impulse and measured with work, these forces are squaring the opposite Pythagorean Triangle side. When an electron moves to a higher orbital, after absorbing a e𝕪×-𝕘d photon, this increases the -𝕆D kinetic probability and inversely decreases the +𝕆D potential probability. That is because the more likely the electron is to move higher, the less likely it is to move lower. That happens because the two probabilities only interfere destructively.

Much the same reasoning explains how a rocket or jet aircraft accelerates. **FIGURE 11.26** shows a rocket with a parcel of fuel on board. Burning converts the fuel to hot gases that are expelled from the rocket motor. If we choose rocket + gases to be the system, the burning and expulsion are both internal forces. There are no other forces, so the total momentum of the rocket + gases system must be conserved. The rocket gains forward velocity and momentum as the exhaust gases are shot out the back, but the *total* momentum of the system remains zero.

Section 11.6 looks at rocket propulsion in more detail, but even without the details you should be able to understand that jet and rocket propulsion is a consequence of momentum conservation.

STOP TO THINK 11.5 An explosion in a rigid pipe shoots out three pieces. A 6 g piece comes out the right end. A 4 g piece comes out the left end with twice the speed of the 6 g piece. From which end, left or right, does the third piece emerge?

FIGURE 11.26 Rocket propulsion is an example of conservation of momentum.



A Pythagorean Triangle has one dimension

In this model impulse only acts on one straight-line, converting this to two or three dimensions is a classical approximation only. That is because a Pythagorean Triangle has only one straight dimension, it also has only one spin dimension and so it cannot spin in two or three dimensions. It can be converted to higher dimensions by adding more Pythagorean Triangles, but each of these would represent impulse or work.

Torque and single dimensions

Two or three dimensions can also be where a torque from work turns a ball in different directions. The displacement vectors such as E𝕍 would still add together with the dot product, the spin on the balls would add with the cross product. This can be observed as a lattice with the E𝕍/-𝕚d inertial impulse for example, it makes up the model of the clockwork universe with no fields. Each angle with a collision would come from the E𝕍/-𝕚d inertial impulse and the angle θ in their -𝕚d and e𝕧 Pythagorean Triangles.

11.5 Momentum in Two Dimensions

The law of conservation of momentum $\vec{P}_f = \vec{P}_i$ is not restricted to motion along a line. Many interesting examples of collisions and explosions involve motion in a plane, and for these both the magnitude *and the direction* of the total momentum vector are unchanged. The total momentum is the vector sum of the individual momenta, so the total momentum is conserved only if each component is conserved:

$$(p_{fx})_1 + (p_{fx})_2 + (p_{fx})_3 + \cdots = (p_{ix})_1 + (p_{ix})_2 + (p_{ix})_3 + \cdots$$
$$(p_{fy})_1 + (p_{fy})_2 + (p_{fy})_3 + \cdots = (p_{iy})_1 + (p_{iy})_2 + (p_{iy})_3 + \cdots \quad (11.34)$$

Let's look at some examples of momentum conservation in two dimensions.

Collisions and explosions often involve motion in two dimensions.

Three orthogonal Pythagorean Triangles

In this model there can be three orthogonal Pythagorean Triangles which are similar to the x, y, and z axes. Because they are orthogonal their +𝕀D×eh gravitational work for example would be independent of each other. This would be three degrees of freedom in probability, it relates to the equipartition theorem of molecules and heat. Here kT is the Boltzmann constant +𝕠d ×e𝕒 /+𝕆d which can be set for the proton, T then is the additional factor e𝕒 to make it equivalent to the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy.

Three generations of quarks and leptons

The three orthogonal Pythagorean Triangles are used in this model to give three generations of quarks and leptons, a quark for example can undergo a torque to point 90° in a new Pythagorean Triangle. This allows it to also interact with another quark in the first Pythagorean Triangle a π+ meson then might have an up quark and an antidown quark in the first +𝕠d and e𝕒 Pythagorean Triangle. With an additional +𝕆D potential torque this can become an up quark and an anti-strange quark as a K+ meson.

A lattice from torque or isopin

This can create a lattice as in the diagram, when a strange quark decays this would happen with torque, if the quark is +𝕠d, d=2/3 this would be a +𝕆D potential torque. If the quark is -𝕠d, d=1/3 this would be a -𝕆D kinetic torque. A K+ meson could decay into a π+meson where the +𝕠d anti-strange quark would have this +𝕆D potential torque turn it to a +𝕠d, d=1/3, antidown quark. In particle physics this is called isospin.

Photons from torque

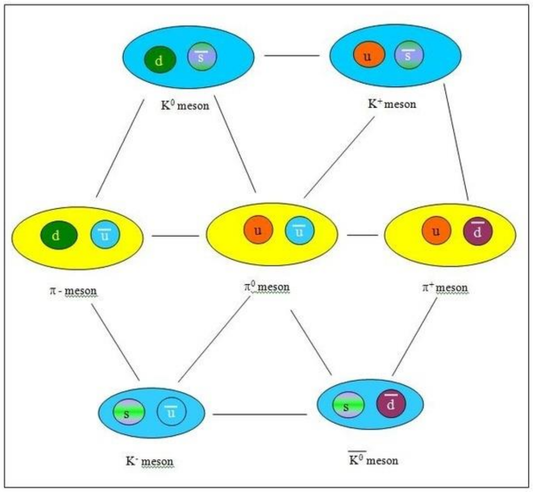
E𝕪×-𝕘d photons can be emitted, these are the same in this model as the differences in -𝕆D kinetic probabilities as an electron changes its orbital. They are also the same as in Quantum Field Theory where an electron and positron might annihilate each other. The difference between their +𝕠d and -𝕠d spin Pythagorean Triangle sides acts like the difference between +𝕠d from a proton and -𝕠d from an electron.

Three degrees of freedom

The three generations of quarks allows for these three degrees of freedom to also have a +𝕆D potential probability and -𝕆D kinetic probability of occurring. Because these are proportional to the +𝕀D gravitational probability and -𝕀D inertial probability the quarks can change their masses, also because the spin Pythagorean Triangle sides are time this can cause them to decay on an exponential curve from the constant areas of the Pythagorean Triangles.

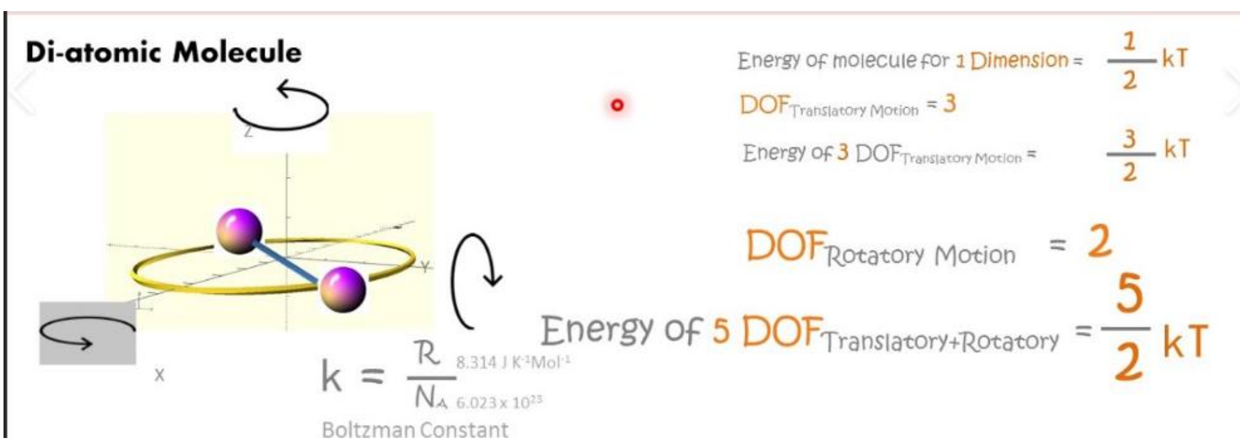
Photon emission in quark decays

The -𝔾D light probability in a photon emission is where this torque was released by the anti-strange quark returning to being a bottom quark in its original +𝕠d and e𝕒 Pythagorean Triangle. If this is an +𝕘d×e𝕒 virtual photon then that would be a +𝔾D light probability going backwards in time.



Different forces

The three orthogonal Pythagorean Triangles can also have different forces, in the diagram there can be a translatory motion with the E𝔸/+𝕠d potential impulse. Another +𝕠d and e𝕒 Pythagorean Triangle can have a rotatory motion with +𝕆D×e𝕒 potential work, the third might vibrate as another degree of freedom with +𝕆D×e𝕒 potential work. These can be a classical approximation in a molecule, the different protons each have one +𝕠d and e𝕒 Pythagorean Triangle with two possible other +𝕠d and e𝕒 Pythagorean Triangles orthogonal to it. With additional protons and neutrons in the nucleus this becomes more complicated with how the forces interact.



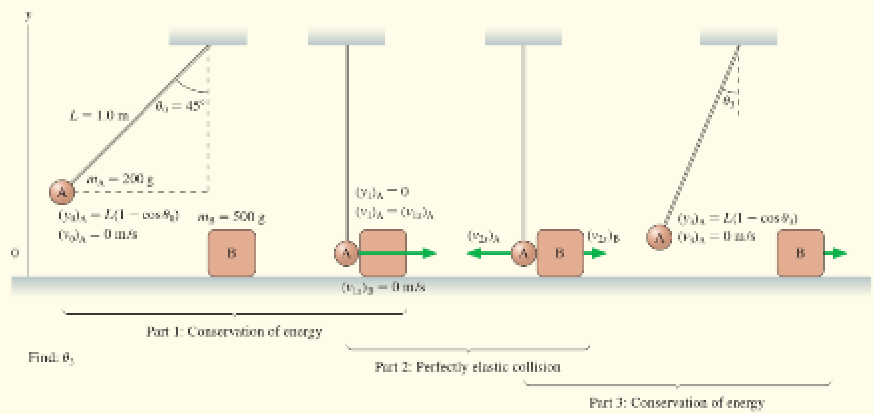
Oscillation of a pendulum

In this model a pendulum swings with an oscillation of -𝕀D×e𝕧 inertial work, this reacts against the +𝕀D×e𝕙 gravitational work pulling it down. If the +𝕀D×e𝕙 gravitational work is stronger then this adds more to the -𝕀D inertial torque of the pendulum's swing, that reduces the duration from one side to the other.

Transferring a kinetic impulse to a block

It can also be regarded as an E𝕍/-𝕚d inertial impulse, the period of the pendulum would be -𝕚d inertial time on a clock gauge. This can hit a black in the diagram with a straight-line force, this transfers the E𝕐/-𝕠d kinetic impulse that would have originally swung the pendulum. This is modeled below as a perfectly elastic collision which is impulse.

FIGURE 11.30 Four moments in the collision of a pendulum with a paperweight.



Rotation of a rigid body

A rigid body is held together by probabilities in this model, molecular bonds have a constructive interference which attracts atoms to each other. They also have a destructive interference with a repulsion in some cases, that causes molecules to assume a rigid shape. With constructive interference the probabilities are added together, this is the same as how a magnet works.

Most probable electron paths

The +𝕆D×e𝕒 potential work of the nuclei has a +𝕆D potential probability, this gives how close the electrons can probably come to it. When they are too close it reacts against this, the -𝕆D kinetic probability of the electrons is subtracted destructively from the +𝕆D potential probability. Because +𝕆D decreases as an inverse square with the radius or altitude e𝕒, this gives an orbital where an electron is most probably found. The path of the electron is a series of e𝕪 positions on a scale, the -𝕆D kinetic probability interferes as in a path integral.

Probability compressions and expansions

These bonds can be compressed or expanded from external work, that makes it more probable the atoms change their shapes and the electrons their orbitals. For example, a rubber wheel might be bent into other shapes.

Impulse and molecular bonds

Electrons can be shared with other atoms with this interference, atoms can also be attracted with the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. This is from the Coulomb force as an electric charge, for example NaCl has a positive and a negative ion.

Positive and negative are from spin

In this model the positive and negative signs are only for the spin Pythagorean Triangle sides, but the e𝕒 potential electric charge is associated with the +𝕠d potential magnetic field. The e𝕪 kinetic electric charge is associated with the -𝕠d kinetic magnetic field so this is a classical approximation.

Gravity perturbing electron orbitals

The atoms also do +𝕀D×e𝕙 gravitational work from the nucleus, this is a weaker +𝕀D gravitational probability. It can cause electrons to move downwards in an orbital and emit e𝕪×-𝕘d photons, the protons with their +𝕆D×e𝕒 potential work react against this. Together the +𝕀D gravitational and +𝕆D potential probabilities work together, the electron with its -𝕆D×e𝕪 kinetic work also has -𝕀D×e𝕧 inertial work reacting against being pulled down to a lower orbital.

Impulse in the macro world

In the macro world impulse dominates, this causes atoms to act more like particles. They cannot pass through each other like waves, the -𝕆D×e𝕪 kinetic work in between the molecules is too small to be measured in larger scales. This constructive and destructive interference also appears in the macro world, magnets can attract and repel each other.

Gyroscopes and interference

A bike wheel can have an increased -𝕀D inertial mass force, also a -𝕀D inertial probability it will continue to rotate. If a second bike wheel is connected to its axis and rotated in the opposite direction, the -Id inertial probabilities interfere destructively, and the gyroscopic effect is stopped. In molecules a destructive interference with -𝕀D×e𝕧 inertial work causes the atoms to move away from some shapes with inertia.

12.1 Rotational Motion

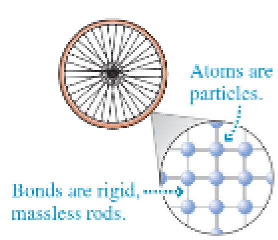
Thus far, our study of motion has focused almost exclusively on the *particle model*, in which an object is represented as a mass at a single point in space. As we expand our study of motion to rotation, we need to consider *extended objects* whose size and shape *do* matter. Thus this chapter will be based on the **rigid-body model:**

MODEL 12.1

Rigid-body model

A **rigid body** is an extended object whose size and shape do not change as it moves.

- Particle-like atoms are held together by rigid massless rods.
- A rigid body cannot be stretched, compressed, or deformed. All points on the body have the same angular velocity and angular acceleration.
- Limitations: Model fails if an object changes shape or is deformed.



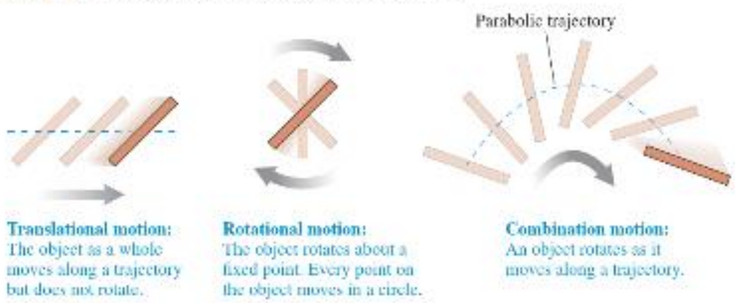
Exercise 1

Work and impulse

In this model translational motion comes from impulse, rotational motion from work. These cannot combine together completely because of the uncertainty principle, the third motion would be a combination of work and impulse.

FIGURE 12.1 illustrates the three basic types of motion of a rigid body: **translational motion, rotational motion,** and **combination motion.**

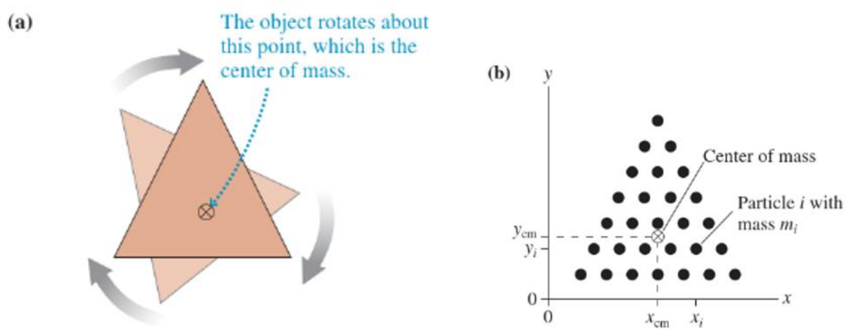
FIGURE 12.1 Three basic types of motion of a rigid body.



Center of mass from torque

In this model mass comes from the spin Pythagorean Triangle side, this is rotation. The force is a -𝕀D inertial torque for example, the -𝕀D×e𝕧 inertial work around the triangle becomes balanced. This is because of the inverse square rule, as the e𝕧 length outwards from the center increases the -𝕀D inertial torque decreases as a square. This causes an area of increased -𝕀D inertial probability to be in a smaller e𝕧 length area. With +𝕀D×e𝕙 gravitational work there is also a gravitational spin, a planet spins around its center of +𝕚d gravitational mass. This also spins like a clock gauge with the Eℍ/+𝕚d gravitational impulse.

FIGURE 12.4 Rotation about the center of mass.



Gravity as probability

The +𝕚d and e𝕙 Pythagorean Triangle as gravity, and the +𝕠d and e𝕒 Pythagorean Triangle as the proton give circular or spherical geometry. This is because the spin Pythagorean Triangle side is larger when the straight Pythagorean Triangle side is smaller. With +𝕀D×e𝕙 gravitational work then the +𝕀D gravitational probability is stronger when the e𝕙 height is smaller, that causes objects to be attracted to a lower height because they are more probably to be found there.

Balancing interference

Inside a planet the e𝕙 height points in different directions, this causes an increasingly destructive interference. Gravity is measured to decline, at the center it is balanced by opposing destructive interferences. Approaching this center there is an increased +𝕀D gravitational probability, it is also increasingly being destructively interfered with by the +𝕀D gravitational probability on the other side of the center.

Balancing torque

That allows a planet to rotate around this center, an axis through it also has a balance of destructive interferences on opposite sides of it. This is because the +𝕀D gravitational probability is also gravitational torque, there is an even rotation because the torque is balanced as probabilities. If these were not balanced, then there would be a net torque in a direction to balance them again.

Rotating with inertia

When a planet rotates this is also through inertia, there is a -𝕀D inertial torque like turning a nut with a wrench. This is also an inertial probability, the planet is more inertially likely to keep turning with this torque. In this model the -𝕀D×e𝕧 inertial work is subtracted from the +𝕀D×e𝕙 gravitational work, as the planet spins faster there is more -𝕀D inertial torque. If fast enough then some matter can be flung off into orbit, this is where the -𝕀D inertial torque is stronger than the +𝕀D gravitational torque at the surface.

Inertial rotation

In this model -𝕀D×e𝕧 inertial work is done with satellites orbiting around a planet, it is the same as the rotation of the planet or the satellites themselves. Rotation needs a motion at right angles to the e𝕙 height of the +𝕀D×e𝕙 gravitational work, that means the +𝕚d gravitational field itself does not rotate. Instead it can deflect an inertia trajectory into a rotation such as an orbit. A circular orbit, or the surface of the planet, is a balance between the -𝕀D×e𝕧 inertial work and the +𝕀D×e𝕙 gravitational work exerting a torque on each other.

Gravitational and inertial mass as inverses

For a +𝕚d gravitational mass to rotate around the center this -𝕀D inertial probability must also rotate around that center. This is because -𝕀D is subtracted inversely from +𝕀D at every e𝕙 and e𝕧 position. If the -𝕚d inertial mass was not an inverse to the +𝕚d gravitational mass, then spinning a planet would change its axis as with spinning a top.

Destructive inertial interference

Inside the planet there is also a constructive and destructive interference with the -𝕀D inertial probability. Approaching the center the -𝕀D values interfere destructively, this is e𝕧 direction is opposite on the other side. That is like the e𝕙 height being opposite in direction on the other side of the center, that causes the +𝕀D gravitational probabilities to also interfere destructively. This is balanced at the center so there is no net -𝕀D inertial torque there, also not along the axis of rotation.

Potential and kinetic mass

The +𝕠d and e𝕒 Pythagorean Triangle, as the proton, also has an increased +𝕆D potential probability at a lower e𝕒 altitude. This causes there to be a center of the potential magnetic field, like a center of mass. Electrons with their -𝕠d kinetic magnetic field, like a kinetic mass, then orbit around this potential mass like the asteroids around a planet. The proton with its +𝕆D×e𝕒 potential work reacts against the -𝕆D×e𝕪 kinetic work of the electron, it does this evenly because for the same e𝕒 altitude the +𝕆D potential probability and torque is the same.

Small objects with gravity and inertia

In Biv space-time around a planet there can be space dust, hydrogen atoms, etc which also do +𝕀D×e𝕙 gravitational work, they can interfere constructively and destructively with a planet's gravity. They would also do -𝕀D×e𝕧 inertial work that interferes destructively with gravity. Where there are no particles or waves as iotas, in this model there are no Pythagorean Triangles.

The vacuum and matter

The vacuum does not then have virtual particles, this can only happen where these Pythagorean Triangles already are. With no observation of a particle there is no impulse, with no measurement of a wave there is no work.

Change mediated with Gravis

For there to be a change there needs to be +𝔾D×e𝕙 Gravi work or a e𝔹/+𝕘d Gravi impulse, this is where changes in e𝕙 height or its inverse e𝕓 depth are transmitted at c. The vacuum in this model has no energy because this would only be from impulse, where there is no particle there is no displacement history.

Cosmological constant

In this model the cosmological constant does not come from a vacuum energy, instead this represents a minimum angle θ, and a minimum value of +𝕚d gravitational mass from the +𝕚d and e𝕙 Pythagorean Triangle. As the e𝕙 height increases in any direction this is observed as a Eℍ/+𝕚d gravitational impulse, because the +𝕚d gravitational time moves towards the past it looks like objects are falling downwards.

Expansion of the universe

Closer to an observer this is a minimum value, it is like a shallow slope extending in all directions. A ball would then start to roll with an increasing acceleration, the -𝕚d inertial time moves forward opposite to this. That causes all particles to be observed as decelerating from the Big Bang explosion, the expansion slowing to the present day.

Expansion and contraction of the universe

Because of this the universe cannot continue to expand in this model, nor can it contract to another singularity. The expansion in this model is an illusion from the +𝕚d and e𝕙 Pythagorean Triangle and its constant area, further away has e𝕪×-𝕘d photons redshifted more because they climb the e𝕙 height of a gravitational well.

Change as position and time

In this model changes in the four main Pythagorean Triangles are mediated through changes in the four central Pythagorean Triangles. These are the e𝕪 and -𝕘d Pythagorean Triangle with the e𝕪×-𝕘d photon, the e𝕒 and +𝕘d Pythagorean Triangle with the +𝕘d×e𝕒 virtual photon, the e𝕧 and -𝕘d Pythagorean Triangle with the virtual Iner from inertia, and the +𝕘d and e𝕓 Pythagorean Triangle with the Gravi from gravity.

Photons and time direction

The e𝕪×-𝕘d photon moves forward in -𝕘d light time, the +𝕘d×e𝕒 virtual photon moves backwards in +𝕘d light time. When they are not squared they are like moments on a clock gauge, a e𝕪×-𝕘d photon then has a rotational frequency like a handing moving around a clock. This is the frequency of a photon but is not a force, in this model the hand is the e𝕪 kinetic electric charge as a phasor. The +𝕘d×e𝕒 virtual photon is like the hand moving in reverse around the clock, the hand is the e𝕒 altitude or potential electric charge.

Emitting and receiving a clock time

Both photons rotate with no force at a constant frequency, as a derivative the photon would be e𝕪/-𝕘d or e𝕒/+𝕘d but it is still not observable without a force. This is superposed with e𝕪×-𝕘d or +𝕘d×e𝕒 as a field, it means that they can be observed as a derivative particle or an integral field but not both at the same instant and infinitesimal position.

Vacuum dimensions and particles

The vacuum is defined by the straight Pythagorean Triangle sides going through it like a lattice, that maintains and conserves its shape. With photons these are the e𝕪 kinetic electric charge and the e𝕒 potential electric charge, they are proportional to Biv space-time dimensions as e𝕧 length and e𝕙 height. There are also the spin Pythagorean Triangle sides, changes in time are mediated by -𝕘d and +𝕘d.

Photon electron collision

For a particle to be observed there must be impulse, for example a e𝕪×-𝕘d photon might collide with an electron as a particle with its e𝕐/-𝕘d light impulse.

A photon into an electron and positron

For a particle to be observed there must also be a change from no observation, for example a e𝕪×-𝕘d photon might break into an electron and positron. This is because -𝕘d is the difference between the -𝕠d kinetic magnetic field and the +𝕠d potential magnetic field, it can also be the difference between -𝕠d in the electron and +𝕠d in the positron.

Gravity separating electrons and positrons

For there to be a change the photon might be near a gravitational field, that makes the electron perhaps at a greater e𝕙 height to the positron. This would cause the electron to have a velocity e𝕧/-𝕚d different from the e𝕙/+𝕚d gravitational speed of the positron and so they separate. They may also recombine into a e𝕪×-𝕘d photon. This change would be mediated by the +𝕘d×e𝕓 Gravi, the positron would have a different +𝕘d Gravi time to the electron's -𝕘d Iner time.

Vacuum fields

The vacuum can also contain fields, this is where the Pythagorean Triangles are integrals rather than derivatives. The e𝕪×-𝕘d photon then is not being measured, because -𝕘d is not squared as -𝔾D, when it is measured then there is a -𝔾D light probability which can interfere with other photons to give an interference pattern. When the constructive interference is large enough this can be the difference between a particle and an antiparticle, such as the electron and positron.

Particles and antiparticles closer to the CMB

With a greater e𝕙 height the +𝕚d gravitational mass is contracted, Biv space-time at greater distances appears more redshifted as e𝕪×-𝕘d photons climb through the gravitational wells. This looks like a larger +𝕚d gravitational mass, with this larger difference the e𝕪×-𝕘d photons can appear as more different particles and antiparticles. The particles can last for longer because the +𝕚d gravitational time in the Eℍ/+𝕚d gravitational impulse is slower, the Eℍ displacement history of the photons is larger closer to the CMB.

Electrons and photons move forwards in time

As these particles and antiparticles decay, the e𝕪×-𝕘d photons move forward in time to the local observer and measurer. The +𝕘d×e𝕒 virtual photons are not observed or measured, they move further back in time. This allows for normal matter to be observed and measured, antimatter can only be observed and measured further back in time. Protons also move backwards in time, but these are observed and measured by electrons and photons moving forwards in time.

Antiprotons and positrons

Antiprotons could only be observed and measured by positrons and +𝕘d×e𝕒 virtual photons moving backwards in time, so they are not detected in the visible universe. They would need to be in the future, but a greater e𝕙 is already moving towards the past in +𝕚d gravitational time.

Geodesics

Without being measured there is no work force, the Pythagorean Triangles have no squared spin Pythagorean Triangle sides. A planet then does not do +𝕀D×e𝕙 gravitational work around it unless there is an object, such as an asteroid, then it appears to move in a geodesic. The shape of this geodesic would be measured by the -𝕀D×e𝕧 inertial work of the asteroid. Its inertial path integral would be from its inertial e𝕧 path and its -𝕀D inertial torque or probabilities subtracted from the +𝕀D gravitational torque and probabilities from the planet.

Inertia and probability

The -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle are in hyperbolic geometry, the -Od kinetic and -𝕀D inertial probabilities do not point towards a center as with gravity. Instead the maximum -𝕀D inertial probability is with a smaller e𝕧 length, this is the same as with the +𝕀D×e𝕙 gravitational work with a decreased e𝕙 height because of the constant Pythagorean Triangle areas. That causes the -𝕀D inertial probability to react against a small motion, close to stationary.

Constant acceleration as increments

If this was not so then pushing on a heavy block might be easier at first then harder. Instead increasing the velocity e𝕧/-𝕚d of a block each time has the same initial -𝕀D reactive probability, accelerating the block then feels even at different velocities.

Electromagnetism and kinetic probability

With the -𝕠d and e𝕪 Pythagorean Triangle as the electron, this causes the -𝕆D kinetic probability to be strongest when the e𝕪 kinetic electric charge is weakest. That is how electromagnetism works, the +𝕠d magnetic field is strongest when the e𝕪 kinetic electric charge is weakest. A magnet can then have its strongest -𝕆D magnetic force with no discernible electric current.

Large voltage and small current

An electric generator works like pushing a heavy block, the -𝕆D kinetic probability is strongest over a small amount of e𝕪 kinetic current. This is how a transformer works with the +𝕆D×e𝕒 potential work and the -𝕆D×e𝕪 kinetic work, in this model the voltage is in between the +𝕆D potential difference and the -𝕆D kinetic difference.

Increased voltage as an attractive force

Increasing the voltage of a current increases this difference in probability, that gives a stronger attractive force between the two. This is because the +𝕆D potential probability adds more to the -𝕆D kinetic probability as electrons get closer to a positive terminal, this acts like a slope causing them to accelerate.

A transformer and work

The +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle have a constant area, so a larger +𝕠d or -𝕠d give a smaller e𝕒 or e𝕪. When this is measured as work then +𝕆D as the potential difference and -𝕆D as the kinetic difference are increased as squares in a transformer. That gives a smaller current of electricity in amperes.

Increments of rotation

Each time a generator increases its rotation, this gives an additional increment of e𝕪 kinetic current pushed by an increased -𝕆D kinetic difference or voltage. It is like pushing the block with -𝕀D×e𝕧 inertial work, an increase in pressure on the block is reacted against with a large -𝕀D inertial probability. This happens at different velocities, the increment of a minimum e𝕧 length has this maximum -𝕀D inertial probability.

Uncertain increments

Increasing the rotation rate of the generator has this same ratio, a small amount of e𝕪 kinetic electric charge from a larger change in -𝕆D kinetic probability or torque. This gives a constant acceleration of the current, the rotational frequency is constant then this gives a constant +𝕆D potential difference and -𝕆D kinetic difference. This increment of work is more wavelike, it is similar to inside an atom where the -𝕆D×e𝕪 kinetic work of an electron acts as a wave. Because a small change in positions happens first then there is an uncertainty with probability, that is from the uncertainty principle.

12.2 Rotation About the Center of Mass

Imagine yourself floating in a space capsule deep in space. Suppose you take an object like that shown in FIGURE 12.4a and spin it so that it simply rotates but has no translational motion as it floats beside you. *About what point does it rotate?* That is the question we need to answer.

An unconstrained object (i.e., one not on an axle or a pivot) on which there is no net force rotates about a point called the **center of mass.** The center of mass remains motionless while every other point in the object undergoes circular motion around it. You need not go deep into space to demonstrate rotation about the center of mass. If you have an air table, a flat object rotating on the air table rotates about its center of mass.

To locate the center of mass, FIGURE 12.4b models the object as a set of particles numbered $i = 1, 2, 3, \ldots$. Particle i has mass m_i and is located at position (x_i, y_i). We'll prove later in this section that the center of mass is located at position

$$x_{cm} = \frac{1}{M}\sum_i m_i x_i = \frac{m_1 x_1 + m_2 x_2 + m_3 x_3 + \cdots}{m_1 + m_2 + m_3 + \cdots}$$
$$y_{cm} = \frac{1}{M}\sum_i m_i y_i = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3 + \cdots}{m_1 + m_2 + m_3 + \cdots} \quad (12.4)$$

where $M = m_1 + m_2 + m_3 + \cdots$ is the object's total mass.

Asymmetrical shapes and probability

When an asymmetrical shape rotates there is still -𝕀D×e𝕧 inertial work being done, at some point the -𝕀D inertial probabilities on both sides cancel. That point then is not likely to move elsewhere to a different e𝕧 position. The individual points each have a -𝕀D inertial probability and torque, this is smaller towards the edges because the velocity is larger as e𝕧/-𝕚d so -𝕚d is contracted.

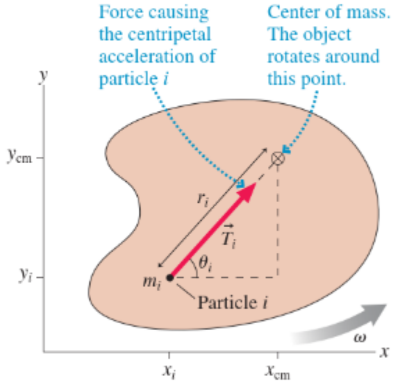
A center is more probable

The most probable position to rotate around then would have the smallest velocity as e𝕧/-𝕚d, appearing at rest. That maximizes the -𝕀D inertial torque, so this position has the -𝕀D moment of inertia. It is then more probable for a center of rotation to form rather than the shape spinning chaotically.

Centripetal force and impulse

The -𝕚d and e𝕧 Pythagorean Triangle with inertia is in hyperbolic geometry, that means the iotas in the shape tend to move outwards with a centripetal force instead of inwards like gravity. When they are constrained in a rotating shape the E𝕍/-𝕚d inertial impulse still acts in a straight-line forming this force.

FIGURE 12.8 Finding the center of mass.



Kinetic energy as work and impulse

The individual positions on a shape can be regarded as e𝕧 positions with -𝕀D×e𝕧 inertial work, also as e𝕪 positions with -𝕆D×e𝕪 kinetic work. This can be converted into the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy by combining the -𝕆D×e𝕪 kinetic work and the E𝕐/-𝕠d kinetic impulse. This gives two orthogonal forces, the centripetal force is directed in a straight-line with the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. The -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work is at right angles to this.

Gravity and inertia

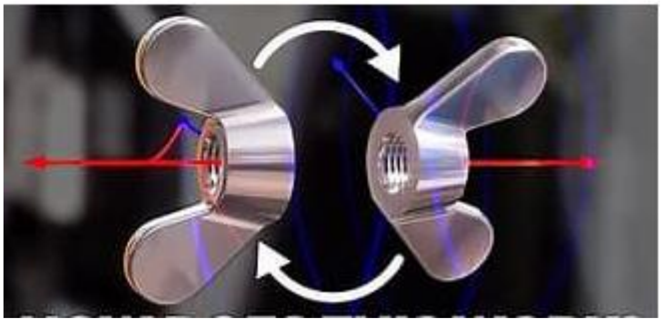
The shape also has a gravitational field though this is small, though it can be a large asteroid with an asymmetrical shape. Then there is a Eℍ/+𝕚d gravitational impulse pulling inwards with a centrifugal force against the E𝕍/-𝕚d inertial impulse. There is also +𝕀D×e𝕙 gravitational work where objects tend to go into orbit around it, the -𝕀D×e𝕧 inertial work of some atoms can be a balance of +𝕀D gravitational probability and -𝕀D inertial probability.

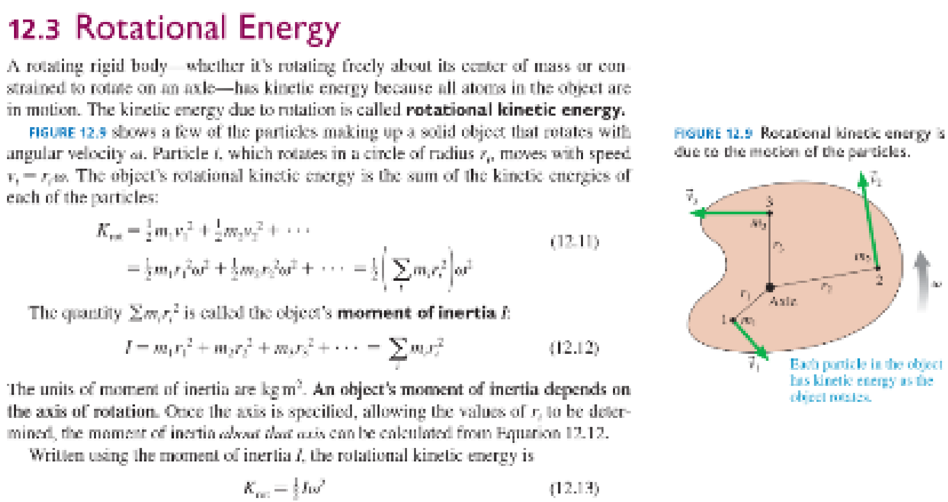
The potential and molecular bonds

There is also +𝕆D×e𝕒 potential work holding the molecules together in the shape, this acts like a +𝕆D potential probability reacting against the -𝕆D×e𝕪 kinetic work of the rotation. The E𝔸/+𝕠d potential impulse reacts against the E𝕐/-𝕠d kinetic impulse pointing outwards as a centripetal force.

Chaotic rotation

An asymmetrical shape can have different ratios of work and impulse around it, that can cause chaotic motion. For example a wingnut can spontaneously flip over when weightless. In this model chaos comes from β and δ, β approaches √1/2π. This gives a smooth rotation with -𝕀D×e𝕧 inertial work when the shape is a disk, when the shape is not round there can be chaotic rotations from β. Another example is the moon Hyperion, the direction of its axis changes unpredictably.





12.3 Rotational Energy

A rotating rigid body—whether it's rotating freely about its center of mass or constrained to rotate on an axle—has kinetic energy because all atoms in the object are in motion. The kinetic energy due to rotation is called **rotational kinetic energy.**

FIGURE 12.9 shows a few of the particles making up a solid object that rotates with angular velocity ω. Particle i, which rotates in a circle of radius r_i, moves with speed $v_i = r_i\omega$. The object's rotational kinetic energy is the sum of the kinetic energies of each of the particles:

$$K_{rot} = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 + \cdots = \frac{1}{2}m_1r_1^2\omega^2 + \frac{1}{2}m_2r_2^2\omega^2 + \cdots = \frac{1}{2}\left(\sum_i m_ir_i^2\right)\omega^2 \quad (12.11)$$

The quantity $\sum m_ir_i^2$ is called the object's **moment of inertia** I:

$$I = m_1r_1^2 + m_2r_2^2 + m_3r_3^2 + \cdots = \sum_i m_ir_i^2 \quad (12.12)$$

The units of moment of inertia are kg m^2. **An object's moment of inertia depends on the axis of rotation.** Once the axis is specified, allowing the values of r_i to be determined, the moment of inertia *about that axis* can be calculated from Equation 12.12.

Written using the moment of inertia I, the rotational kinetic energy is

$$K_{rot} = \frac{1}{2}I\omega^2 \quad (12.13)$$

FIGURE 12.9 Rotational kinetic energy is due to the motion of the particles.

Rotational kinetic energy

In conventional physics the rotational kinetic energy has a similar form to the linear kinetic energy, as shown in the diagram. If this was a large asteroid the moment of inertia I acts like the +𝕀D gravitational torque, and the -𝕀D inertial torque. acts like the -𝕚d inertial mass.

Gravitational time and spin

Taking the +𝕚d and e𝕙 Pythagorean Triangle as gravity, this is drawn with a e𝕙 height above the asteroid, at this height the +𝕚d gravitational mass is the spin Pythagorean Triangle side. This points in one direction, that would give a +𝕀D gravitational torque onto a smaller asteroid rotating around it. When taking as a derivative this becomes +𝕚d gravitational time, the small asteroid rotates around the larger one like a hand on a clock gauge.

Inertial time and an orbital period

There is also inertia from the -𝕚d and e𝕧 Pythagorean Triangle, the small asteroid has an orbital period according to its own -𝕚d inertial mass, when this is subtracted from +𝕚d that gives the overall +𝕚d gravitational mass the asteroid experiences as well as its orbital period.

A clock with a moment of inertia

A clock gauge has a moment of inertia, the term used in conventional physics, where the hand attaches to the motor or spring. The hand also has an angular velocity, taking the e𝕙 height up to the small asteroid this acts like the clock hand giving an orbital period.

Kinetic energy and impulse

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is typically used to observe particles, in this model that comes from the E𝕐/-𝕠d kinetic impulse. The two other -𝕠d factors cancel out, as the kinetic magnetic field and kinetic time, to leave the kinetic impulse only, the ½ factor comes as a midway point between two velocities or two e𝕪/-𝕠d kinetic velocitys. Impulse is used because particles are easier to observe than waves are to measure.

Rotational gravitational energy

The rotational kinetic energy formula is the same, it becomes ½×+𝕚d×E𝕙/+𝕀D, the two +𝕚d factors cancel again because +𝕚d acts as a gravitational mass as well as gravitational time. This leaves the E𝕙/+𝕚d gravitational impulse.

Angular brevity

The gravitational angular brevity as e𝕙/+𝕚d is a constant, it occurs at a e𝕙 height to give that angle θ in the +𝕚d and e𝕙 Pythagorean Triangle. In this model the word brevity is used instead of velocity for the +𝕚d and e𝕙 Pythagorean Triangle, it keeps the term velocity for its uses in conventional physics. This brevity can also accelerate downwards with the E𝕙/+𝕚d gravitational impulse or +𝕀D×e𝕙 gravitational work. Without a force it represents a constant e𝕙 height, the motion in +𝕚d gravitational time then must be in a circle.

Velocity as a rolling wheel

With velocity this is in a straight-line, it can also be regarded as like a wheel rolling where e𝕧 is the radius and -𝕚d is the inertial time it takes for a rotation. The +𝕚d and e𝕙 Pythagorean Triangle as gravity then rotates like a clock, the -𝕚d and e𝕧 Pythagorean Triangle as inertia rotates the same way but rolls as it moves. This can be in a hyperbolic trajectory outside a +𝕚d gravitational field.

Electrons and photons as rolling wheels

The electron in this model rolls around the orbital, its -𝕆D×e𝕪 kinetic work gives an integer number of rotations around it. Elliptical orbitals will be covered later. The e𝕪×-𝕘d photon also acts like a rolling wheel, its e𝕪 phasor rotates like a spoke on an axle as -𝕘d or the rotational frequency. This transmits the changes in the rotation of the electron rolling wheel in an orbital.

Gravitational waves

The +𝕘d×e𝕓 Gravi transmits the changes in the e𝕙/+𝕚d brevity with gravity, these are measured as gravitational waves. Here e𝕓 is the depth in a gravitational field, e𝕙 height is the inverse of depth. These also moves as a wheel, a e𝕓 phasor around a +𝕚d gravitational time. When received this increases the +𝕚d gravitational mass of matter, that causes a change in the e𝕓 depth of the +𝕚d gravitational field which is observed as the E𝕙/+𝕚d gravitational impulse.

Not actually spinning

The +𝕚d and e𝕙 Pythagorean Triangle and its angular brevity e𝕙/+𝕚d need not be actually spinning, because it is not observed or measured it represents a probability of the +𝕀D gravitational torque being measured. It also is a possibility of the Eℍ/+𝕚d gravitational impulse being observed, the angular brevity to be conserved then needs to be observed and measured according to possibility and probability. There is a related paradox in quantum mechanics where the proton and electron are not actually spinning, but when measured there is a probability of where the particle will be observed associated with spin and torque. The electron can have its spin reversed because of ½π and β^2 from the ground state and α. This is also for higher orbitals as increments of α.

Angular momentum and the proton

The +𝕠d and e𝕒 Pythagorean Triangle as the proton also has this angular brevity, here it is called the e𝕒/+𝕠d potential speed. This would be represented by the ground state orbital for example, it is an altitude e𝕒 where the potential magnetic field has a strength +𝕠d. This is also written as the potential angular momentum +𝕠d×e𝕒/+𝕠d, a superposition of the +𝕠d×e𝕒 potential electromagnetic field.

ℏ and h

This tendency to spin is related to ℏ, that was originally divided by 2π because of the idea of a unit of energy as spin. In this model h as -𝕠d ×e𝕐/-𝕠d is the interval between observations of particles in orbitals. A quantized orbital in this model acts as a wave not a particle, it does -𝕆D×e𝕪 kinetic work. To observe this orbital a E𝕐/-𝕠d kinetic impulse is taken as a starting point in Schrodinger's equation. That uses the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy as $p^2/2m$ where p is the momentum -𝕠d×e𝕪/-𝕠d and 1/2m is ½×1/-𝕠d, that factors out to ½×e𝕐/-𝕆d ×-𝕠d.

Schrodinger's equation

It also reduces to the E𝕐/-𝕠d kinetic impulse, this acts as increments of energy in between the orbitals which are -𝕆D×e𝕪 kinetic work. This work is the wave function because the -𝕆D kinetic probability is a square like $-\psi^2$. The changes in the potential energy are written as V in Schrodinger's equation, this also changes with increments of h as angular momentum or ℏ.

The proton and ℏ

The +𝕠d and e𝕒 Pythagorean Triangle version of h is +𝕠d × e𝔸/+𝕠d, it is like the potential momentum +𝕠d×e𝕒/+𝕠d except that the e𝕒 altitude is observed as the E𝔸 potential displacement history. This would give increments of angular momentum to the rotational potential energy as ½×+e𝔸/+𝕆d ×+𝕠d, in this model it is called the linear potential energy because it reduces down to the E𝔸/+𝕠d potential impulse.

Increments of ℏ

The increments of ℏ come from the quantized values of E𝔸, the straight Pythagorean Triangle side when squared are not quantized but this is also the interval between units of +𝕆D×e𝕒 potential work. It then observes the intervals between the quantized values of the +𝕆D×e𝕒 potential work, these are the inverses of the circular orbitals of -𝕆D×e𝕪 kinetic work. In between those orbits are increments of h as -𝕠d ×e𝕐/-𝕠d.

Changing kinetic velocity

This process can be illustrated with an electron in the ground state, it absorbs a e𝕪×-𝕘d photon which changes its e𝕪/-𝕠d kinetic velocity in a higher orbital. This is slower as a velocity e𝕧/-𝕚d, the electron acts like a rolling wheel around the orbital where -𝕚d has an extra 1 added to d and 1 less in e with e𝕪.

The intervals between orbitals as h

The difference between these orbitals is h as -𝕠d ×e𝕐/-𝕠d, d has increased by 1 and e𝕪 in E𝕐 has e decrease by 1. This is observing the change in the kinetic momentum -𝕠d×e𝕪/-𝕠d by squaring E𝕐 to be the kinetic displacement history of this change.

The intervals between angular momenta as h

That also changes the +𝕠d and e𝕒 Pythagorean Triangle with its potential speed e𝕒/+𝕠d, e increases by 1 as the altitude above the proton increases and +𝕠d has d decrease by 1. That is observed with +𝕠d × e𝔸/+𝕠d as h, the increment of 1 is the same because E𝔸 changed inversely to E𝕐. When this is taken as ℏ it is like -𝕠d ×e𝕐/-𝕠d as a circumference, that is the standing deBroglie waves of the electron around the orbital. Divided by 2π this gives the radius as the observed E𝔸 potential displacement history. It is observations of ℏ changing as increments of potential angular momentum.

The two h values as inverses

Because D in -𝕆D from the -𝕆D×e𝕪 kinetic work must be an integer, otherwise there would be a fraction in the orbital making it a derivative impulse, the value of E𝔸 must be the same as it. That comes from the Pythagorean Triangles being inverses from their constant areas, E𝔸 changes with the same proportions as -𝕆D. The angular potential speed e𝕒/+𝕠d changes inversely to the electron's e𝕪/-𝕠d kinetic velocity, that is observed as a change of 1 in h in this angular momentum.

Bifurcations

It also connects ½π to the -𝕆D×e𝕪 kinetic work and orbitals, this begins at the ground state where α is the ratio of the electron velocity compared to c. In this model β is the second Fiegenbaum number, it represents the width of the tines where the first Fiegenbaum number bifurcates. It is also close to the square root of ½π, here the chaotic bifurcation into these intervals is the electron spin in a direction around an orbital.

The Gaussian from negative inverse squares

In between these values of ℏ there is no +𝕆D×e𝕒 potential work measured from the potential angular momentum, that is because ½π is part of the formula for the Gaussian or normal curve. That is because E𝔸 as ½π is also part of the formula for the normal curve. It is formed by the inverses of the negative squares in the exponent of e, in this model these are where any spin Pythagorean Triangle side is squared as an inverse such as $e^{1/\text{-}𝕆D}$.

Chaos between orbitals

In between these values of ½π then there is no measurable quantized work, this is chaotic in this model. Also in between orbitals this is in between values of δ as the first Fiegenbaum number, that allows for the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse to not be quantized from δ^2 and not be Gaussian probabilities from β^2.

Exponentials and Gaussians from a constant area

The Gaussian curve is another form of the exponential curve and exponential spiral, that is derived from the constant area of a Pythagorean Triangle.

The ground state and half spin

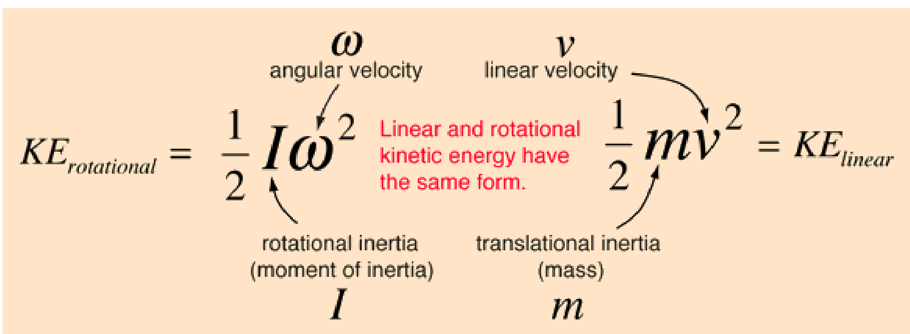
The ground state in this model comes from α, that is the first Fiegenbaum number δ squared and divided by β squared to give $e^{-\mathbb{O}D}$ -where D=1. That gives the first orbital as the ground state, from 1 this increases with increments of 1 as intervals of h. The value of α is also approximately $e^{1/2\pi}$ which gives a half spin, that is half of a circle. It then allows for two electrons to fit into this circle, like the two tines of β as a bifurcation.

Period of rotation

This also gives a half spin to the proton from ℏ. The angular momentum of the +𝕠d and e𝕒 Pythagorean Triangle is like the +𝕚d and e𝕙 Pythagorean Triangle with gravity, the e𝕒 altitude extends out from the proton and there is a +𝕠d spin Pythagorean Triangle side connected at right angles. This gives a potential angular momentum in the direction it points as +𝕠d×e𝕒/+𝕠d. It acts like a period of rotation for a circular orbital like with the smaller asteroid orbiting the larger asteroid earlier.

Potential moment and inertial moment

It also gives a potential moment which is like inertia, but in this model inertia only refers to the -𝕚d and e𝕧 Pythagorean Triangle.



Moment of inertial time

In this model the moment of inertia comes from -𝕚d inertial time, in moments on a clock gauge. When this -𝕚d inertial mass is concentrated more on the outer rim there is a stronger -𝕀D inertial probability in -𝕀D×e𝕧 inertial work. This makes it harder to start or stop the spin, the probability reacts against a change in the motion. When the mass is more in the center then the velocity of the atoms is lower on average, this decreases the -𝕀D inertial probability and inertial temporal history.

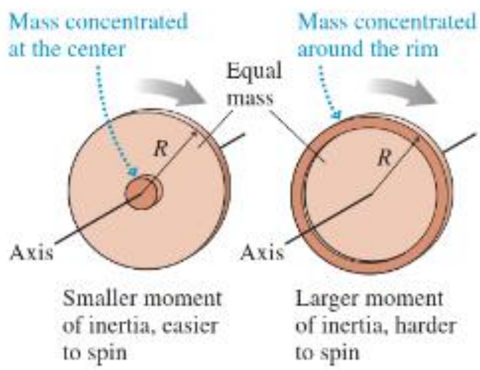
A connection between atoms

It is not the same as a satellite orbiting a planet more closely, the atoms here are all connected by +𝕆D×e𝕒 potential work from molecular bonds. There is also a greater attraction between them with +𝕀D×e𝕙 gravitational work.

A galaxy as a disc

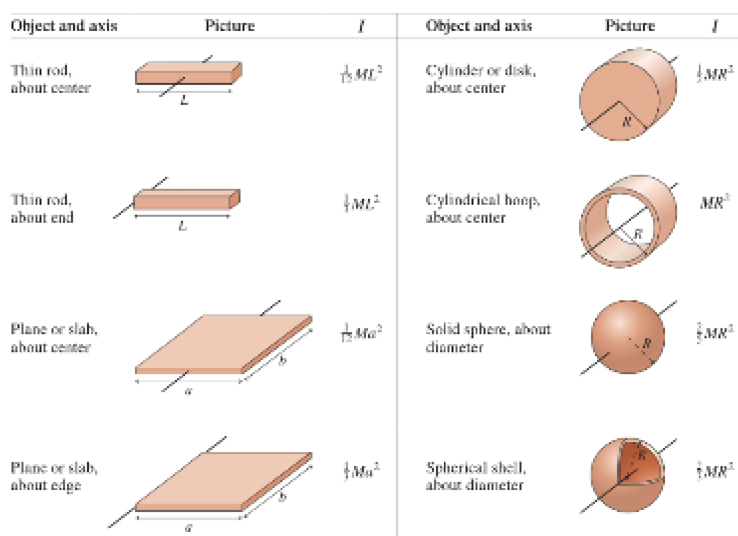
This is also like how galaxies spin more like a disc than separate stars, the +𝕀D×e𝕙 gravitational work between them causes resonations like quantized connections. This makes them act more like molecules and the whole galaxy a disc. It is more like an exponential decay spiral or logarithmic spiral, the +𝕀D gravitational probability decreases as a square with a greater e𝕙 height from the center. This gives the spiral shape which has the correct distribution of stars.

FIGURE 12.11 Moment of inertia depends on both the mass and how the mass is distributed.



Inertial probability and potential friction

Each shape has a different amount of -𝕀D×e𝕧 inertial work from the spin. The -𝕀D inertial probability would be opposed by the reactionary +𝕆D×e𝕒 potential work of friction as they moved. This is where the molecular bonds form with the shape and then are broken by the continued motion, the -𝕀D inertial probability dissipates randomly as a Gaussian causing a loss of the E𝕍/-𝕚d inertial impulse.



Object and axis	Picture	I	Object and axis	Picture	I
Thin rod, about center		$\frac{1}{12}ML^2$	Cylinder or disk, about center		$\frac{1}{2}MR^2$
Thin rod, about end		$\frac{1}{3}ML^2$	Cylindrical hoop, about center		MR^2
Plane or slab, about center		$\frac{1}{12}Ma^2$	Solid sphere, about diameter		$\frac{2}{5}MR^2$
Plane or slab, about edge		$\frac{1}{3}Ma^2$	Spherical shell, about diameter		$\frac{2}{3}MR^2$

Summing the inertial impulse

Here this would be summing the E𝕍/-𝕚d inertial impulse, the r^2 would act as E𝕍 pointing directly outwards with the spin. This is -𝕚d in the denominator as the inertial time, when this is smaller then the acceleration is faster outwards. This means that -𝕚d×E𝕍 is a classical approximation because a larger -𝕚d inertial mass is proportional to this -𝕚d shorter inertial time. The E𝕍/-𝕚d inertial impulse can be used as this sum Σ because the -𝕚d inertial time implies the inertial mass, but this cannot be an integral field except as an approximation.

Integrating the inertial work

Taking this as the -𝕀D×e𝕧 inertial work this can be an integral, -𝕚d×e𝕧 is the area of the -𝕚d and e𝕧 Pythagorean Triangle which is also an integral. This is similar to 𝕚d×E𝕍 from the E𝕍/-𝕚d inertial impulse, it is convertible because the impulse is seconds×meters^2 and from work it is seconds^2×meters. The -𝕀D and e𝕧 Pythagorean Triangle gives this integral area, the -𝕀D×e𝕧 inertial work of a rotating object can then be different Pythagorean Triangles.

12.4 Calculating Moment of Inertia

The equation for rotational energy is easy to write, but we can't make use of it without knowing an object's moment of inertia. Unlike mass, we can't measure moment of inertia by putting an object on a scale. And while we can guess that the center of mass of a symmetrical object is at the physical center of the object, we can *not* guess the moment of inertia of even a simple object. To find I, we really must carry through the calculation.

Equation 12.12 defines the moment of inertia as a sum over all the particles in the system. As we did for the center of mass, we can replace the individual particles with cells 1, 2, 3, … of mass Δm. Then the moment of inertia summation can be converted to an integration:

$$I = \sum_i r_i^2 \, \Delta m \xrightarrow[\Delta m \to 0]{} I = \int r^2 \, dm \qquad (12.15)$$

where r is the distance from the rotation axis. If we let the rotation axis be the z-axis, then we can write the moment of inertia as

$$I = \int (x^2 + y^2) \, dm \qquad \text{(rotation about the } z\text{-axis)} \qquad (12.16)$$

NOTE You *must* replace dm by an equivalent expression involving a coordinate differential such as dx or dy before you can carry out the integration.

Gravitational and potential torque

In this model there is a +𝕆D potential torque and a +𝕀D gravitational torque, they are in circular geometry. This is where the torque is larger as the straight Pythagorean Triangle side contracts, for example with +𝕀D×e𝕙 gravitational work the gravitational torque is stronger as the height contracts. This is why gravity is stronger near matter.

Kinetic and inertial torque

With the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle there is also the -𝕆D kinetic torque and -𝕀D inertial torque, these do not act around a pivot as they are in hyperbolic geometry. They do have a focus point of the hyperbola, an asteroid going past a planet then would have a focus of their hyperbolic trajectory. That focus acts like a pivot for this -𝕀D inertial torque.

Focus and pivot of a hyperbola

The -𝕀D inertial torque can move in a circle when -𝕀D is less than +𝕀D, otherwise their spin is in a hyperbolic trajectory. The pivot in each case comes from a cone and the conic sections. They move in a path integral where different probabilities interfere constructively and destructively, when measured these become one probability on a positional scale.

A rolling wheel

The kinetic and inertial torque can also be around a central pivot, like where a wheel rolls. The moon turns around an axis as it rotates around the Earth, this is from its -𝕀D inertial torque. It also has a +𝕀D gravitational torque, this turns asteroids towards it in a curved trajectory. The potential and gravitational torque are like turning a nut as a pivot with a wrench.

A rotating phasor

The wheel need not be rolling along the ground, it is an e𝕧 phasor like a wheel spoke that rotates around the -𝕚d inertial axle or axis. In this model the electron spins like this around an orbital, when measured this gives a -𝕆D kinetic torque or probability of where the electron is. If a wheel is rolling along the ground with inertia, this has a pivot but the motion is not towards the pivot like gravity. It is also not reacting against motion towards the pivot as with the +𝕠d and e𝕒 Pythagorean Triangle or proton. The -𝕚d inertial mass moves in this circle as it rolls to give a straight-line motion, that can be observed as an E𝕍/-𝕚d inertial impulse or measured as -𝕀D×e𝕧 inertial work.

Work with sines, impulse with cosines

The angle of this -𝕀D inertial torque for example is from the angle θ of the -𝕚d and e𝕧 Pythagorean Triangle, as the angle changes so does the force -𝕀D. In this model sinθ is used when the spin Pythagorean Triangle side is measured, this is the angle opposite it. When the straight Pythagorean Triangle side is observed as a square, cosθ can be used. This is consistent with the dot product being from cosθ, there is no spin. The cross product gives a spin vector, that connects to the spin Pythagorean Triangle side and sinθ. In this model however only tanθ is needed.

Constant area trigonometry

This is in constant area trigonometry, the angles sines and cosines are the same but the area is a constant not the hypotenuse. It can be converted to conventional trigonometry by adjusting the area so the hypotenuse remains constant.

1. The magnitude F of the force.
2. The distance r from the point of application to the pivot.
3. The angle at which the force is applied.

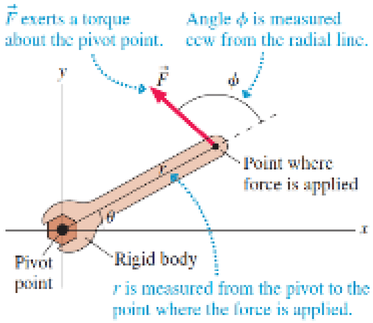
We can incorporate these three factors into a single quantity called the *torque*. FIGURE 12.18 shows a force $\vec{F}$ trying to rotate the wrench and nut about a *pivot point*—the axis about which the nut will rotate. We say that this force exerts a **torque** τ (Greek tau), which we define as

$$\tau = rF\sin\phi \qquad (12.20)$$

Potential torque from molecular bonds

In the diagram there is a +𝕆D potential torque from the nut's friction, the molecular bonds create a constructive interference that attracts the nut and the thread together. Against this is a -𝕀D inertial torque, also a -𝕆D kinetic torque where a hand applies a force to the handle. This force need not be associated with a circle, for example an asteroid exerts a -𝕀D inertial torque on a planet even if it is not captured by its +𝕀D×e𝕙 gravitational work.

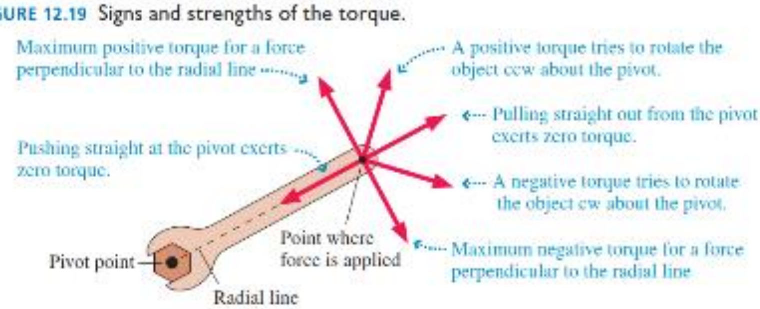
FIGURE 12.18 Force $\vec{F}$ exerts a torque about the pivot point.



Inertial work or impulse

Different angles θ do different -𝕀D×e𝕧 inertial work on the nut, where there is less work there is more E𝕍/-𝕚d inertial impulse. The handle can be pushed directly downwards or pulled upward with less or no rotation.

FIGURE 12.19 Signs and strengths of the torque.



The moment arm as a straight Pythagorean Triangle side

In this model the moment arm is the straight Pythagorean Triangle side, then the other side is spin. With the -𝕚d and e𝕧 Pythagorean Triangle the moment arm would be e𝕧 and the other side would exert a -𝕀D inertial torque. This does not use the hypotenuse, it also allows for a constant area Pythagorean Triangle with the same relative sizes of the Pythagorean Triangle sides.

The plus and minus signs

The sign of equation (12.22) does not change here for clockwise and counterclockwise because this would obscure which spin Pythagorean Triangle sides are being measured. The wrench could be turned by a pulley and a weight, that would use +𝕀D×e𝕙 gravitational work where the sign is positive. It could also use -𝕆D×e𝕪 kinetic work from an electric motor where the sign is negative, that includes the +𝕆D×e𝕒 potential work from the +𝕆D potential voltage and the -𝕆D kinetic voltage.

Interpreting Torque

Torque can be interpreted from two perspectives, as shown in FIGURE 12.20. First, the quantity $F \sin \phi$ is the tangential force component F_t. Consequently, the torque is

$$\tau = rF_t \tag{12.21}$$

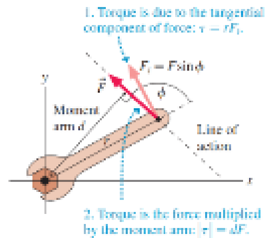
In other words, torque is the product of r with the force component F_t that is tangent to the circular path followed by this point on the wrench. This interpretation makes sense because the radial component of $\vec{F}$ points straight at the pivot point and cannot exert a torque.

A second perspective, widely used in applications, is based on the idea of a *moment arm*. Figure 12.20 shows the **line of action**, the line along which the force acts. The minimum distance between the pivot point and the line of action—the length of a line drawn *perpendicular to the line of action*—is called the **moment arm** (or the *lever arm*) d. Because $\sin(180° - \phi) = \sin\phi$, it is easy to see that $d = r \sin\phi$. Thus the torque $rF \sin\phi$ can also be written

$$|\tau| = dF \tag{12.22}$$

NOTE Equation 12.22 gives only $|\tau|$, the magnitude of the torque; the sign has to be supplied by observing the direction in which the torque acts.

FIGURE 12.20 Two useful interpretations of the torque.



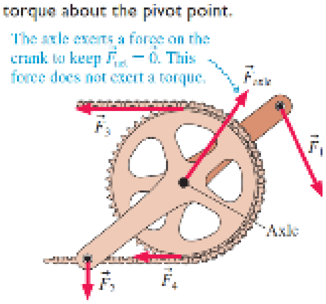
Summing positive and negative torques

The net torque is found in this model by constructive and destructive interference. These sum to probabilities, it becomes a path integral where the path taken by the chain is calculated. These torques can be a mixture of positive and negative probabilities with +𝕆D, -𝕆D, +𝕀D, and -𝕀D, to denote the correct directions cw and ccw can be used. The plus and minus signs sum together with their own constructive and destructive interference, if the directions were all the same then +𝕆D and +𝕀D would sum together.

Summing different torques

-𝕆D and -𝕀D would be subtracted, the D values would depend on the relative forces. For example with an electric motor there would be the +𝕆D potential difference or voltage, the -𝕆D kinetic difference or voltage, these would usually be equal and opposite to each other. If the wheel was itself part of the electric motor then there could be different +𝕆D and -𝕆D voltages on each side, then it could be moved like a motorized pulley. It might then be using -𝕆D×e𝕪 kinetic work to raise a weight while +𝕀D×e𝕙 gravitational work was pulling it down, -𝕀D×e𝕧 inertial work might cause it to overshoot an exact e𝕧 position aimed at. In each case using cw and ccw can avoid ambiguities.

FIGURE 12.22 The forces exert a net torque about the pivot point.



Net Torque

FIGURE 12.22 shows the forces acting on the crankset of a bicycle. The crankset is free to rotate about the axle, but the axle prevents it from having any translational motion relative to the bike frame. It does so by exerting force $\vec{F}_{axle}$ on the crankset to balance the other forces and keep $\vec{F}_{net} = \vec{0}$.

Forces $\vec{F}_1, \vec{F}_2, \vec{F}_3, \ldots$ exert torques $\tau_1, \tau_2, \tau_3, \ldots$ on the crankset, but $\vec{F}_{axle}$ does *not* exert a torque because it is applied at the pivot point and has zero moment arm. Thus the *net* torque about the axle is the sum of the torques due to the applied forces:

$$\tau_{net} = \tau_1 + \tau_2 + \tau_3 + \cdots = \sum_i \tau_i \tag{12.23}$$

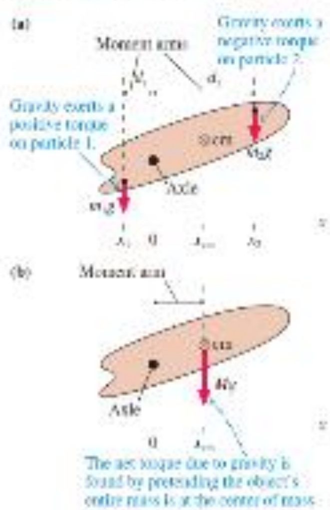
Gravitational probabilities

When the board moves with +𝕀D×e𝕙 gravitational work it reacts with -𝕀D×e𝕧 inertial work. The +𝕀D gravitational torque from each proton interferes with the others, constructively and destructively. On opposite sides of the pivot there is a destructive interference, the sum of all the

+𝕀D gravitational probabilities causes the board to rotate with an overall attraction to the ground.

Gravitational Torque

FIGURE 12.23 Gravitational torque



Gravity exerts a torque on many objects. If the object in FIGURE 12.23 is released, a torque due to gravity will cause it to rotate around the axle. To calculate the torque about the axle, we start with the fact that gravity acts on *every* particle in the object, exerting a downward force of magnitude $F_i = m_i g$ on particle i. The *magnitude* of the gravitational torque on particle i is $|\tau_i| = d_i m_i g$, where d_i is the moment arm. But we need to be careful with signs.

A moment arm must be a positive number because it's a distance. If we establish a coordinate system with the origin at the axle, then you can see from Figure 12.23a that the moment arm d_i of particle i is $|x_i|$. A particle to the right of the axle (positive x_i) experiences a *negative* torque because gravity tries to rotate this particle in a clockwise direction. Similarly, a particle to the left of the axle (negative x_i) has a positive torque. The torque is opposite in sign to x_i, so we can get the sign right by writing

$$\tau_i = -x_i m_i g = -(m_i x_i)g \qquad (12.24)$$

The net torque due to gravity is found by summing Equation 12.24 over all particles:

$$\tau_{grav} = \sum_i \tau_i = \sum_i (-m_i x_i g) = -\left(\sum_i m_i x_i\right)g \qquad (12.25)$$

But according to the definition of center of mass, Equations 12.4, $\Sigma m_i x_i = Mx_{cm}$. Thus the torque due to gravity is

$$\tau_{grav} = -Mgx_{cm} \qquad (12.26)$$

where x_{cm} is the position of the center of mass *relative to the axis of rotation*.

Hyperbolic geometry and spin

In this model the -𝕚d and e𝕧 Pythagorean Triangle is in hyperbolic geometry, when it is constrained in circular geometry it undergoes a force from that. This is from the +𝕠d and e𝕒 Pythagorean Triangle with the molecular bonds, also the +𝕚d and e𝕙 Pythagorean Triangle with gravity. It reacts against these forces with -𝕀D×e𝕧 inertial work, the -𝕀D inertial probability is more likely to move outwards like an attractive centrifugal force. This comes from the -𝕆D kinetic probability as the shape is rotated, the -𝕆D kinetic torque tends to move outwards like electrons move to higher orbitals with this torque.

A reaction force only

This inertia is a reactive force only, when the rotation stops there is no -𝕆D×e𝕪 kinetic work being done and so the centrifugal -𝕀D×e𝕧 inertial work also stops. The -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work have a spin in hyperbolic geometry, this is straighter than a circular motion and so the -𝕀D inertial probability is pointing outwards. It is not the same as the E𝕍/-𝕚d inertial impulse which would point straight outwards.

12.6 Rotational Dynamics

What does a torque do? **A torque causes an angular acceleration.** To see why, FIGURE 12.26 shows a rigid body undergoing *pure rotational motion* about a fixed and unmoving axis. This might be a rotation about the object's center of mass, such as we considered in Section 12.2. Or it might be an object, such as a turbine, rotating on an axle.

The forces $\vec{F}_1, \vec{F}_2, \vec{F}_3, \ldots$ in Figure 12.26 are external forces acting on particles of masses $m_1, m_2, m_3, \ldots$ that are part of the rigid body. These forces exert torques $\tau_1, \tau_2, \tau_3, \ldots$ about the rotation axis. The *net* torque on the object is the sum of the torques:

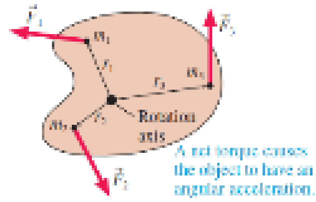
$$\tau_{net} = \sum_i \tau_i \qquad (12.27)$$

Focus on particle i, which is acted on by force $\vec{F}_i$ and undergoes circular motion with radius r_i. In Chapter 8, we found that the radial component of $\vec{F}_i$ is responsible for the centripetal acceleration of circular motion, while the tangential component $(F_i)_t$ causes the particle to speed up or slow down with a tangential acceleration $(a_i)_t$. Newton's second law is

$$(F_i)_t = m_i(a_i)_t = m_i r_i \alpha \qquad (12.28)$$

where in the last step we used the relationship between tangential and angular acceleration: $a_t = r\alpha$. The angular acceleration α does not have a subscript because *all particles in the object have the same angular acceleration*. That is, α is the angular acceleration of the entire object.

FIGURE 12.26 The external forces exert a torque about the rotation axis.



Rotational and linear dynamics

In this model rotational dynamics come from work, the +𝕠d and e𝕒 Pythagorean Triangle as the proton, the +𝕚d and e𝕙 Pythagorean Triangle as gravity, the -𝕠d and e𝕪 Pythagorean Triangle as the electron, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia. Rotational dynamics in this model refers to work, linear dynamics comes from these four Pythagorean Triangles also as impulse.

Work and impulse

When these are combined each Pythagorean Triangle can take on the characteristics of work or impulse, the electron can do -𝕆D×e𝕪 kinetic work with rotational dynamics inside an atom but outside in free flight it cannot absorb a photon as a wave. This is because it is no longer rotating in an orbital, it moves in a straight line with a E𝕐/-𝕠d kinetic impulse. When the electron is near a proton it can absorb this -𝔾D×e𝕪 light work from a photon, that makes a change in its -𝕆D kinetic torque and its orbital.

Wavelike in small distances

It can become wavelike without entering an atom again, for example in a double slit experiment the small e𝕧 length between the slits makes the -𝕀D inertial probability dilate. If the slits are observed to see which slit a photon came through, that makes it act as a e𝕐/-𝕘d light impulse.

Protons with a potential impulse

When a rocket moves with a E𝕐/-𝕠d kinetic impulse the protons in it also move in straight lines with a E𝔸/+𝕠d potential impulse. This also allows for protons to be accelerated as particles in an accelerator, more usually they react with +𝕆D×e𝕒 potential work collecting electrons in rotational orbitals around them.

Potential time dilation with proton collisions

This E𝔸/+𝕠d potential impulse is observed with the +𝕠d potential time dilation with protons, when they are collided with other particles they can decay more slowly because of their velocity.

Impulse outside a gravitational orbit

A satellite orbiting around a planet does -𝕀D×e𝕧 inertial work, this is subtracted from the +𝕀D×e𝕙 gravitational work of the planet. When the satellite leaves this +𝕚d gravitational field it moves more with an E𝕍/-𝕚d inertial impulse, in this model however the +𝕚d gravitational field extends all the way to the CMB as a maximum e𝕙 height. This is because it moves in more of a straight-line, that comes from the e𝕧 straight Pythagorean Triangle side. When nearer a +𝕚d gravitational mass the satellite moves in more of a curve with -𝕀D×e𝕧 inertial work.

Orbits and orbitals as spin

A rocket moves with an E𝕍/-𝕚d inertial impulse, the protons in it also move with a E𝔸/+𝕠d potential impulse along with the electrons and the E𝕐/-𝕠d kinetic impulse. The atom by its nature has more spin with its electron orbitals, in Biv space-time galaxies, stars and planets also have more spin with their +𝕚d gravitational fields capturing matter in orbits. Where there is more spin then the rotational dynamics dominates.

Rotational dynamics with the proton and electron

Rotational dynamics in this model refers to the micro world in Roy electromagnetism, because atoms are smaller the e𝕒 altitude above a proton is contracted and so the +𝕆D potential torque or probability is dilated. When an electron is confined in this smaller space inside an atom its e𝕪 kinetic electric charge is contracted and acts as a kinetic position. That makes the -𝕆D kinetic torque or probability dilated and so it acts more like a wave with rotational dynamics.

The gravitational micro world

In Biv space-time a planet can have moons around it, this appears to be the macro world for Roy electromagnetism because atoms and the ionization level are small by comparison. For gravity this is the micro world, because of this work dominates more than impulse.

Gravitational and inertial waves

The gravitational field acts as a wave between matter, also inertia in objects acts more like a wave. The -𝕀D×e𝕧 inertial work is able to react against a change in its position, this is a kind of -𝕚d inertial field similar to the concept of a Higgs field.

Action and reaction waves

Electrons in moving through this inertial field with their -𝕆D×e𝕪 kinetic work cause a reaction with -𝕀D×e𝕧 inertial work, the field appears to push back against the -𝕆D kinetic torque or probability in the -𝕆D×e𝕪 kinetic work. The Higgs field causes an electron to have its spin reversed to an anti-positron and back to an electron over and over. The -𝕆D kinetic torque would be reacted against by the -𝕀D inertial torque, that would cause -𝕆D to oscillate backwards and forwards.

Maximum height and gravity

In this model the maximum e𝕙 height of the +𝕚d and e𝕙 Pythagorean Triangle is to the CMB, in comparison a star system is small like an atom. That smaller e𝕙 height means the +𝕀D×e𝕙 gravitational work is stronger, moons move in orbitals with rotational dynamics. The moons also move with -𝕀D×e𝕧 inertial work because of the stronger wave nature of the +𝕀D gravitational torque.

General Relativity as wavelike

Gravity acts more like +𝕀D×e𝕙 gravitational work and a field in a solar system, as the e𝕙 height increases it can act more like a Eℍ/+𝕚d gravitational impulse. This makes General Relativity more wavelike with a geodesic around a gravitational mass, also its coordinates are better described by curved spin Pythagorean Triangle sides than straight Cartesian coordinates.

The metric tensor

In General Relativity there is a Cartesian coordinate system of straight orthogonal Pythagorean Triangle sides, these are like the e𝕧 lengths from the -𝕚d and e𝕧 Pythagorean Triangle. These are curved by the tensors in the Einstein field equations to approximate the geodesic paths a satellite would take in a gravitational field. This is called the metric tensor. The curved geodesics are formed by the +𝕀D gravitational torque and the -𝕀D inertial torque in this model.

Galaxies as exponential spirals

Galaxies in this model act more like atoms, the distance e𝕙 to the CMB is still much larger by comparison. That makes the +𝕀D×e𝕙 gravitational work stronger than the Eℍ/+𝕚d gravitational impulse, the galaxies tend to form an exponential spiral where the e𝕙 height from the center is not squared and the +𝕀D gravitational probability and torque is squared. With a constant +𝕚d and e𝕙 Pythagorean Triangle area this traces out an exponential spiral.

Resonations of gravitational interference

Because of this wavelike nature the stars in a galaxy are mainly constrained by quantization, their relationships to each other by resonations of overlapping gravitational interference patterns.

A galaxy as a semisolid disk

Because the number of stars is much larger than the protons in an atom, the constructive and destructive interferences cause them to be hold together like molecular bonds. This makes the galaxy turn more like a semisolid disk, the Eℍ/+𝕚d gravitational impulse in between galaxies in stronger and so they can remain separate.

Distances between atoms

Atoms do more +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work inside them up to an ionization level, when they get too large they tend to break apart with radioactivity. They then form more stable atoms with large distances between them.

Maximum stable size of galaxies

Because the +𝕚d and e𝕙 Pythagorean Triangle is much larger than the +𝕠d and e𝕒 Pythagorean Triangle, the e𝕙 height where a galaxy becomes unstable is much greater. As its e𝕙 height from each star to another increases, the Eℍ/+𝕚d gravitational impulse also increases along with the E𝕍/-𝕚d inertial impulse. That causes the outermost stars to have more centrifugal force and leave the galaxy, it also prevents interstellar dust and Hydrogen from entering deeper into a galaxy to form stars.

The cosmic web like sound waves

The cosmic web is formed by more constructive and destructive interference from +𝕀D×e𝕙 gravitational work, towards the CMB there is a e𝕙 height contraction, so this web appears as sound waves on a nearly flat surface. These sound waves are also quantized, they form resonations so the galaxies are connected like atoms in long chains of molecules.

The CMB as an ionization level

When e𝕙 is large enough it approaches the CMB in height from any observer anywhere in an endless universe, this is like the ionization level in an atom. In this model the universe has no end, the CMB is an illusion from any position because this is the maximum e𝕙 height of an +𝕚d and e𝕙 Pythagorean Triangle.

A maximum gravitational displacement and temporal history

With this maximum e𝕙 height there is a maximum Eℍ gravitational displacement history, that is between the observer and the CMB. That increasingly acts like particles with a Eℍ/+𝕚d gravitational impulse, this appears as a large Big Bang explosion. There is also a maximum +𝕀D gravitational temporal history, this is the time light takes from the CMB to any observer anywhere. This has a maximum +𝕀D×e𝕙 gravitational work which gives the CMB its wavelike appearance.

A combined wave and particle appearance

The two then combine as the appearance of a maximum Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work, the impulse appears to explode outwards exponentially. This comes from the Eℍ gravitational displacement which increases as a square from the CMB, with the +𝕚d gravitational time this gives an exponential curve.

Compton scattering from electron particles

Stars can act with more of a Eℍ/+𝕚d gravitational impulse on the edge of a galaxy, Compton scattering can also occur on the outermost orbitals of an atom. This is where the e𝕐/-𝕘d light impulse from photons collides with electrons with their E𝕐/-𝕠d kinetic impulse instead of being absorbed with -𝕆D×e𝕪 kinetic work. Because the electrons act more like particles with a E𝕐/-𝕠d kinetic impulse on the edge of an atom, they can leave as particles.

The CMB frozen in time as an event horizon

Because Eℍ as the gravitational displacement history approaches its maximum, then the +𝕚d gravitational time is contracted which causes it to move slower on a clock gauge. The Big Bang CMB appears to be frozen and cold with no changes in time like an event horizon. Because the +𝕚d gravitational timeline goes back billions of years to the CMB this is also a gravitational temporal history as +𝕀D, that makes the e𝕙 height contracted.

Temperature and height contraction

The temperature of the CMB then is flatter as the e𝕙 height contraction makes the e𝕒 altitude around protons also contracted. This causes the emission of e𝕪×-𝕘d photons similar to in a star, the CMB glows from these photons. Because of the e𝕒 altitude contraction above the protons, the photons appear to have a low temperature e𝕪. This is like a star that has burned its fuel and still has the strong +𝕀D×e𝕙 gravitational work contracting its e𝕙 height.

Inertial time slowed and a length contraction

The e𝕙 height contraction and slowed time is also found in Special Relativity. In that case the E𝕍 inertial displacement history is larger as a rocket approaches c, this is like Eℍ reaching its maximum at the CMB. The rocket is observed to have a slowed -𝕚d inertial time by a stationary observer, the CMB appears to have a slowed +𝕚d gravitational time by the same observer. The rocket has a larger -𝕀D inertial temporal history and so its e𝕧 length appears contracted. The CMB has a larger +𝕀D gravitational temporal history and so its e𝕙 height appears contracted.

Rotational dynamics and local inertia

In Biv space-time the -𝕚d and e𝕧 Pythagorean Triangle as inertia also extends to the CMB, this is with linear dynamics and the E𝕍/-𝕚d inertial impulse. An electron does -𝕀D×e𝕧 inertial work in an orbital along with its -𝕆D×e𝕪 kinetic work, when it leaves an atom it has more of a E𝕐/-𝕠d kinetic impulse. It begins then with rotational dynamics and when it leaves the atom this is in linear dynamics.

Linear dynamics and the macro world

Leaving the atom the electron moves more with linear dynamics because the distances are larger. Roy electromagnetism is wavelike in smaller distances with work and rotational dynamics, the macro world is more observable with linear dynamics and impulse. The particle nature of the macro world then comes from atoms and Roy electromagnetism, these move with a E𝔸/+𝕠d potential impulse and a E𝕐/-𝕠d kinetic impulse such as with electricity.

The macro world as particles and waves

Rotational dynamics is also seen in this macro world, there is +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work which causes these atoms to move around like waves. For example, the Moon's gravity moves water molecules as tides of +𝕀D gravitational probability, the ocean waves move them with -𝕀D×e𝕧 inertial work. Roy electromagnetism forces the macro world to be like particles in some ways, in others Biv space-time forces atoms to move around as waves.

Inertial work and orbital periods

This -𝕀D×e𝕧 inertial work extends out to between planets of a star system, that causes resonations of -𝕀D constructive and destructive probability. This causes the planets and moons to be quantized into resonations of whole number orbital periods, where there is destructive interference the planets and moons appear to be repelled from some orbital motions.

Interference attracts and repels

With constructive interference they are attracted into more stable orbits. This is because the -𝕀D inertial probability reacts against changes in other active forces such as gravity. When there is a -𝕀D destructive interference between planets they react against moving into some configurations. This is like a repulsive force, with destructive interference the planets are less likely to go there. With a -𝕀D constructive interference the planets react against moving away from some configurations, this is like being attracted into these orbits.

Three body problem

When two of three spins are opposed, as in a three body problem, asteroids for example can move more chaotically with a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse. The spins in the asteroid belt are chaotic to some degree, they also form resonations of +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work with a larger ring. These resonations of work also form rings around Jupiter and Saturn.

Galactic inertia

Through a galaxy the stars also move with -𝕀D×e𝕧 inertial work and resonations from the -𝕀D inertial probabilities. These inertial constructive and destructive interferences are not measured directly as with inertia generally. Instead they are subtracted from the +𝕀D gravitational probabilities, the galactic disk then moves not only as a gravitationally solid disk but also with -𝕀D×e𝕧 inertial work that holds it together.

Galaxy collisions

When galaxies collide they do this with +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, the stars tend to form resonations rather than colliding with each other as particles. This would mean colliding galaxies would usually not have the stars colliding, instead the increased +𝕀D×e𝕙 gravitational work would cause the stars to orbit each other or oscillate in whole number periods. The +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work is similar to in molecular bonds, the whole number resonations comes from +𝕚d and -𝕚d being square roots of integers. When these are squared they give integers, if they were fractions then this would be like a derivative fraction as impulse.

Proton and electron impulse

Electrons don't usually act with a E𝕐/-𝕠d kinetic impulse to collide with protons, instead they form orbitals with their -𝕆D×e𝕪 kinetic work and the proton's +𝕆D×e𝕒 potential work. In the same way stars don't collide with each other with a Eℍ/+𝕚d gravitational impulse and an E𝕍/-𝕚d inertial impulse, their +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work causes the stars to move in curves with the +𝕀D gravitational and -𝕀D inertial torque. When stars get closer together this causes them to spin more around each other, like a satellite around a planet.

Wave nature of galaxies

Because these stellar interactions are small, compared to the maximum e𝕙 height of the CMB, the wave nature is stronger with a +𝕚d gravitational field and mass. The wave nature of the -𝕚d inertial mass is stronger as well, galaxies can attract each other without many stellar collisions.

Neutron stars spiraling together

An example of this is neutron stars orbiting and then spiraling in together, this causes the emission of +𝔾D×e𝕙 Gravi work as gravitational waves. The exponential spiral comes from the squared +𝔾D Pythagorean Triangle side and the e𝕙 unsquared side, with a constant Pythagorean Triangle area these give an exponential curve. The changing resonations of stars in a galaxy would be emitting and absorbing quanta of this +𝔾D×e𝕙 Gravi work, according to this model, like with e𝕪×-𝕘d photons.

Quantization of Roy and Biv

This quantization is synchronized with Roy electromagnetism, the jump of an electron to another orbital gives the same amount of +𝕆D×e𝕒 potential work as +𝔾D×e𝕙 Gravi work. If this was not so then the relative masses of the proton and electron would give difference forces to those from electromagnetism. The electron would experience a force in one direction from gravity and another from the proton for example. This quantization then cannot be detected as a graviton with this model, it has the same proportions as the photon.

Changing kinetic and potential work

A change in an electron orbital is through -𝕆D×e𝕪 kinetic work, proportionally there is a reaction against this with -𝕀D×e𝕧 inertial work. The proton also reacts against this with +𝕆D×e𝕒 potential work, proportional to this is the active +𝕀D×e𝕙 gravitational work. The e𝕪×-𝕘d photon is emitted as the electron drops an orbital, an +𝕘d×e𝕒 virtual photon is added to this going backwards in time.

Photon work and Gravi work

The +𝔾D×e𝕙 Gravi work is done with the emission of gravitational waves, the e𝕙 height of the electron above the proton decreases and so the +𝔾D rotational torque increases with the same proportion as from the +𝔾D×e𝕒 virtual light work. Because the e𝕪×-𝕘d photon does -𝔾D×e𝕪 light work on an electron when it reaches another atom, there is -𝔾D×e𝕧 reluctance work which is virtual like +𝔾D×e𝕒 virtual light work.

Conserving changes in Roy and Biv

This balances the emission and absorption of work from Roy electromagnetism to Biv space-time, because -𝕆D×e𝕪 kinetic work is proportional to -𝕀D×e𝕧 inertial work then the -𝔾D×e𝕪 light work as a change is proportional to the change -𝔾D×e𝕧 reluctance work. If not then then the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work would no longer be proportional to each other after photon emissions.

Changing potential work and gravitational work

The +𝕆D×e𝕒 potential work also changes as the electron moves down an orbital, this receives +𝔾D×e𝕒 virtual light work from an +𝕘d×e𝕒 virtual photon. That is proportional to the change in +𝕀D×e𝕙 gravitational work, as the electron moves closer to the +𝕚d gravitational mass of the proton. This is quantized as +𝔾D×e𝕙 Gravi work so, proportionally with the same +𝔾D change as a virtual light probability, there is a +𝔾D change in the Gravi probability. This makes the change in +𝕀D×e𝕙 gravitational work proportional to the change in +𝕆D×e𝕒 potential work.

Inverse changes in work

Because of this the -𝕆D×e𝕪 kinetic work changes inversely with active forces to the +𝕆D×e𝕒 potential work with reactive forces. The -𝕀D×e𝕧 inertial work changes inversely with reactive forces to +𝕀D×e𝕙 gravitational work with active forces. The changes are mediated by e𝕪×-𝕘d photons, +𝕘d×e𝕒 virtual photons, -𝕘d×e𝕧 Iners, and +𝕘d×e𝕓 Gravis. The Gravis can also be written as +𝕘d×e𝕙 where the e𝕙 height is the inverse of the e𝕓 depth, it can be converted from one to another this way.

Galaxies and atoms

In this model a galaxy forms with +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, this forms like an atom because the galaxy is small compared to the e𝕙 height to the CMB. Just as Roy electromagnetism form atoms then Biv space-time forms galaxies. The atoms form because with a smaller distance as e𝕒 and e𝕪 there are larger spin Pythagorean Triangle sides of +𝕠d and -𝕠d. This makes the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work stronger than the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse, the Pythagorean Triangles then move more with torque to form atoms.

Torque and galaxy formation

With the +𝕚d and e𝕙 Pythagorean Triangle being much larger than the +𝕠d and e𝕒 Pythagorean Triangle as the proton, the size of a galaxy makes the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work dominate. Dust and molecular hydrogen then moves more with work and torque forming spirals and vortices. In between these the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse dominates, space then has little dust and hydrogen like in between atoms has few particles.

Inelastic collisions and galaxy formation

Dust tends to form in a swirl like a vortex or exponential spiral, the increased +𝕀D gravitational probability makes it more likely for the hydrogen and other atoms to move to a lower e𝕙 height. The Eℍ/+𝕚d gravitational impulse is smaller and so the dust particles do not elastically collide with each other, that would cause the dust to move outwards again.

Inelastic collisions in dust

Instead, there are more inelastic collisions where the +𝕀D gravitational torque interferes constructively, this makes it more likely for the dust to adhere into larger clumps. Because of this constructive interference the exponential spiral forms in one direction, planets around a star also form Fibonacci exponential spirals as their orbital periods squared add up as probabilities. Opposed spins, like two exponential spirals in opposite directions, interfere destructively making these unlikely to continue. This acts like gravitational constructive interference as an attraction into the spiral shape, and a gravitational destructive interference as a repulsion away from other shapes.

A longer temporal history contracts height and length

The +𝕚d gravitational time is longer back to the CMB compared to the timescales in local experiences. This is also moving backwards from the present to the past, that is because +𝕚d is positive. The +𝕀D gravitational temporal history is the same both ways, the duration does not get its force from a direction but from the increased time between the starting and initial gravitational moments.

Gravitational probability of forming a galaxy

Because the galaxies appear to have existed for a long +𝕚d gravitational time, back to the CMB, this is dilated causing a e𝕙 height contraction. This is also a consequence of a smaller e𝕙 height having a larger +𝕀D gravitational probability. This increased probability acts like an attractive force, over a longer +𝕚d starting to final time this +𝕀D temporal duration causes galaxies to become denser.

Galaxies are less dense at a greater height

Locally then stars and galaxies are compacted in e𝕙 height, towards the CMB the dust is more spread out. This is because the greater e𝕙 height away from a measurer has a smaller +𝕀D gravitational probability, because there was less constructive interference as attraction then galaxies were more spread out or unformed from this dust and Hydrogen.

A longer temporal history and Special relativity

This is like with Special Relativity, a rocket as it approaches c has a greater -𝕀D inertial temporal history from rest. This causes a e𝕧 length contraction. Here -𝕀D is the inertial temporal history, from the -𝕚d inertial time the rocket was at rest until the measurement of its e𝕧 length.

Height contraction and fusion

The larger +𝕀D gravitational temporal history back to the CMB causes a similar eh contraction forcing stars to be compressed into fusion. This is a relativistic component of galaxy formation, the +𝕀D gravitational probability attracts Hydrogen into a smaller eh height as a star. When this +𝕀D gravitational temporal history is long enough there is an additional eh height contraction, that causes more Hydrogen to fuse in Helium and higher elements.

The cosmic web and sound waves

It also causes the space between galaxies to have less Hydrogen, that creates a cosmic web of galaxies. These correspond to the sound waves in the CMB, these are also formed by a e𝕧 length contraction in some areas with the maximum -𝕀D inertial temporal history from -𝕀D×e𝕧 inertial work.

General Relativity and a height contraction

This increased +𝕀D gravitational temporal history also causes a eh height contraction according to General Relativity. That results in the hydrogen atoms acting more like waves with each other rather than bouncing off each other as particles with impulse.

The strong and weak force

The hydrogen atoms then can fuse into larger atoms such as Helium, the strong force works more with this superposition of waves while the weak force is where neutrons can break apart as particles. This results in e𝕪×-𝕘d photons being emitted when the -𝕠d and e𝕪 Pythagorean Triangles as electrons move closer to the proton nuclei.

Supernovae

With a larger +𝕀D gravitational temporal history stars do more +𝕀D×eh gravitational work, this binds its atoms together with a strong +𝕀D gravitational probability. That is stronger than the -𝕀D×e𝕧 inertial work and so the stars cannot fly apart, except with the occasional supernova. That is where the hydrogen is largely fused into bigger atoms up to Iron, that increases their E𝕍/-𝕚d inertial impulse. The star becomes like a radioactive atom, it is too large for its +𝕀D×eh gravitational work to hold the higher elements together. The explosion comes from the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse.

The cosmic web as molecules

The visible universe is more like large chains of molecules in this model, the stars measure this +𝕀D×eh gravitational work up to the CMB as the limit of visibility with e𝕪×-𝕘d photons. Stars can move around in a galaxy with some E𝕍/-𝕚d inertial impulse, that allows them to move from one resonation of work to another like molecules in a liquid. The galactic disk acts like a solid with rotation, but also with some viscosity. An individual star can sometimes move chaotically or oscillate from one position to another with -𝕀D×e𝕧 inertial work.

Galactic dust as a plasma

Outside these galaxies interstellar dust and lone planets can move with more E𝕍/-𝕚d inertial impulse, but in this model they are more like electrons loosely held in a plasma rather than being free of the +𝕀D×eh gravitational work from stars and galaxies. There is also a plasma in Roy electromagnetism where the atoms can be separated into E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

Electrons as waves outside the atom

The electron can still act as a wave outside the atom, in going through a double slit its -𝕆D kinetic probability can be measured to create interference patterns. This is because the e𝕪 and e𝕧 positions of the interference patterns are being measured on a screen, this prevents the E𝕐 kinetic displacement and E𝕍 inertial displacement from being observed as particles. The electrons move with a E𝕐/-𝕠d kinetic impulse outside the atom, not because they have changed from being able to do -𝕆D×e𝕪 kinetic work, but because the distances are larger which increases the forces of the E𝕍/-𝕚d inertial impulse.

Linear dynamics and electromagnetism

When electrons leave an atom they are in free flight, they have entered the macro world where the e𝕪 and e𝕧 positions on a scale are large enough, their E𝕐 kinetic displacements and E𝕍 inertial displacements are stronger forces than their -𝕆D kinetic probabilities and their -𝕀D inertial probabilities respectively. This makes linear dynamics more important with Roy electromagnetism, for example electricity from the e𝕒 potential electric charge and the e𝕪 kinetic electric charge is used by liberating electrons from atoms with their E𝕐/-𝕠d kinetic impulse. Magnetism has less strength from -𝕆D×e𝕪 kinetic work compared to inside the atom.

Angular acceleration

In table 12.3 below, there is an angular acceleration as radians/sec^2, in this model that would be torque from the +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work. The radians are equivalent to the angle θ in the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity, a change in this angle corresponds to the angular momentum being measured as work. This angular acceleration is like an electric motor increasing its rpm from the +𝕆D potential difference and the -𝕆D kinetic difference as voltage or torque.

Gravitational angular acceleration

With the +𝕚d and e𝕙 Pythagorean Triangle there is also an angle θ in radians, that is associated with a e𝕙 height because of the constant Pythagorean Triangle area. If this height decreases for example, then the angular acceleration increases as a square. The gravitational angular acceleration is then proportional to a particular e𝕙 height, also the angle θ in the Pythagorean Triangle. The force is the +𝕀D gravitational torque as gravitational seconds^2, this is multiplied with e𝕙 in +𝕀D×e𝕙 gravitational work.

Kinetic angular acceleration

In this model the electron also has an angular acceleration, its angle θ relates to its e𝕪 kinetic electric charge value as a position. The time is kinetic seconds^2, that is multiplied as a field in -𝕆D×e𝕪 kinetic work. This contains the same information as radians/second^2, the -𝕆D kinetic torque comes from squared kinetic time and the angle is from the e𝕪 straight Pythagorean Triangle side. This -𝕆D kinetic torque would accelerate the rotation of the electron moving it outward to a higher orbital.

Inertial angular acceleration

The -𝕚d and e𝕧 Pythagorean Triangle as inertia also has an angular acceleration from its inertial momentum -𝕚d×e𝕧/-𝕚d. This causes a moon for example to spin around a planet with a -𝕀D inertial torque. This is proportional to the -𝕆D×e𝕪 kinetic work accelerating the electron with a -𝕆D kinetic torque.

Torque as a temporal history

A torque begins at an initial moment, then with this angular acceleration there is a final moment of measurement. The duration between these gives that acceleration as an angle in radians, this can also form an exponential spiral such as where the squared +𝕀D gravitational torque in a galaxy is measured against the e𝕙 height. This height as a position substitutes for the radians in the angular acceleration definition, from Table 12.3.

The electron in an exponential spiral

The electron would also move upwards in an exponential spiral with the kinetic angular acceleration. This is not observed as a particle because it is not the E𝕐/-𝕠d kinetic impulse, the exponential spiral is in waves as quantized orbital jumps.

A proton captures an electron

With a proton as a positive ion, this would capture an electron in a similar way to a satellite by a planet. The +𝕆D×e𝕒 potential work of the proton has its +𝕆D potential torque measured from an initial +𝕠d potential moment to a final moment compared to a position e𝕒. The electron has its -𝕆D kinetic torque measured from an initial -𝕠d kinetic moment to a final moment at a position e𝕪. The +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work combine as waves of probability to make it more likely the proton and electron come together.

Starting and final positions or moments

In rotational dynamics then there must be a starting and final moment with the torque measurement. With linear dynamics there must be a starting and final position with a displacement force between them observed. If there is no observation of a displacement, there is no impulse.

Moments and durations

The moment of inertia in Table 12.3 would only refer to the -𝕚d and e𝕧 Pythagorean Triangle in this model, an inertial moment would be on a clock gauge as a -𝕚d inertial time. When this is measured from a starting to a final moment, this is called a moment of torque in conventional physics. Here that would be the beginning of the torque at a -𝕚d inertial moment to the final moment, such as in winding a spring or turning a wrench. Each of the four Pythagorean Triangles has this moment of torque, moment would refer to this duration from a starting to a final moment.

Mass and time

The mass in linear dynamics in Table 12.3 also comes from the spin Pythagorean Triangle sides, but in impulse these are not squared and measured. Instead in impulse the mass acts like time, a heavier mass takes longer to move with impulse and so in this model mass is equivalent to time. The difference is gravitational mass is part of an integral field such as +𝕚d×e𝕙, gravitational time is part of a derivative such as e𝕙/+𝕚d.

Gravity and acceleration equivalence

In General Relativity the acceleration of an elevator upwards is similar to gravity, a person inside may find it impossible to tell the difference. This is called the equivalence principle, in this model the +𝕚d gravitational mass is equivalent to +𝕚d acting as gravitational time.

Gravitational speed and acceleration

When and object has a gravitational speed e𝕙/+𝕚d this would be a constant when a satellite was orbiting it. The e𝕙 height remains a constant as does the +𝕚d period of rotation, this is like e𝕧/-𝕚d where that is constant in a straight-line. As the +𝕚d gravitational mass increases then this gravitational speed accelerates downward, that acts like e𝕙/+𝕀D in meters/second^2.

Mass equivalent to a change in acceleration

The gravitational mass gives an equivalent attraction to the +𝕚d gravitational time in acceleration. When there is a constant velocity e𝕧/-𝕚d increasing the -𝕚d inertial mass means accelerating an object is more difficult, here the e𝕧/-𝕀D inertial acceleration increases like the gravitational speed e𝕙/+𝕀D.

Work on the elevator

With a stationary elevator there is +𝕀D×e𝕙 gravitational work done on it by the planet under it. If the elevator was accelerating in space this feeling of weight would come from the -𝕀D×e𝕧 inertial work being done to it.

Gravitational and inertial weight

The +𝕚d and e𝕙 Pythagorean Triangle as gravity and the -𝕚d and e𝕧 Pythagorean Triangle as inertia are equivalent because the +𝕀D×e𝕙 gravitational work is added to the -𝕀D×e𝕧 inertial work. An elevator accelerating upwards has an increased -𝕀D×e𝕧 inertial work where -𝕀D is subtracted from the +𝕀D gravitational probability to give the measured weight.

Ratios of gravitational and inertial work

By changing this -𝕀D×e𝕧 inertial work and the e𝕙 height above the planet the ratios of -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work can be changed. This is because the +𝕀D gravitational probability weakens as a square with a greater e𝕙 height, it can model a planet with less gravitational mass. The person in the elevator would not know what the relative ratios are by checking their weight on a spring scale. This makes them consistent with the equivalence principle.

Torque and mass

The Eℍ/+𝕚d gravitational impulse is also approximately equivalent to the +𝕀D×e𝕙 gravitational work, the +𝕀D gravitational mass is squared as a force in work. In the Eℍ/+𝕚d gravitational impulse it is not squared, instead it acts as moments of +𝕚d gravitational time on a clock gauge.

Torque on a pulley

For example a pulley might be turned by a weight pulled down by gravity. The pulley wheel experiences a +𝕀D gravitational torque in meters/second^2, this comes from the change in e𝕙 height of a point on the rope as the pulley turns. This force is from angular acceleration, it could also be written as radians/second^2 as in Table 12.3. The weight is also falling with a Eℍ/+𝕚d gravitational impulse in meters^2/second. The equivalence principle here is that for values of d and e, meters/second^2 with work = meters^2/second with impulse.

Torque and an equivalence principle

The pulley would be measured as the same if it was turned by a -𝕀D inertial torque, for example a heavy weight sliding on a flat surface. A -𝕆D kinetic torque would also be measured as the same with a voltage from a motor as a +𝕆D potential torque. This is a kind of equivalence principle, mass is not just equivalent to energy here in $e=mc^2$ but the torque from a mass cannot be distinguished from the torque from the potential or kinetic magnetic fields in an electric motor. In this model then the +𝕚d gravitational mass is equivalent to the +𝕠d potential magnetic field, the -𝕚d inertial mass is equivalent to the -𝕠d kinetic magnetic field.

$E=mc^2$

In this model energy refers to impulse, the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia have the same format as $e=mc^2$ except for the ½ factor. E𝕍/-𝕀D is meters²/seconds² in the same format as c^2, and -𝕚d is the inertial mass as the mass m in $e=mc^2$. Also, there is an equivalence where the -𝕚d inertial mass in the ½×e𝕍/-𝕀d ×-𝕚d linear inertia acts the same as -𝕠d in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. Each Pythagorean Triangle in this model has impulse in the same format as $e=mc^2$ which is called energy in conventional physics. Torque becomes equivalent in all four Pythagorean Triangles like energy is equivalent in all four Pythagorean Triangles with impulse.

Definition of energy

Because the word energy is prevalent in conventional physics, it is also used here to show consistency with this model. Energy is associated with impulse here not work, in conventional physics work is often described as energy as well. To avoid confusion where possible the term energy is used, with explanations of what it refers to in this model.

Inertial mass to kinetic energy

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is proportional to the ½×e𝕍/-𝕀d ×-𝕚d linear inertia, here the -𝕚d inertial mass is converted into kinetic energy by these proportions. For example an object in an elevator might have a ½×e𝕍/-𝕀d ×-𝕚d linear inertia calculated from its velocity and its -𝕚d inertial mass. This can also be described as a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, an electric motor would use a current proportional to the change in inertia.

Gravity and the potential

If the elevator moves upward against gravity that is in this model as the ½×+𝕚d ×eℍ/+𝕀d linear gravitation, this is proportional to the +𝕆D potential difference in the electric motor as the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. The inertia then is a reaction against being moved upwards from the kinetic energy, those are proportional to each other. The kinetic energy is the inverse of the potential energy, from the positive side of the current running the electric motor. This potential energy reduces the kinetic energy proportionally to the gravitational potential energy as ½×+𝕚d ×eℍ/+𝕀d.

Inertia to heat

When an accelerated object collides with a target the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy might be observed by the heat produced, that causes the emission of e𝕪×-𝕘d photons proportional to the object's change in inertia. With this model that is the same as directly converting an electron into photons, a change in orbital here is a change in the -𝕚d inertial mass of the electron. That causes an emission or absorption of e𝕪×-𝕘d photons as energy, the conversion of inertial velocity to heat here would also conform to $e=mc^2$.

Mass into photons

Using the term energy becomes more ambiguous in this model where mass is converted into energy, this usually means the mass is turned into photons. Then those photons might be observed with impulse, for example making particles change their vector directions and magnitude. This is because it is easier to observe a change in particles with impulse. The wave function -ψ from work is more difficult to measure as a probability function.

Light energy as particles

When photons are energy they act as particles with a e𝕐/-𝕘d light impulse, these can collide with electrons but without this -𝔾D light torque they cannot make the electron change orbitals. With the photoelectric effect photons do -𝔾D×e𝕪 light work exerting a -𝔾D light torque on electrons, this also happens with a photovoltaic solar cell.

The double slit experiment and photon energy

The difference is important in this model because of the double slit experiment, when light acts as particles of energy it does not create an interference pattern. When it acts as a wave with torque it does create interference patterns. The photon can be observed as a particle with energy, the same photon might be instead measured as a wave with work.

Mass to energy, measured as mass

In this model the -𝔾D×e𝕪 light work is in effect changing the energy back into the equivalent of mass with $e=mc^2$, so it is not a conversion of mass into energy. The -𝕚d inertial mass of the electron then decreases, its drops an orbital emitting a e𝕪×-𝕘d photon. This is absorbed into a photoelectric cell, for example, to measure this energy change in the electron.

Mass and energy

With $e=mc^2$ this is the same form as the ½×e𝕍/-𝕀d ×-𝕚d linear inertia except that E𝕍/-𝕀D is c^2 as a constant, that represents the conversion of +𝕚d gravitational mass and -𝕚d inertial mass into e𝕪×-𝕘d photons. These are referred to as energy in conventional physics. This is because c is the velocity of photons, in this model when an electron emits a e𝕪×-𝕘d photon it drops to a lower orbital. This decreases its -𝕚d inertial mass, that difference was converted into a e𝕪×-𝕘d photon.

Difference of inertial mass

Here then -𝕘d is the rotational frequency of the e𝕪×-𝕘d photon, it is the difference between the -𝕚d inertial mass of the two orbitals. Taken as a derivative the e𝕪/-𝕘d photon has -𝕘d as light time, this is then the difference between the velocity of the electron dropping an orbital as its e𝕪/-𝕚d kinetic velocity increases. The e𝕪/-𝕘d photon emitted then has e𝕪 as its kinetic electric charge which has increased in the electron and -𝕘d as the rotational frequency which has decreased. This is because the e𝕪/-𝕠d kinetic velocity increases in lower orbitals.

Inertial mass to energy

In this model then part of the -𝕚d inertial mass of the electron was converted to energy as the e𝕪/-𝕘d photon, this is the same as in $e=mc^2$. Here there is no rest mass because that would mean the electron was stopped, that is not allowed by the uncertainty principle. Its velocity as e𝕧/-𝕚d would have e=0, so the Pythagorean Triangle would not exist.

Inertial mass to rotation frequency

When the photon is absorbed by another electron its -𝕚d inertial mass increases, the energy from the photon is converted back into inertial mass. This is because the inertial mass here is the same as spin, the rotational frequency of the photon is equivalent to spin.

Light time

It is also proportional to light time, the e𝕪 phasor in a photon turns like a hand on a clock gauge. How fast this turns as light time is proportional to how much the -𝕚d inertial mass of the electron changes when it is emitted. This -𝕘d light time becomes -𝔾D when squared as the light torque absorbed into the -𝕆D kinetic torque of the electron. The rotation of -𝕘d in the e𝕪×-𝕘d photon is then proportional to the change in rotation of the electron.

Electric charge as energy

Because e𝕪 is conventionally regarded as energy, this is the inverse of the -𝕘d rotational frequency, also the inverse of the change in -𝕚d inertial mass of the electron. That connects the energy in $e=mc^2$ to the inertial mass. In this model the observation of this energy is not the same as the value and nature of this energy as a Pythagorean Triangle side.

Observing energy

For example in a nuclear reactor, the reduction in +𝕚d gravitational mass and -𝕚d inertial mass of radioactive matter could occur by a conversion to e𝕪×-𝕘d photons. That would heat the e𝕪 temperature of the water, perhaps observed by an increased pressure of the E𝕍/-𝕚d inertial impulse of steam molecules. In this model the conversion of a spin Pythagorean Triangle side as mass to a straight Pythagorean Triangle side as energy occurs, then this can be observed as impulse or measured as work.

Increase in velocity as energy

The loss of -𝕚d inertial mass in dropping an orbital is proportional to a gain in the e𝕪 kinetic electric charge, this is equivalent to an increase in velocity as e𝕧/-𝕚d. As -𝕚d as the inertial time or mass decreased then e𝕧 and proportionally e𝕪 increased because of the constant Pythagorean Triangle area. In this model that is a gain of e𝕪 energy that was converted from the -𝕚d inertial mass consistent with $e=mc^2$, it is also the same as the e𝕪 kinetic electric charge of the emitted photon as energy.

Conserving the light displacement and temporal history

The photon moves at a velocity e𝕧/-𝕚d as c, this is not the wavelength e𝕧 divided by the rotational frequency of the photon. Instead, this comes from the e𝕐/-𝕘d light impulse and the -𝔾D×e𝕪 light work, the e𝕪×-𝕘d photon has an E𝕐 light displacement history and a -𝔾D light temporal history.

Conserving the light history

These must be conserved, for example E𝕐 would come from e𝕪/-𝕘d photons colliding as particles. E𝕪×-𝕘d photons would have -𝔾D light probabilities which also must be conserved, otherwise a change in their constructive and destructive interference would be an attraction or repulsion. The photon would then be attracted or repelled, this does happen when a photon comes nearer a +𝕚d gravitational field and so this slows c to a lower velocity.

Light as a scale and clock gauge

The rotational frequency of the photon is only measured as -𝔾D×e𝕪 light work, when the e𝕪×-𝕘d photon acts as a field. This is not from the velocity of c, also the e𝕪 kinetic electric charge of the photon is only observed as the e𝕐/-𝕘d light impulse. As long as E𝕐 and -𝔾D are conserved then c will also be conserved, other than the exception of being nearer a +𝕚d gravitational field as a separate case. This is because e𝕪 acts as a scale in -𝔾D×e𝕪 light work, -𝕘d acts as a moment on a clock gauge in the e𝕐/-𝕘d light impulse.

Photons as a rolling wheel

In this model the e𝕪×-𝕘d photon moves like a rolling wheel with a velocity e𝕧/-𝕚d as c. The e𝕪 kinetic electric charge acts like a phasor or spoke of this wheel as it rotates, the -𝕘d rotational frequency is how quickly the axle turns so the photon acts like the hand of a clock gauge.

Frequency and wavelength are not velocity

Because the e𝕪 and -𝕘d Pythagorean Triangle area is constant, a change in one Pythagorean Triangle side makes an inverse change in the other. If the e𝕪 phasor doubles then the -𝕘d rotational frequency of the axle halves, the wheel turns more slowly but at the same c velocity. This is because the photon only transmits changes in the e𝕧/-𝕚d velocity or e𝕪/-𝕚d kinetic velocity of the electron.

A constant c^2

The decrease in the -𝕚d inertial mass is emitted as the -𝕘d rotational frequency of the photon, this is a mass to energy conversion. The E𝕍/-𝕀D value as c^2 in $e=mc^2$ does not change because the rolling wheel's velocity of c does not change. The photon then is this change of -𝕚d inertial mass of the electron, it will be absorbed in another electron and increase its -𝕚d inertial mass with that -𝕘d energy.

Electrons and positrons

This allows for $e=mc^2$ to convert inertial mass into energy as photons, when an electron and positron meet they annihilate both masses into photons as energy according to $e=mc^2$. This mass difference is between +𝕠d as the positron mass and -𝕚d as the inertial mass. This also is a change as -𝕘d because that is the change in overall spin Pythagorean Triangle sides between +𝕚d and -𝕚d.

Matter and antimatter annihilation and orbitals

That is the same as an electron in a Hydrogen atom dropping an orbital, the difference there is also in terms of +𝕚d and -𝕚d as a photon. In this model the annihilation of matter and antimatter is the same spin Pythagorean Triangle side differences as changing an orbital, this is why they both emit photons.

Inertial mass to energy as an angle

Taking the equation e𝕪=½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, the change in the electron's e𝕪/-𝕠d kinetic velocity is emitted as a e𝕪/-𝕘d photon. This kinetic energy would be observed as E𝕐 from the E𝕐/-𝕠d kinetic impulse, also the -𝕠d kinetic magnetic field would be measured as -𝕆D with -𝕆D×e𝕪 kinetic work. That is proportional to -Id in -𝕀D×e𝕧 inertial work. The ½×e𝕐×-𝕠d equation then becomes E𝕐=E𝕐/-𝕆D × -𝕆D or E𝕐/-𝕆D=E𝕐/-𝕆D.

Fixed c^2

That has fixed values of D and E as a conversion between mass measured in work and impulse observed in impulse, this is because E𝕐/-𝕆D is proportional to E𝕍/-𝕀D as c^2. When c^2 is used in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy equation this gives a mass and energy conversion as work and impulse. Because e𝕧 is large as 3×10^8 meters, and -𝕚d is small as 1 second, this refers to a small angle θ in the -𝕚d and e𝕧 Pythagorean Triangle as a maximum velocity e𝕧/-𝕚d.

Measuring an inertial mass to convert to energy

When there is a -𝕚d inertial mass to convert to energy, it must be measured as to its weight. This is calculated by exerting a force on it, for example the inertial mass of a block would be from -𝕆D×e𝕪 kinetic work pushing it a known e𝕧 distance. The -𝕀D×e𝕧 inertial work reacts against this -𝕆D×e𝕪 kinetic work, that measures the inertial mass of the block.

Comparing the inertial mass to the energy

When that inertial mass is converted into e𝕪/-𝕘d photons as energy that then has to be observed, this needs to be compared with $e=mc^2$ to check the equation. The photons might heat some water for example, so the E𝕐/-𝕠d kinetic impulse is observed as a temperature change. These then give a ratio between what a force did to a mass with -𝕀D×e𝕧 inertial work, and what those photons do as a E𝕐/-𝕠d kinetic impulse.

Energy conversion values

In this model the conversion of the -𝕚d inertial mass into the e𝕪 kinetic electric charge as energy comes from the constant Pythagorean Triangle sides. A separate question is why this conversion has these values, also why c has this particular velocity.

Inertial mass and the ground state

In this model when an electron moves down an orbital, its -𝕚d kinetic magnetic field decreases and its e𝕪 kinetic electric charge increases. This goes down to the ground state, there the velocity of an electron has increased to e𝕧/-𝕚d also called α or the fine structure constant. This is proportional to e𝕪/-𝕠d as the kinetic velocity.

α and c

This is ≈ 1/137 of c, that defines what the velocity of light is. If α was different then c would also be different, that is because the ground state has a known e𝕧/-𝕚d velocity. This also gives the concepts of a scale as e𝕧 and a clock gauge as -𝕚d, there is a maximum velocity and a minimum velocity.

Foundations of the model

In this model the aim is to derive all physical phenomena and constants from simple mathematical constructions. The Pythagorean Triangle is perhaps the most basic geometric form known, this is given a constant area and sides of distance and spin. α is an important foundation of building the model from the most basic principles. α is not a dimensionless constant in this model, it is the ratio of a straight Pythagorean Triangle side to a spin Pythagorean Triangle side, it is also a square.

Infinite or zero velocity

For example velocity from a Pythagorean Triangle could not be infinite or zero because then the ratio, and the Pythagorean Triangle could not exist. This implies a maximum velocity of c, otherwise it would keep increasing by comparison with other velocities. For example two rockets approaching each other just under c implies a new maximum velocity of 2c, if that is the maximum then two rockets at just under 2c in velocity imply a new maximum of 4c.

Derivatives and integrals with limits

This would lead to an infinite velocity and the Pythagorean Triangles could not have a constant area. The same problem occurs in calculus, this is avoided by the concept of a limit. Otherwise a calculus Pythagorean Triangle observing a slope of a curve could become horizontal, then the integral disappears. The Pythagorean Triangle of infinitesimals also disappears with a horizontal line, a second derivative of this equals zero.

Velocity as a distance over time

A velocity implies a e𝕧 length and a -𝕚d inertial time as a e𝕧/-𝕚d velocity. α is also a cosine of the -𝕚d and e𝕧 Pythagorean Triangle with the velocity of the ground state. That implies a e𝕙 height with a relationship to a e𝕧 length, these are referred to as units called meters. Gravity has an acceleration so there is a +𝕚d gravitational time and a e𝕙/+𝕚d gravitational speed in meters/second.

α leads to work and impulse

This angle θ as α then gives the dimensions of Biv space-time in this model. So far it does not give the relative relationships between them, but that in the ground state there is a velocity. Assuming squared forces this leads to the concepts of +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, also a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse.

α leads to Roy electromagnetism

It also leads to Roy electromagnetism because the electron is orbiting a proton, in the ground state there is then +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, also a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. This assumes squared forces, that the magnetic fields are proportional to mass and time, and that the electric charges are proportional to distances as height and length.

α defines four Pythagorean Triangles

In a Hydrogen atom for example, the ground state has α defining the relative values of the +𝕚d and e𝕙 Pythagorean Triangle as gravity, the -𝕚d and e𝕧 Pythagorean Triangle as inertia, the +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the +𝕠d and e𝕒 Pythagorean Triangle as the electron. So far there is no change from being in this ground state orbit, only that the four Pythagorean Triangles connect in this way.

Changing consistently from the ground state

If changes from this ground state can occur consistently, this allows for each Pythagorean Triangle side to change as a squared force and unsquared. The changes may also be mediated by something, in this model that is from four other Pythagorean Triangles. These are the e𝕪 and -𝕘d Pythagorean Triangle as the photon, the e𝕒 and +𝕘d Pythagorean Triangle as the virtual photon, the +𝕘d and e𝕓 Pythagorean Triangle as the Gravi, and the e𝕧 and -𝕘d Pythagorean Triangle as the Iner. A change in one of the four main Pythagorean Triangle is defined as another Pythagorean Triangle. Only eight Pythagorean Triangles are needed then to explain all these changes.

Relative masses of the proton and electron

The conversion of the -𝕚d inertial mass to a e𝕪 kinetic electric charge in a photon begins from the relative masses of the proton and electron, the proton has a +𝕚d gravitational mass ≈ 1836.15 that of the -𝕚d inertial mass of the electron. In the ground state that defines the velocity of the electron from its -𝕚d inertial mass, also the +𝕚d gravitational mass of the proton.

The relative masses define the height and length

This +𝕚d value also implies a e𝕙 height of the ground state with the strength of the gravitational field there. The -𝕚d electron mass also defines this ground state, if the electron had more inertial mass it would move to a greater e𝕙 height. That would also change its e𝕧 length in its velocity e𝕧/-𝕚d.

Gravity and inertia proportional to electric charge

This ground state e𝕙 height and e𝕧 length must also be proportional to the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron. This is because they are attracted to each other with a Coulomb force like gravity, this is set so each attracts the other by the same amount. That is referred to as a positive and negative charge, in this model that would be positive from the +𝕠d potential magnetic field and negative from the -𝕠d kinetic magnetic field.

Balancing Biv space-time and Roy electromagnetism

In this model the forces in the ground state are balanced, the +𝕚d and e𝕙 Pythagorean Triangle as gravity pulls down the electron. That is reacted against by the inertia of the electron maintaining the ground state orbit. The proton is also attracting as a reactive force the electron's active kinetic force. The two need to be the same in the ground state, otherwise the force imbalance would move the ground state up or down.

Squared forces and changes

Also they both need to change as squared forces, such as with the inverse square rule. Otherwise, the electron could not move up and down in quantized whole number orbitals. This is done by the constant Pythagorean Triangle areas, also a side being squared as work or impulse.

Biv space-time work and impulse

The relative masses of the proton and electron then have to be such that in the ground state the +𝕚d gravitational mass attracts the -𝕚d inertial mass with a given force. That can be measured as +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, also as the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse.

Roy electromagnetism work and impulse

That force needs to be proportional to the +𝕆D×e𝕒 potential work from the proton and the -𝕆D×e𝕪 kinetic work from the electron, also the E𝔸/+𝕠d potential impulse from the proton and the E𝕐/-𝕠d kinetic impulse of the electron. If this was not so, then the gravitational force would be different to the potential force.

Moving up and down in orbitals

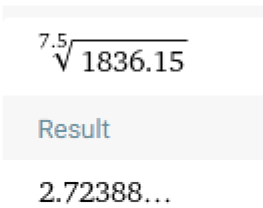
Because they are balanced in the ground state, that would mean one is changing differently to a square. Then $e=mc^2$ would be different because the squared c would not give the correct ratio of mass to energy.

Conserving changes in orbitals with photons

The forces then must have a relative proportion of squared strengths, that also comes from $e=mc^2$. The α fine structure constant as a velocity is a proportion of c, it is also a balance of the gravitational and potential forces. The kinetic and inertial forces are also balanced, then they must also remain balanced with each change in an orbital. If so then the e𝕪×-𝕘d photons emitted and absorbed will conserve the changes in orbitals, in transmitting this energy in between electrons.

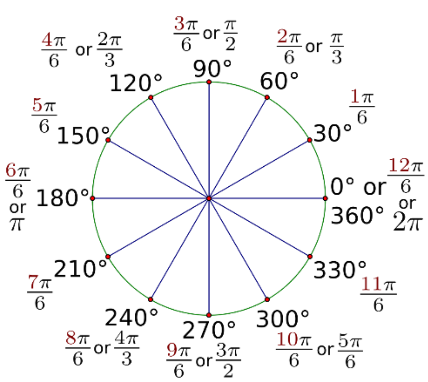
α and the masses of the proton and electron

The value α can be taken as a cosine, this is ≈ 7.5 degrees or 48/360. With $1/1836.15^{7.5}$ or $1/1836.15^{\cos\alpha}$ this gives ≈ e^1 as the Euler constant. This value of 1 in the exponent represents spin because it comes from the relative masses, this is the electron's exponent as 1/1836.15 of the proton's mass. This is also a square because the mass is being measured with the +𝕀D×e𝕙 gravitational work and the -𝕀D×e𝕧 inertial work as a mass ratio. If this was not a square then it could not be measured because there would be no force.



The relative masses as a radian

That can also be written as e^{-ni} where n=1, $1/1836.15^{7.5}$ ≈ 2.72388… close to e as 2.71828…. This value of n is a radian where a full circle is 2π. This makes it ½π, it is the square of the second Fiegenbaum constant ≈ 2.501.. or 1/√2π. Taking the full circle this gives 2π in the diagram. The orbital can then be broken up into integer values of deBroglie waves as the -𝕠d and e𝕪 Pythagorean Triangle electrons. Because this is ½ of π the electron has a half spin, the radius of 1 is half the diameter. This radian value acts as a torque because it is a square.

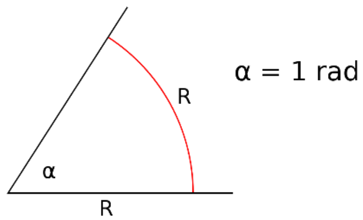


Constant values

In this model e and π are transcendental, they cannot be expressed as a finite number of Pythagorean Triangles. The Euler Mascheroni constant γ is the difference between adding a harmonic series and the hyperbola with its area as e. The deviation here from the exact value of e may also be related to γ, the inverse value below is much more accurate.

Cosine of α

When the cosine of 1/α is taken this is ≈ e^{-1}, that gives a second relationship of α to the ground state. When α is an exponent, this gives the value of the radius of a circle as 1. The proton and electron masses have a ratio of 1 radian. This allows for different orbitals to change with this radius, the relative charges of e𝕒 and e𝕪 are set at 1 each.



Roy electromagnetism

Because the Coulomb force between e𝕒 as the potential electric charge and e𝕪 as the kinetic electric charge is proportional to the gravitational force, alpha would also give the relative values of these. They are defined as a positive charge of 1, here as +𝕠d, and a negative charge of -1 here as -𝕠d, in conventional physics.

Circumference of an orbital

The circumference of an orbital can act as a standing deBroglie wave, when divided by two this allows for two electrons to fit into one orbital. When divided by four this gives 4 electrons, each relates to the radian from the proton and electron masses.

Radians and kinetic torque

Because the radian is a square, this is the +𝕆D kinetic probability and kinetic torque. When D=2 this is a second orbital, or the two radian values can fit in a single orbital like two radii equals a diameter. This would form a boson pair, the two radii halves are like the difference between two half spin electrons as a whole number 1.

Orbital increments of 1

The -𝕆D kinetic torque can increase by 1 to fill circular orbitals, this is also h as -𝕠d ×e𝕐/-𝕠d. The -𝕆D×e𝕪 kinetic work increases by 1 to raise an electron up an orbital, this comes from the radian square. Then the E𝕐/-𝕠d kinetic impulse can be observed, the electron acts as a particle.

The radian as a probability

Because this is a spin or torque the position is not defined, instead it is a circular force. It is a temporal duration from a starting to a final value, this is not moments as particular points on a clock gauge but in between them. That makes it a probability, like spinning a pointer or phasor on a wheel. Where it points after a torque is applied has some uncertainty, this is because the direction is not simultaneously observed by squaring its magnitude.

The electron as a rolling wheel

In this model the electron can be regarded as a rolling wheel, in the first orbital it would have a e𝕪 kinetic electric charge as a phasor equaling 1. The radian is the torque on the -𝕠d axle of the electron, when this is not measured it is still 1 as a square root. A 1 in this model can act as a force when squared, also have the same value unsquared and not a force.

An oscillation as π

An oscillation of the electron rolling wheel is like a deBroglie wave, a complete turn of the e𝕪 phasor is half the circle as π. Because the radian is ½π this allows for two oscillations of π in the first orbital.

The ground state as 1

Because the ground state is 1 the electron cannot go under this to a lower orbital. If the -𝕆D kinetic torque was ½ for example then this is a fraction like a derivative slope of the Pythagorean Triangle. An oscillation cannot stop half way so it cannot act as a wave, the electron would act with a E𝕐/-𝕠d kinetic impulse.

Measuring the rolling wheel

The wheel is not being observed or measured without a force, when the -𝕆D×e𝕪 kinetic work is measured this squares the radian. It is like applying a -𝕆D kinetic torque to the e𝕪 phasor of 1 so the orientation of it is measured. This can interfere constructively and destructively with other radians, two electrons in an orbital can interfere constructively to double their -𝕆D probabilities of being measured there.

Absorbing a photon

When the rolling wheel absorbs a e𝕪×-𝕘d photon it receives the -𝔾D light torque of 1, that is also an increment of 1 as -𝕠d ×e𝕐/-𝕠d or h. That makes its -𝕆D kinetic torque with D=2 radians, because this is proportional to E𝔸 that makes it jump upwards to next highest orbital. It can then be observed with a E𝕐/-𝕠d kinetic impulse of E=2 there.

A higher orbital has a larger torque

As the electron moves to a greater e𝕙 height there are more oscillations in an orbital, from 2 with ½π to ¼π where 4 electrons can share an orbital. Each rolls like a wheel with an oscillation of π as a revolution, that is 4π oscillations to equal 1/4π each. When an electron goes up an orbital it absorbs an oscillation as -𝕘d from a e𝕪×-𝕘d photon. The wheel rolls faster and so it has a larger -𝕆D kinetic torque.

α decreases in higher orbitals

The velocity of the electron decreases at a higher e𝕒 altitude, this causes α to decrease as a square of the velocity. In the equation $1/1836.15^{\alpha}$ this value of α is smaller, because this gives the -𝕀D inertial probability or mass squared of the electron that means its inertial mass is increasing. This is also because of the constant Pythagorean Triangle area, as e𝕧 contracts the -𝕚d as the inertial time dilates. The -𝕆D×e𝕪 kinetic work is stronger at higher orbitals because -𝕚d and -𝕠d have dilated.

The electron as a rolling wheel

In the rolling wheel model this is similar to the e𝕪×-𝕘d photon rolling wheel, the electron is spinning faster with its -𝕠d kinetic magnetic field. For example if the oscillation of the electron increases 4 times then the e𝕪 phasor decreases to ¼ of its size. The e𝕒 altitude of the orbital increases proportionally to the 4 times oscillation frequency, the electron is 4 times higher up. The orbital period of the electron is the inverse of the +𝕠d potential magnetic field, because this is 4 times weaker that this e𝕒 altitude then the electron has an orbital period 4 times slower.

The proton as a rolling wheel

The -𝕠d and e𝕪 Pythagorean Triangle as the electron then acts as a rolling wheel, the +𝕠d and e𝕒 Pythagorean Triangle as the proton also acts like a rolling wheel causing the electron to rotate around the orbital. This is like the +𝕚d and e𝕙 Pythagorean Triangle with gravity, the e𝕙 height of an electron determines the +𝕚d period of its rotation around the orbital.

Potential and gravitational frame dragging

This +𝕆D potential torque, and proportionally the +𝕀D gravitational torque act like frame dragging in General Relativity. It is also like an exponential spiral, the potential and gravitational torque cause the electron to move with an orbital period that is larger and longer at a higher e𝕒 altitude and e𝕙 height.

Inertial oscillation

The -𝕚d and e𝕧 Pythagorean Triangle with inertia oscillates proportionally with the electron rolling wheel, this has a larger -𝕚d inertial mass at a greater e𝕙 height. The e𝕧 length or wavelength of the electron is the diameter of a complete oscillation as π.

Potential and gravitational torque from α

The value of Eℍ was 1 from α, this also gives a radian value of 1 as +𝕀D for the gravitational probability and +𝕆D as the potential probability. These make it more likely for the electron to move around the orbital, it is the inverse to the -𝕠d and e𝕪 Pythagorean Triangle.

The potential and kinetic torque as inverses

When the electron rolling wheel oscillates 4 times around an orbital then the +𝕆D potential probability exerts a torque making it complete a revolution. When the electron oscillates 8 times around an orbital then the +𝕆D potential torque is 8 times lower, this causes the electron to still complete 1 revolution.

The electron with a constant angular velocity

The electron as a rolling wheel moves with a constant velocity in each orbital, this is because the increase in its -𝕠d orbital frequency has an inverse decrease in the e𝕪 phasor size. Because the electron is a wave here the -𝕠d and e𝕪 Pythagorean Triangle acts as a -𝕠d×e𝕪 integral.

An integral as c

If this was a derivative then the electron would move with a velocity of c like the photon. For example when 3×10^8 meters is multiplied by 1 second this is not a velocity but is a field density, the meters are proportional to the phasor size and the second to the rotational frequency. The dimensions are much smaller so the wavelength and rotational frequency fit into the atom.

The photon as a derivative and an integral

The photon is e𝕪×-𝕘d as an integral, also e𝕪/-𝕘d as a derivative depending on whether it is measured with -𝔾D×e𝕪 light work or observed as a e𝕐/-𝕘d light impulse. This allows it to move at a constant velocity of c as the rolling wheel, also to have the ratio of the e𝕪 phasor to the -𝕘d rotational frequency of an oscillating field.

Photon absorbed as π

The photon rolling wheel completes a revolution as π and so it can be absorbed into an electron orbital as a π oscillation, the electron would then jump into a higher orbital according to the +𝕆D×e𝕒 potential work from the proton to allow for the π oscillation to in an orbital. This might for example cause an electron to move from being a boson pair as 2×1/2π to being a fermion with a half spin as ½π.

The photon and a circle's area

The rolling wheel has an area of e𝕪×-𝕘d, this is calculated by the e𝕐/-𝕘d light impulse as π revolutions of -𝕘d light time with the radius squared as E𝕐 to give πr^2 as the field integral area. This can also be calculated where -𝔾D is proportional to $1/r^2$ times e𝕪 which is proportional to -𝕘d to give the same integral area but from work.

Impulse and velocity

When the e𝕐/-𝕘d light impulse is calculated this is also from the velocity e𝕪/-𝕘d of the rolling wheel as c, E𝕐 is observed which can only happen with a particle having a position divided by time. A field does not have a velocity because the two Pythagorean Triangle sides are multiplied together.

Electron annihilation

This allows for the electron as an integral field to be annihilated into a derivative of its Pythagorean Triangle sides, that becomes e𝕪×-𝕘d photons. Also a change in the electron's orbital is emitted as a photon with a velocity of c, this is the rolling wheel's change in its -𝕠d rotational frequency and its e𝕪 phasor.

Photon as a particle emitted from an electron

As a change over time this is a derivative fraction, the e𝕪/-𝕘d photon acts as a particle in being emitted from the electron. This is because to leave the electron it must have a velocity. When the photon is absorbed into an electron it arrives as a derivative fraction e𝕪/-𝕘d to become part of the field as e𝕪×-𝕘d.

The electron as a field of c

In this model the electron has a -𝕚d inertial mass, with $e=mc^2$ this can be converted into photons. The -𝕘d rotational frequency of the photons is proportional to -𝕚d giving an inertial mass to energy conversion. This also happens because the electron is a kinetic field -𝕠d×e𝕪, when this is converted into a derivative as e𝕪/-𝕠d it has a velocity of c with a rotational frequency of -𝕠d=-𝕘d.

The electron wave and c

Because the -𝕠d×e𝕪 kinetic field of the electron is c as e𝕪/-𝕠d, the rolling wheel gives the constant c^2 in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. The deBroglie wavelength is proportional to the changing field of the rolling wheel as -𝕠d×e𝕪.

The electron outside the atom

When the electron leaves the atom it is usually observed as a particle, its velocity comes from e𝕪/-𝕘d photons colliding with it. This also changes the ratios of its Pythagorean Triangle sides, as a rolling wheel it now can have its velocity changed in a collision. The rolling wheel would reach a low velocity when it reaches the ionization level and is going to leave the atom, the -𝕠d kinetic magnetic field is at a maximum and the e𝕪 kinetic electric charge at a minimum.

Conversion to slower photons

If the matter is highly compressed, such as in a star, then the E𝕐 kinetic displacement history and -𝕆D kinetic temporal history would cause the electron rolling wheel to have a contracted e𝕪 phasor and slower -𝕠d axle. If the electron is annihilated there then it would be converted into e𝕪×-𝕘d photons, c would be slower as those photons rolling wheels would also have a shorter e𝕪 phasor and slower -𝕘d rotational frequency.

Different sized rolling wheels

Where c is the same different electron rolling wheels might have a longer e𝕪 phasor than others, inversely a slower -𝕠d rotational frequency. These would have the same changes in collisions, some rolling wheels are then smaller but rotating faster to give the same velocity changes.

Different impulse and work

The different sized rolling wheels would have a different E𝕐/-𝕠d kinetic impulse and do -𝕆D×e𝕪 kinetic work, where the e𝕪 phasor is larger the E𝕐/-𝕠d kinetic impulse would be greater. This is like different sized balls colliding, the ones that are larger and rotating more slowly

Compressing atoms and electron rolling wheels

When atoms are compressed by a strong +𝕚d gravitational mass, the electron rolling wheels contract their e𝕪 phasors. They also slow their -𝕠d axles, this reduces their -𝕆D×e𝕪 kinetic work more because the -𝕆D kinetic probability and torque is a square. That causes the electrons to move to lower orbitals, this also happens because α contacts. This causes the probability of an electron to emit a photon as √α to decrease also, the -𝕠d kinetic probability of this decreases.

Conserving histories in collisions

As a -𝕠d×e𝕪 oscillating field in an orbital it could not collide with particles, now to conserve displacement and temporal histories the rolling wheel changes its velocity from them. It still also acts as an oscillating field with its constant Pythagorean Triangle area, that means it can be annihilated into e𝕪/-𝕘d photons.

The rolling wheel electron approaching c

These electrons can also be annihilated, then the angle θ in the -𝕠d and e𝕪 Pythagorean Triangle will give the -𝕘d rotational frequency and e𝕪 kinetic electric charge of the photons emitted. The electron still acts as a rolling wheel, when collisions increase its velocity then it can have e𝕪 contract and the -𝕘d rotational frequency slow as it approaches c. This would cause the rolling wheel to not be able to reach c when collisions increase its velocity, the wheel has its spoke phasor e𝕪 contracting and its -𝕠d axis slowing.

Protons and electrons in a double slit experiment

The electron can still act as a -𝕠d×e𝕪 kinetic field for example in a double slit experiment, this can also be done with protons and even whole atoms.

Photons still mediate changes in electrons

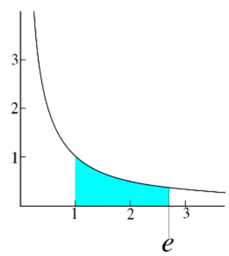
The photons still mediate changes in the electron but now as a particle, the collisions like in Compton scattering change the e𝕪/-𝕘d photons -𝕘d rotational frequency. They also cause the deBroglie wave of the electron to change as the angle θ of the -𝕠d and e𝕪 Pythagorean Triangle changes. If the electron slowed enough then it could return to an atom, the velocity of electrons in the upper orbitals is very slow. Then it would act as an oscillating field again doing -𝕆D×e𝕪 kinetic work, instead of outside the atom with a E𝕐/-𝕠d kinetic impulse.

Pythagorean Triangles as exponents

The exponent as a squared radian does -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, this is connected to the derived value of ≈ e so the Pythagorean Triangles can be modeled as exponents.

The electron trajectory and the hyperbola

This allows for the exponent as a squared spin to increase in increments of D=1 consistent with logarithms. It also connects the trajectory of an electron as a hyperbola where the integral area under the curve for 1 is e.



Repulsion between electrons

The spin of the electron in repelling another electron, gives a hyperbola where the integral area of this repulsion is in quantized increments of 1. This also gives the probabilities of electrons emitting e𝕪×-𝕘d photons between them, these are in increments of √α which is also related to ½π and renormalization.

Quantum electrodynamics

From this is associated quantum electrodynamics where this repulsion is in increments of e𝕪×-𝕘d photons also as 1 from the changing -𝕀D inertial torque of 1 between orbitals. The coupling constant as √α between a photon and electron gives the probability of it emitting a photon and dropping an orbital. In this model that is 1/√2π which is also used in the normal curve formula below. The exponent is also from the inverses of negative squares, in this model they are the squares of spin Pythagorean Triangle sides such as +𝕚d or -𝕚d.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

The normal distribution and α

The orbitals then are consistent with a normal curve distribution, also associated with -𝕠d ×e𝕪/-𝕆d as the Boltzmann constant. This is -𝕆D as a square so the kinetic probability is being measured. This is also a coupling constant for the electron in an orbital, whether it will emit a e𝕪×-𝕘d photon, just as it is a constant in the normal curve function.

Relative masses and times

Earlier it was shown how mass is proportional to time, mass comes from an integral and time from a derivative of a Pythagorean Triangle. The electron at this velocity has a -𝕚d inertial mass inversely associated with its -𝕚d inertial time in going around this ground state. The relative masses of the proton and electron then give the orbital period of the electron around the proton in the ground state. Because the relative masses of the proton and electron give ½π this also gives the orbital period. That is an orbital circumference of 2π compared to a e𝕒 or e𝕙 height of 1.

Impulse and α

The e𝕙 height as 1 also gives the Eℍ/+𝕚d gravitational impulse, this is squared so in the formula cos 1/α ≈ e^{-1} or 1/e this gives a value of α associated with Eℍ.

The Eℍ height displacement and -𝕀D inertial torque

Because the Pythagorean Triangles have a constant area this implies the Eℍ gravitational displacement of the -𝕚d and e𝕧 Pythagorean Triangle, this needs to be proportional to -𝕀D in the exponent. The radian value of 1 as a square is then proportional to the value of Eℍ of 1 as a square. This proportionally means E𝔸 is also 1. The 4 Pythagorean Triangles then have straight Pythagorean Triangle sides of 1 and are related to a radian value of 1. This gives the value of α, a derivation of ½π, and the relative masses of the proton and electron.

Inverse square rule

They change proportionally to each other, the Eℍ value as it increases gives the inverse square rule. The ½π radian value gives quantized integer values of orbitals, these are whole number probabilities from the normal curve formula. Each increases with the same proportion further from matter, the Eℍ value of E is proportional to D in -𝕀D.

Proportional Pythagorean Triangle sides

That means the other squared Pythagorean Triangle sides are also proportional, +𝕀D to E𝕍. Because the +𝕠d and e𝕒 Pythagorean Triangle is proportional to the +𝕚d and e𝕙 Pythagorean Triangle, and the -𝕠d and e𝕪 Pythagorean Triangle is proportional to the -𝕚d and e𝕧 Pythagorean Triangle, the radian and height values are the same in Roy electromagnetism.

Constant Pythagorean Triangle areas and inverses

This is a consequence of the constant Pythagorean Triangle areas, the same as the -𝕚d and e𝕧 Pythagorean Triangle changing inversely to the +𝕚d and e𝕙 Pythagorean Triangle as well as the -𝕠d and e𝕪 Pythagorean Triangle changing inversely to the +𝕠d and e𝕒 Pythagorean Triangle.

Centrifugal force

The $e^{-\mathbb{I}D}$ exponent is proportional to the -𝕀D×e𝕧 inertial work, the -𝕀D inertial torque increases as a square as the Eℍ height increases at the same rate. Conversely the +𝕀D gravitational torque increases proportionally to the E𝕍 inertial displacement. This would give the centrifugal force as a square, proportional to the inverse square law of gravitation. A satellite then has an E𝕍 centrifugal force proportional to the +𝕀D gravitational torque, these are balanced and so it would remain in a circular orbit. It also has a proportional -𝕀D inertial torque reacting against the Eℍ gravitational displacement pulling it downwards.

Balanced Biv work and impulse

A satellite would then move to different orbits conserving the Pythagorean Triangle angles, the squared forces remain balanced. Because the Eℍ/+𝕚d gravitational impulse is proportional to the -𝕀D×e𝕧 inertial work the +𝕀D×e𝕙 gravitational work is proportional to the E𝕍/-𝕚d inertial impulse. That also conserves the forces of the other squared Pythagorean Triangle sides.

Balanced Roy work and impulse

Because Roy electromagnetism is proportional to Biv space-time, the +𝕆D×e𝕒 potential work is proportional to the E𝕐/-𝕠d kinetic impulse. All four Pythagorean Triangles can change with squared forces consistent with the ground state values and α.

Deriving c from α

This also derived the velocity of c as ≈ 137 times α. As the electron orbital changes then so does its velocity as e𝕧/-𝕚d, that implies changes in its -𝕚d inertial mass converging to a limit of c^2. In $e=mc^2$ then c is squared because α is also a square, the radian value from α is a square and the Eℍ gravitational displacement is a square. The energy is proportional to a straight Pythagorean Triangle side such as Eℍ=1, the -𝕀D inertial mass is proportional to the radian square also 1.

Converting one Pythagorean Triangle into the other

This can be written $e/m=c^2$ which is a constant k. So as e doubles for example the m spin Pythagorean Triangle side halves, this gives a constant area Pythagorean Triangle. The changing angle θ converted one Pythagorean Triangle side into another like mass and energy conversion into each other.

Square root speeds

The velocity c would then be the two square roots e𝕧/-𝕚d, a square root e𝕧 length divided by a square root -𝕚d as inertial time. It also appears as square roots in e𝕙/+𝕚d as the brevity or kinetic velocity. In Roy electromagnetism e𝕪/-𝕠d as the kinetic velocity and e𝕒/+𝕠d as the potential speed are also square roots.

The permittivity and permeability constants

It also implies c has a special relationship in Roy electromagnetism, this is $1/\sqrt{\epsilon_0 \times \mu_0}$ from the permittivity and permeability constants. In this model they change to a value in the ground state with c as a limit. Here ϵ_0 is from a straight Pythagorean Triangle side as the permittivity constant, it refers to the motion of the e𝕪 kinetic electric charge through free space. The μ_0 value comes from the permeability constant, this is the kinetic magnetic field in free space.

The CMB and an event horizon

This connects $e=mc^2$ to the Pythagorean Triangle values, the velocity of c comes from α. The -𝕚d inertial mass is also derived to give a squared -𝕀D inertial torque, this can be converted into e𝕪×-𝕘d photons with the changing of orbitals. The c value as a speed limit would occur at the CMB and the Schwarzschild radius of a black hole. This is where the ground state values of α continue to increase as a velocity, when this reaches the limit as c^2 in the ½×e𝕍/-𝕀d ×-𝕚d linear inertia.

Relativistic changes in c

This can change when the ground state is compressed, for example where a heavy star does strong +𝕀D×e𝕙 gravitational work pushing the hydrogen atoms closer together. In this model that gives an increased Eℍ gravitational displacement history, that is from the atoms coming together to lower e𝕙 heights in forming the star. There is also a +𝕀D temporal displacement history, the temporal duration of the atoms moving into the star with +𝕀D×e𝕙 gravitational work. Together this cause a e𝕙 height contraction and +𝕚d gravitational time dilation, that slows √α as the e𝕙/+𝕚d gravitational speed in the ground state.

Slowing α

Because this is 1/137 of c that also causes c to be slower in the presence of the star's mass. Proportionally there is also a larger E𝕍 inertial displacement history and a -𝕀D inertial temporal history, this is from the inertia of the Hydrogen atoms being compressed. That causes a e𝕧 contraction and a -𝕚d inertial time slowing with α as a velocity as well.

The speed of light slows around matter

In this model c can be slowed in the presence of matter, this comes from the increased Eℍ gravitational displacement history and +𝕀D gravitational temporal history of it. A black hole has a e𝕙 height for the maximum value of c, a lower velocity than this would be where e𝕪×-𝕘d photons can escape. With a lower c value then the event horizon would be at the greater e𝕙 height where the c velocity is lower.

The event horizon from the angle θ

The maximum c velocity is not infinite, that means the e𝕙/+𝕚d gravitational speed also stops before an infinitesimally small limit as an event horizon. This gravitational speed refers to an orbital height rotating around matter with a period +𝕚d in gravitational time. The velocity of this rotation comes from the -𝕚d and e𝕧 Pythagorean Triangle, this changes inversely to the +𝕚d and e𝕙 Pythagorean Triangle. As the e𝕙 height decreases then the e𝕧/-𝕚d velocity approaches the limit c. The e𝕙 height is then proportional to the -𝕚d inertial time in the velocity.

Size of a black hole

In this model more matter can then increase the size of a black hole, this is from the same formula as the slowing of c near matter. A black hole also appears larger with a greater e𝕙 height, so when they are further away towards the CMB they appear bigger. This is also further back in the +𝕚d gravitational time as the past.

Distant black holes are larger

This is because further away the E𝕍 inertial displacement history is larger as well as the -𝕀D inertial temporal history, together they make e𝕧 contract and -𝕚d inertial time run slower. This slower c around the black hole gives it a larger e𝕙 height. The change is proportional to the redshift of the photons, that also comes from the e𝕙 height away from an observer and measurer where they are emitted. That gives a larger Eℍ gravitational displacement history and +𝕀D gravitational temporal history from a given e𝕙 height above a black hole. These histories appears the same as a redshift from around a heavy mass, because of this the redshift around a black hole reaches the event horizon at a higher e𝕙 height than a nearby black hole.

Rockets approaching at near c

The light speed appears to slow in the same process as with two rockets approaching each other near c. The speed of light between them cannot exceed c from one rocket to the other, the increased E𝕍 inertial displacement history and -𝕀D inertial temporal history causes e𝕧 as length to contract and -𝕚d as inertial time to run slower as a slower c speed.

Proper length and inertial time

Each rocket has its own -𝕚d proper inertial time and proper e𝕧 length, c would be the maximum speed in the rocket. Observing and measuring the other rocket, it has a larger E𝕍 inertial displacement history and -𝕀D inertial temporal history. This is because the other rocket had to accelerate from rest, in doing so it accumulated the large E𝕍 inertial displacement history and -𝕀D inertial temporal history. That contracts the e𝕧 length in c and slows its -𝕚d inertial time so light from that rocket is under c.

A slower c and a larger event horizon

Around an event horizon this same appearance of a slower c is at a larger e𝕙 height, the event horizon appears to be larger and there is a longer +𝕚d gravitational time to traverse it. This happens because on all sides of the event horizon there is also an E𝕍 inertial displacement history and -𝕀D inertial temporal history, matter falling into it near c would appear to exceed c by other matter falling in the other side of the event horizon.

An event horizon and rockets approaching each other

This limit gives the event horizon, the speed of light and the speed of infalling matter appears to slow between them to be under c overall. This is the same as one rocket observing and measuring the other appear to slow to under c, even though they are both approaching each other at just under c. Because rockets falling into a black hole would be increasing their velocity to near c, they would also observe and measure each other with a e𝕧 length contraction and slower -𝕚d inertial time.

Each rocket appears frozen

This reaches a limit with the e𝕙 height of the event horizon, any matter near this boundary appears to be frozen in +𝕚d gravitational time. This is so the rockets cannot see each other moving faster than light. For example if one rocket is falling at 99% of c then the other can only appear at 1% of c as a limit. This happens by the e𝕧 length in velocity contracted and the -𝕚d inertial time in it slowing as well. This approaches a limit where all the rockets appear frozen to each other at the event horizon. Beyond this event horizon a rocket could only appear to be moving faster than c even if frozen, so it cannot be observed or measured.

Conserving displacement and temporal histories

Because all matter can observe other matter with a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse, and measure it with +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, this freezing of +𝕚d gravitational and -𝕚d inertial time is needed at the event horizon to conserve the displacement and temporal histories all around it. If not then there would be a progressively larger c value until it was infinite, then as e𝕧/-𝕚d the -𝕚d and e𝕧 Pythagorean Triangle would have e𝕧 as infinite and -𝕚d as zero with a zero area. Because this Pythagorean Triangle cannot exist this cannot occur.

Galaxies and event horizons

Galaxies also are surrounded by a spread out +𝕚d gravitational field as well as a large e𝕙 height from the center to the edge. That would give an appearance of the depression used to illustrate Special Relativity, each star is an additional depression and overall this increases the depth of the center. In the diagram a single planet is represented as this depression, a galaxy would have a separate depression for each stat. The center would be progressively lower until this reaches an event horizon.

Event horizon in a galaxy

This gives an increased Eℍ gravitational displacement history and +𝕀D gravitational temporal history in the center where matter has fallen down to it. This decreases c and so the event horizon can grow larger.

A more contracted height in the galaxy center

A star near the center of the galaxy has its own depression around it as its +𝕀D gravitational probability, this area is lower than around the galaxy edges. The +𝕀D gravitational probability means it is more probable for masses to move to that eh height, the smaller the height the greater the +𝕀D gravitational probability.

Height of the depression

Because the eh height of the depression is lower overall around the galaxy center then the +𝕀D gravitational probability reaches its limit at a greater eh height. This is because the +𝕚d and eh Pythagorean Triangles there have their limit as their angles θ, a minimum height gives an event horizon.

A lower overall height

When the +𝕀D gravitational temporal history of matter falling into the galaxy center is added to this then the event horizon must increase in height. This is the same as rockets approaching different sides of a black hole, the event horizon prevents the perception of light being faster than c. Because there is a greater Eℍ gravitational displacement history and +𝕀D gravitational temporal history there the c velocity is slower, so the black hole would be larger.

Visiting the galaxy center

This black hole appears larger the higher the observer and measurer is from the galaxy center. This is because that increases the Eℍ gravitational displacement history and +𝕀D gravitational temporal history. Traveling there would see either no event horizon or a small one, the smaller Eℍ and +𝕀D values would cause a black hole to shrink.

Traversing a black hole

If the black hole existed on approaching the center, then rockets can again be approaching it from all sides. Each rocket appears to be slowed with their -𝕚d inertial time and their e𝕧 length is contracted. The rockets could perhaps travel through the event horizon if this was only caused by the depression from the galaxy's stars. For example the eℍ height decreases around the galaxy center, this may cause an even horizon even if there is no matter there or only normal stars.

Reappearing instantly

If so then rockets could traverse the event horizon like normal space, from a greater eℍ height they would become frozen on the event horizon. They would appear to be frozen on the other side then suddenly appear proportional to the perceived greater than c speed they traveled. For example they might go into the event horizon and then come out a short distance away, not on the other side. A distant observer and measurer would see them become frozen then reappear after they disappeared from the entry point of the event horizon. This would be to conserve the displacement and temporal histories. The rocket traversing it would still experience the journey with its own speed just under c.

Approaching at greater than c

In this model it may be possible to accelerate faster than c. For example if rocket 1 was observing and measuring rocket 2 coming towards it at under c, rocket 2 would appear to slow and become frozen. This is so the difference in velocities between them does not exceed c. Then if Rocket 2 increases their velocity to above c, this would make it impossible even for them to appear slowed or frozen like at an event horizon to keep the perceived velocity under c.

Moving through hyperspace

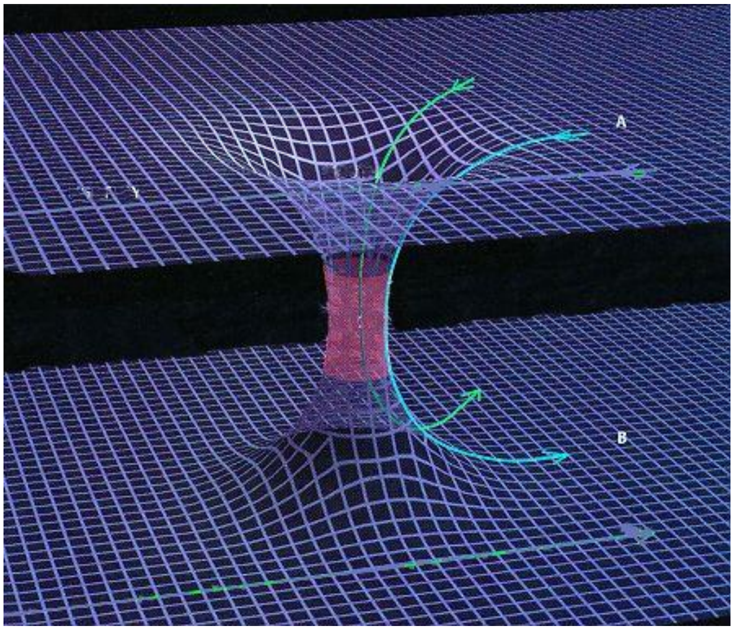
Rocket 2 may then disappear, then reappear when their speed went under c again. This would be the same as entering the event horizon then appearing elsewhere. The E𝕍 inertial displacement histories and -𝕀D inertial temporal histories would need to be conserved, Rocket 2 would disappear for the -𝕚d inertial time to reconcile these histories. Otherwise, there would be the appearance of time travel as described in Special Relativity paradoxes.

Observing and measuring from hyperspace

Rocket 2 would be unable to observe or measure displacement and temporal histories where these exceeded c while in hyperspace, that should not occur at right angles to their trajectory but only forward and behind them. Another possibility is Rocket 2 may appear to move in reverse to maintain an appearance of being under c.

Wormholes

Though this would not be an actual wormhole, the diagram may work in a similar way. A rocket would go into the event horizon at A with General Relativity, or accelerate to past c with Special Relativity. When their velocity exceeded c they could not be observed or measured, then they would reappear when their velocity was again under c at B. In the event horizon they would also disappear, then reappear at B.



Cerenkov radiation

This would happen with Cerenkov radiation, α particles are expelled from a nuclear reactor at close to c. They encounter heavy water where the E𝕍 inertial displacement history and -𝕀D inertial temporal history makes e𝕧/-𝕚d as c slower. This would cause, according to this model, the α particles to appear frozen, then suddenly appear closer to the heavy water molecules as they decelerate.

Slowing near gravitational mass

Because they have mass this deceleration would not be instant, they would be in this hyperspace for a short amount of -𝕚d inertial time. This may be difficult to test, photon emissions or colliding with photons would be needed to measure or observe this. The Cerenkov radiation may come from this slowing but not from the slowing matter itself.

Slowing velocity and photon emission

To conserve the sudden change in velocity there would be an emission of e𝕪×-𝕘d photons as Cerenkov radiation. The deceleration would occur as c decreased, their fraction of c as their velocity would be the same but the deceleration would cause the emission of photons. This would conserve the values of the α particles' E𝕍 inertial displacement history and -𝕀D inertial temporal history.

In practice we often write $\tau_{net} = I\alpha$, but Equation 12.32 better conveys the idea that **torque is the cause of angular acceleration.** In the absence of a net torque ($\tau_{net} = 0$), the object either does not rotate ($\omega = 0$) or rotates with *constant* angular velocity ($\omega = \text{constant}$).

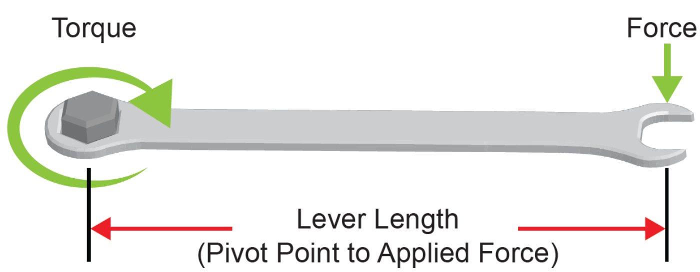
TABLE 12.3 summarizes the analogies between linear and rotational dynamics.

TABLE 12.3 Rotational and linear dynamics

Rotational dynamics		Linear dynamics	
torque (N m)	τ_{net}	force (N)	$\vec{F}_{net}$
moment of inertia (kg m^2)	I	mass (kg)	m
angular acceleration (rad/s^2)	α	acceleration (m/s^2)	$\vec{a}$
second law	$\alpha = \tau_{net}/I$	second law	$\vec{a} = \vec{F}_{net}/m$

A lever and torque

The second law in rotational dynamics refers to work, in this model work is associated with for example the +𝕀D inertial torque. The moment of inertia would be the moment arm size as e𝕧 in -𝕀D×e𝕧 inertial work, when this is longer with a wrench then the torque decreases as an inverse square. That is the action of a lever with -𝕀D×e𝕧 inertial work, as e𝕧 is longer then -𝕀D as the inertial torque decreases as a square.



Levers

This allows for a longer lever as e𝕧 to move a large -𝕚d inertial mass with a -𝕀D inertial torque. Moving the level arm becomes straighter with the increased e𝕧 length, the force is more from an E𝕍/-𝕚d inertial impulse. This allows the user to push with a straighter force rather than turning the bolt directly.

Impulse leverage

With F=ma in linear dynamics this also acts like a lever, it changes a squared straight Pythagorean Triangle side as impulse. The different sides of the lever or hydraulics move at a different velocity e𝕧/-𝕚d. With the spanner the end around the nut moves very slowly, because e𝕧 is contracted then -𝕚d as inertial time is dilated. This can be used for -𝕀D×e𝕧 inertial work where the -𝕀D inertial torque is much stronger.

Kinetic impulse and inertial impulse

The operator uses a E𝕐/-𝕠d kinetic impulse to push on the moment arm or spanner, this is reacted against with an E𝕍/-𝕚d inertial impulse. This pushing the moment arm in a straighter line with impulse is converted into stronger -𝕀D×e𝕧 inertial work and -𝕀D inertial torque. Pushing the moment arm is at a faster velocity, so E𝕍 as the inertial displacement force is stronger and the -𝕚d inertial time of pushing on the moment arm is shorter.

Hydraulics

With hydraulics a smaller -𝕚d inertial mass is needed to push a fluid through a small pipe, this can lift a much larger -𝕚d inertial mass as a car. With F=ma for a constant force as f, the operator observes a fast velocity e𝕧/-𝕚d of the fluid going through a small pipe. This is connected to a wider pipe under the car, the velocity of the fluid decreases and so e𝕧 is contracted and -𝕚d is dilated. The operator is using an active E𝕐/-𝕠d kinetic impulse to push the fluid, this reacts with an equal and opposite E𝕍/-𝕚d inertial impulse.

Inertial probability and hydraulics

This allows for the faster E𝕍/-𝕚d inertial impulse with the small pipe to be converted into -𝕀D×e𝕧 inertial work under the car. Because -𝕚d is dilated then the -𝕀D inertial probability is stronger to push up the car. This probability is where the fluid is more attracted into the upper side of the pipe pushing the car up.

Time equivalent to mass

The velocity of the fluid has the -𝕚d inertial time undergo a gearing change, from being contracted in time to dilated. Because in this model -𝕚d inertial time is equivalent to the -𝕚d inertial mass, the same gearing change occurs in lifting the larger inertial mass of the car with a smaller inertial mass.

Gravitational time and gravitational mass

This small inertial mass moves downward under gravity at a faster velocity, the Eℍ/+𝕚d gravitational impulse is stronger because the +𝕚d gravitational time is contracted. Under the car the Eℍ/+𝕚d gravitational impulse is weaker because the +𝕚d gravitational time is dilated, the car moves upward with a slower e𝕧/-𝕚d velocity and e𝕙/+𝕚d gravitational speed.

Gravitational displacement to gravitational probability

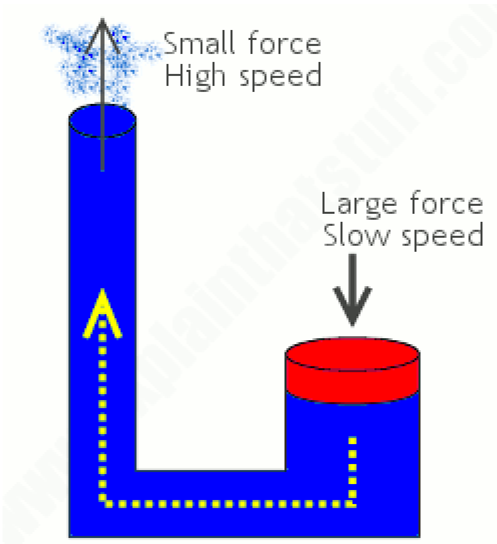
Because of this the car moves upward more with +𝕀D×e𝕙 gravitational work, the change in e𝕙 height of the car is much smaller than the change in height of the weight as it moved downward. With constant Pythagorean Triangle areas this means +𝕀D is stronger, there is a stronger +𝕀D gravitational probability of the fluid moving upwards. The -𝕀D inertial probability of the car reacts against this, but the +𝕀D gravitational probability is stronger because of the smaller change in e𝕙 height.

Relative distances as leverage

In the pipe on the right, shown below, the E𝕍 displacement force moves at a slower velocity over a smaller e𝕧 length. Because the -𝕚d inertial time is dilated on the right the -𝕚d inertial time also appears to be dilated, for example a weight 10 times larger might move with the displacement force 10 times slower. If the car was being pushed up the same e𝕧 length then the force needed would be the same, because it is being pushed 1/10 the e𝕧 length it needs 1/10 of the E𝕍 displacement force.

Hydraulics and pressure

Hydraulics can be described as impulse or work, with impulse hydraulics here works with pressure from E𝕍 as a straight force. A 1 tonne car with the brakes off would be free to move on a flat surface. A gearing change from a E𝕐/-𝕠d kinetic impulse would be in striking the car with 1 kilo weights also on wheels. The faster the weights collide with the car the more of a E𝕐/-𝕠d kinetic impulse transmitted to it. The car moves more slowly than the weights, but it is easier to accelerate the weights than to push the car. The fluid molecules in the hydraulic pipes are moved faster like these weights, they strike the fluid reservoir under the large weight and move more slowly as a gearing change.



The Bernoulli principle

When air moves with a faster velocity as e𝕧/-𝕚d there is a stronger E𝕍/-𝕚d inertial impulse, when this flows over a plane wing it creates a low-pressure area causing the plane to rise. This is because the pressure and impulse is moving in one direction, the pressure downwards is much lower. The -𝕀D×e𝕧 inertial work of the air is lower because it is moving in a straight-line, as it becomes more randomized in direction then this pressure becomes more even in all directions. This would be with a slower velocity e𝕧/-𝕚d, the -𝕚d inertial mass is dilated and the e𝕧 length is contracted. That reduces the E𝕍/-𝕚d inertial impulse and increases the -𝕀D×e𝕧 inertial work.

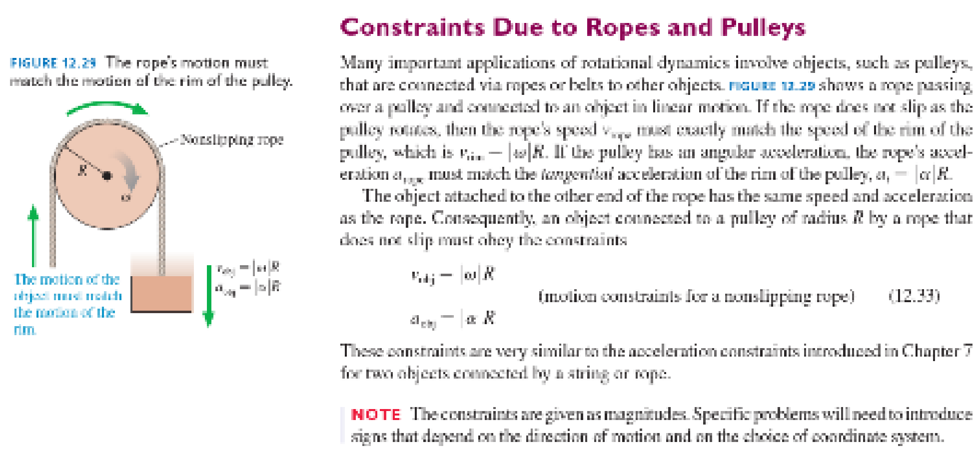


FIGURE 12.29 The rope's motion must match the motion of the rim of the pulley.

Nonslipping rope

The motion of the object must match the motion of the rim.

Constraints Due to Ropes and Pulleys

Many important applications of rotational dynamics involve objects, such as pulleys, that are connected via ropes or belts to other objects. FIGURE 12.29 shows a rope passing over a pulley and connected to an object in linear motion. If the rope does not slip as the pulley rotates, then the rope's speed v_{rope} must exactly match the speed of the rim of the pulley, which is $v_{rim} = |\omega|R$. If the pulley has an angular acceleration, the rope's acceleration a_{rope} must match the *tangential* acceleration of the rim of the pulley, $a_t = |\alpha|R$.

The object attached to the other end of the rope has the same speed and acceleration as the rope. Consequently, an object connected to a pulley of radius R by a rope that does not slip must obey the constraints

$$v_{obj} = |\omega|R \qquad a_{obj} = |\alpha|R \qquad \text{(motion constraints for a nonslipping rope)} \qquad (12.33)$$

These constraints are very similar to the acceleration constraints introduced in Chapter 7 for two objects connected by a string or rope.

NOTE The constraints are given as magnitudes. Specific problems will need to introduce signs that depend on the direction of motion and on the choice of coordinate system.

Action/reaction pairs and torque

In this model a constant torque can be with an action/reaction pair. -𝕆D×e𝕪 kinetic work can be applied to the wheel with an angular acceleration as e𝕪/-𝕆D proportionally as meters/second².

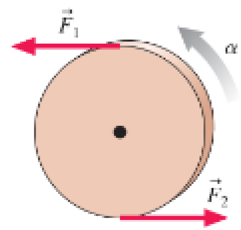
There would be -𝕀D×e𝕧 inertial work done by the wheel reacting against a change in its angular velocity, this would be e𝕧/-𝕀D as meters/second^2. In this model a constant angular speed is not torque because there is no change, there is nothing to observe or measure that is different so there is no force.

MODEL 12.2

Constant torque

For objects on which the net torque is constant.

- Model the object as a rigid body with constant angular acceleration.
- Take into account constraints due to ropes and pulleys.
- Mathematically:
  - **Newton's second law** is $\tau_{net} = I\alpha$.
  - Use the kinematics of constant angular acceleration.
- Limitations: Model fails if the torque isn't constant.



$$\alpha = \frac{\tau_{net}}{I}$$

The object has constant angular acceleration.

Opposing torque

In this model, with no force there is no torque, but opposing force would still have their own torque. Here the bar does +𝕀D×e𝕙 gravitational work with a +𝕀D gravitational torque, the atoms are moving up and down with various e𝕙 heights. There is also -𝕀D×e𝕧 inertial work with a -𝕀D inertial torque reacting against this. The atoms internally have a -𝕆D kinetic torque with their -𝕆D×e𝕪 kinetic work, this acts against the reactive +𝕆D potential torque with +𝕆D×e𝕒 potential work.

At rest and the uncertainty principle

If the bar was at rest this would violate the uncertainty principle, the e𝕙 height of the bar would be fixed because it is known that the bar is at rest. This contraction of the e𝕙 height would make the +𝕀D gravitational probability dilate and it would become less certain where it was. The e𝕙 height is associated with the attractive force of gravity, if this was a constant e𝕙 height then there could be no +𝕀D gravitational torque on it.

Gravitational speed as a constant

The e𝕙/+𝕚d gravitational speed can be constant as an angular speed, this is where the e𝕙 height is a constant with a period of rotation as the +𝕚d gravitational time. It is at rest in the sense that there is no force, it would be a circle as a geodesic. This is from the +𝕚d and e𝕙 Pythagorean Triangle not a +𝕚d gravitational mass, the e𝕧/-𝕚d velocity can also have no force as a constant.

A balance of brevity and velocity

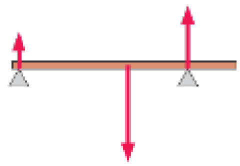
For example a satellite in a circular orbit would have a gravitational speed or brevity as e𝕙/+𝕠d, this is a constant because it also has a velocity as e𝕧/-𝕚d as the inverse. Because the two are balanced there are no forces, there need not be a balance of opposing forces because no observation or measurement is needed for this to happen.

MODEL 12.3

Static equilibrium

For extended objects at rest.

- Model the object as a rigid body with no acceleration.
- Mathematically:
  - No net force: $\vec{F}_{net} = \sum \vec{F}_i = \vec{0}$, and
  - No net torque: $\tau_{net} = \sum \tau_i = 0$
- The torque is zero about *every* point, so use any point that is convenient for the pivot point.
- Limitations: Model fails if either the forces or the torques aren't balanced.

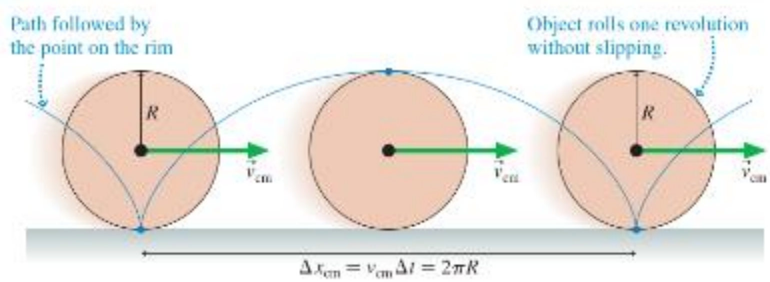


A rolling wheel with no force

In this model the electron moves like a rolling wheel, The radius as the e𝕪 kinetic electric charge spins around like a spoke. The wheel is able to move with no forces with the e𝕒/+𝕕d potential speed, the rolling motion with the e𝕪/-𝕕d kinetic velocity also has no forces. This enables the -𝕕d and e𝕪 Pythagorean Triangle as the electron to oscillate with an integer number of rotations around an orbital.

Destructive interference in an orbital

When measured this is -𝔻D×e𝕪 kinetic work, the -𝔻D kinetic torque of the axle creates interference patterns with the orientation of the phasor. Each electron in an orbital would not get too close to the next because of destructive interference. The radian value of 1 for -𝕕d can give for example π/4 for 8 electrons in an orbital, this is because the radian is ½π. The center of the -𝕚d inertial mass is the axle, this can roll with a frequency ω inversely proportional to the e𝕪 kinetic electric charge. That is because the +𝕕d and e𝕒 Pythagorean Triangle and -𝕕d and e𝕪 Pythagorean Triangle are inverses of each other, so e𝕒 is proportional to -𝕕d and +𝕕d is proportional to e𝕪.



These two expressions for Δx_{cm} come from two perspectives on the motion: one looking at the rotation and the other looking at the translation of the center of mass. But it's the same distance no matter how you look at it, so these two expressions must be equal. Consequently,

$$\Delta x_{cm} = 2\pi R = v_{cm} T \qquad (12.34)$$

If we divide by T, we can write the center-of-mass velocity as

$$v_{cm} = \frac{2\pi}{T} R \qquad (12.35)$$

But $2\pi/T$ is the angular velocity ω, as you learned in Chapter 4, leading to

$$v_{cm} = R\omega \qquad (12.36)$$

Equation 12.36 is the **rolling constraint,** the basic link between translation and rotation for objects that roll without slipping.

A rolling wheel and velocity

Here the point P is at rest, this would be the end of the e𝕪 phasor of the electron. Because of this there is no force as it moves, the e𝕪 value is proportional to the +𝕠d potential magnetic field as the rotational period. If this potential period doubles then so will the e𝕪 phasor, the -𝕠d kinetic magnetic field would halve so the electron has a slower velocity around a higher orbital.

No floor under the electron

There is no floor under the electron in its orbital, but it can move like a rolling wheel with a velocity e𝕧/-𝕚d. This is because the wheel turns with a period -𝕚d in inertial time, the e𝕧 length is the spoke of the wheel. It is then equivalent to rolling along a surface. It is similar to a wheel rolling around the interior of a circle, the +𝕠d potential period gives a single rotation. It can also be regarded as the center of the electron rolling wheel moving around the circle with a potential +𝕠d period, the electron also rotates so it completes an integer number of rotations.

A moon as a rolling wheel

Another example would be a moon that always faces a planet, the orbit has a +𝕚d gravitational period of 1 and a -𝕚d inertial period of 1. If the moon rotated twice in a day then at the same time it would have the same features pointing at the planet. It acts like a rotating wheel except there is no surface to roll on.

A rolling wheel or a screw

The e𝕪×-𝕘d photon also acts like a rolling wheel in this model, the e𝕪 potential electric charge is a phasor or spoke. The -𝕘d rotational frequency acts like an axle, the wheel can point in different directions to give polarized light. The rolling wheel has its e𝕪 phasor change inversely to its -𝕘d rotational frequency, this maintains a constant velocity of c.

Neutrino spin

This could also be modeled as the e𝕪 phasor turning at right angles to the direction of travel, the axle points in that direction and the phasor turns like a screw. Neutrinos are described as having this spin orientation in conventional physics. This neutrino would be orthogonal to the electron and photon spins, it may make the neutrino 𝕆D torque unable to interact with the proton +𝕆D potential torque and the -𝕆D kinetic torque. In this model the neutrino torque is written as 𝕆D because its spin is neither a +𝕠d potential spin nor a -𝕠d kinetic spin. The neutrino spin can then change without affecting +𝕠d and -𝕠d, for example like with precession.

Three orthogonal spins

In this model there are three orthogonal directions of spin, the proton and the electron have orthogonal spins. This enables them to join together in a neutron, the neutrino with the third direction of spin cannot interact with either outside the neutron. The proton with a +𝕠d potential magnetic field or spin causes the electron to move around it, this is like the motion of a moon around a planet.

Vertical and horizontal spin

This spin would be like a vertical axis of a globe, a planet would be viewed from a reference frame where this was vertical by convention. The electron has its spin orthogonal to this like a rolling wheel axle, this would be horizontal by convention. The neutrino would have its spin in the third direction, this cannot interact with the proton or electron.

Electron spun around in its orbital

The +𝕠d potential spin has an e𝕒 altitude as its inverse, when the electron is in a higher orbital there is less +𝕠d potential spin. Because of this the electron moves with a slower velocity, that change dilates its -𝕠d kinetic spin so it changes inversely to the +𝕠d potential spin. This is like a weight on a string being spun around, in this model the +𝕚d gravitational spin also turns a moon around a planet.

Centrifugal force

Using an analogy of the proton and electron, when a bucket of water is spun around there is a centrifugal force. This is where the -𝕆D×e𝕪 kinetic work of the bucket increases from the +𝕆D×e𝕒 potential work done by the person turning it, molecular bonds change as food is burned and the person's limbs move faster increasing the centrifugal force.

Water turning compared to external matter

This relates to Mach's theory of the water turning compared to the rest of the matter in the universe, the torque here comes from -𝕠d and e𝕪 Pythagorean Triangle as -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. Because the bucket would be in the +𝕚d gravitational fields of other stars, in this model those Eℍ gravitational displacement histories and +𝕀D gravitational temporal histories would have to remain consistent.

A Hydrogen atom in a vacuum

A Hydrogen atom far from other matter would have its electron orbiting according to the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle, not external forces. Because there are no forces then there are no observations or measurements, the outside matter is not changing the atom. In that case Mach's Principle is not operating nor any other force.

Mach's Principle

Mach's Principle discusses this situation, whether only external matter caused centrifugal forces to occur. In this model other Pythagorean Triangles from matter are connected by e𝕪×-𝕘d photons and +𝕘d×e𝕓 Gravis, these also must remain consistent. If the bucket is spun faster then there are e𝕪×-𝕘d photons being emitted, these must go to external matter to be absorbed.

Consistent displacement and temporal histories

The energy to spin the bucket can come in part from e𝕪×-𝕘d photons from other galaxies. Gravitational waves from Gravis as +𝔾D×e𝕙 Gravi work would be emitted and absorbed as well. These displacement and temporal histories must remain consistent, the bucket could not turn unless these histories were consistent with external matter as in Mach's Principle. For example, if this was near a sun then the heat would affect how the bucket was spun, and whether it was vaporized.

Relativistic histories

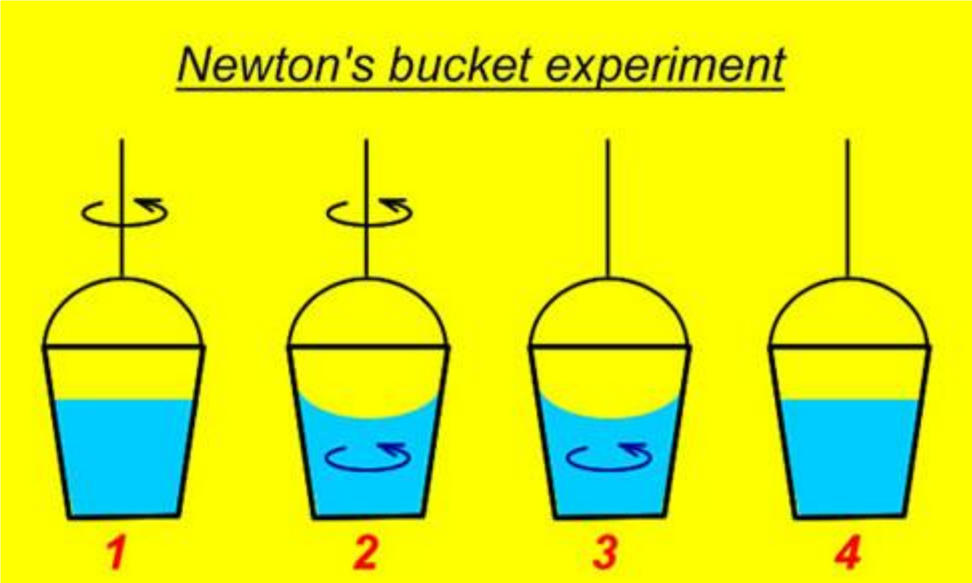
Near a black hole there would be relativistic effects, the bucket would appear to rotate in a flatter shape perhaps as its e𝕙 height and e𝕧 lengths were contracted. In this model the +𝕚d and e𝕙 Pythagorean Triangles extend out to the CMB, this means the bucket has to have its gravitational displacement and temporal histories consistent out to that limit.

Newton's bucket experiment

The diagram below shows a similar experiment done by Newton, the centrifugal force here is where the bucket is spun as shown. The -𝕀D×e𝕧 inertial work done by the water causes a parabolic shape to form, this is y=x^2 or e𝕧=-𝕆D as the relationship between a squared and an unsquared Pythagorean Triangle side. Here e𝕧 would be the inverse of e𝕙 height from the center of the parabola, on the edge the -𝕀D inertial torque would be at its maximum.

Inertial and gravitational work

This is then measuring the -𝕀D×e𝕧 inertial work of the water in an orbit around the center. Further towards the center increases e𝕧 and causes the -𝕀D inertial torque to decrease as a square, this would describe an exponential spiral associated with the parabola. This acts inversely to the +𝕀D×e𝕙 gravitational work with a change in e𝕙 height of the water orbiting around in circles.



Fixing the bucket's height and length positions

The +𝕚d and e𝕙 Pythagorean Triangles have a +𝕚d gravitational field, the water molecules rotate at different points on a slope of this geodesic depression as the parabola. Because the water in the bucket moves closer and further away from nearby reference frames, such as a house, road, other people, etc, the gravitational and inertial displacement and temporal histories must remain consistent with all those reference frames.

Conserving inertial spin in relation to gravitational fields

These fix the bucket's position in space with different e𝕙 heights from each atom in the bucket as well as in those reference frames, also their e𝕧 lengths of inertia. That allows the -𝕚d inertial spin of the bucket to be conserved compared to +𝕚d gravitational masses in reference frames around it, also with the +𝕀D×e𝕙 gravitational work done by the planet under it.

Conserved gravitational and inertial impulse

There would also be a Eℍ/+𝕚d gravitational impulse where the gravitational forces between the bucket and these reference frames was straighter rather than rotational. The bucket can then be spun faster and slower, the -𝕀D×e𝕧 inertial work done is conserved compared to all these reference frames like changing the orbit of a satellite around a planet.

Mach's Principle and impulse

If the bucket is also accelerated in a straight direction, this would be a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. That affects the displacement and temporal histories of the atoms around the bucket. With Mach's Principle this would have no effect locally in the bucket, with this model the displacement and temporal histories change compared to these reference frames but less so in the bucket.

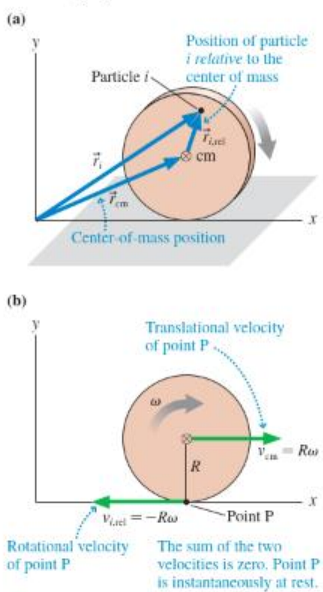
Conserving displacement and temporal histories

The Eℍ gravitational displacement history and the +𝕀D gravitational temporal history give a consistent and conserved history of these motions. One question in conventional physics is whether the bucket would experience a centrifugal force if there was no matter around it. In this model there would then be no external +𝕚d gravitational field, different parts of the water would still need to have a constant Eℍ gravitational displacement history and +𝕀D gravitational temporal history. The atoms would still have the same ratios of the four Pythagorean Triangles, this is because of the mathematical relationships between them.

No way to be outside the gravitational fields

If there was no other matter around them then the centrifugal force would be the same in this model. The water would have to be spun from a slower angular velocity, this would be a change in the E𝕍 inertial displacement history and -𝕀D inertial temporal history. Because the +𝕚d and e𝕙 Pythagorean Triangle +𝕚d gravitational field and e𝕙 height extends out to the CMB the bucket cannot be outside external displacement and temporal histories if these can be observed and measured from it.

FIGURE 12.39 The motion of a particle in the rolling object.



The rolling wheel can be observed or measured

In this model rolling has two aspects, it can be moving in a straight-line with a velocity e𝕧/-𝕚d. That can only be observed with an E𝕐/-𝕠d kinetic impulse by accelerating or decelerating the wheel, the e𝕧 length comes from the e𝕧 phasor or spoke of the wheel. It can also be measured with -𝕀D×e𝕧 inertial work where a -𝕆D kinetic torque is applied to changes its rotational frequency. The center does not measure the -𝕀D inertial torque and so from here the E𝕍/-𝕚d inertial impulse would be observed. From the edges the -𝕀D×e𝕧 inertial work would be measured as the torque the wheel produces. Both are possible because the e𝕧/-𝕚d velocity comes from this rotation, the Pythagorean Triangle sides are not changing so there is no initial force.

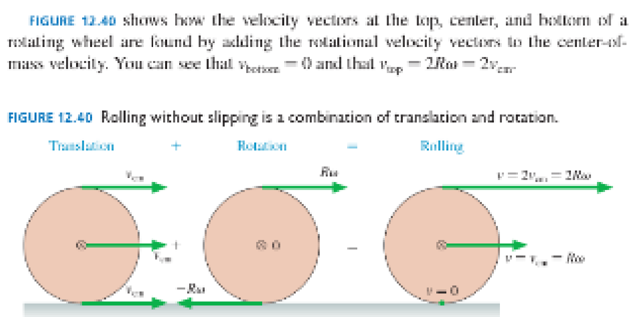


FIGURE 12.40 shows how the velocity vectors at the top, center, and bottom of a rotating wheel are found by adding the rotational velocity vectors to the center-of-mass velocity. You can see that $v_{bottom} = 0$ and that $v_{top} = 2R\omega = 2v_{cm}$.

FIGURE 12.40 Rolling without slipping is a combination of translation and rotation.

Instantaneous axis of rotation

The instantaneous axis of rotation P is like the -𝕠d axle of the electron. This instant is the -𝕠d kinetic moment on a clock gauge. The potential and gravitational energy here is ½×I_P×ω², the moment of inertia here would be the +𝕠d potential magnetic field which is proportional to the +𝕚d gravitational field. This acts like the mass m term in conventional physics with kinetic energy.

Acceleration and torque

That gives the wheel a gravitational mass, to accelerate its rolling is dependent on this mass as well as the +𝕠d potential magnetic field from the protons. To rotate a molecule also requires energy in conventional physics, this is because +𝕠d reacts against a change in its spin orientation. It is like turning the hands of a clock gauge, this requires a torque.

Angular speed

The protons react against this with a +𝕆D potential torque. The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy here is from where the wheel is moving with a constant angular speed, there is then no torque. The angular speed ω would be the potential speed e𝕒/+𝕠d and the gravitational speed e𝕙/+𝕚d, the rotational frequency of the wheel also includes the spin of the nuclei in the wheel's molecules.

Periods and moments

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is where the wheel is moving with a velocity e𝕧/-𝕚d, this is proportional to the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. While this is rotating the observed forces would come from the E𝕐/-𝕠d kinetic impulse, this moves the wheel forward in a straight-line. Here the e𝕧/-𝕚d velocity is not an angular rotation, the -𝕚d inertial time is not a period but a moment on a clock gauge. The difference is a rotational frequency is from a motion in a circle, the moment is an instant in straight-line motion.

Circular and hyperbolic geometry

Each Pythagorean Triangle can do work or have an impulse, the +𝕠d and e𝕒 Pythagorean Triangle as the proton as the +𝕚d and e𝕙 Pythagorean Triangle as gravity mainly do work. This creates atoms, their circular geometry Causes electrons to do -𝕆D×e𝕪 kinetic work in orbitals as waves. Outside the atom the electron has a E𝕐/-𝕠d kinetic impulse in hyperbolic geometry, this is why it can no longer absorb e𝕪×-𝕘d photons. A satellite around a planet does -𝕀D×e𝕧 inertial work, when it leaves the planet it has an E𝕍/-𝕚d inertial impulse in hyperbolic geometry. It depends then on action/reaction pairs, whether one Pythagorean Triangle dominates another.

The rolling wheel and work

The rolling wheel can be regarded as doing +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work as it accelerates, also +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work. This comes from the four kinds of torque as +𝕆D, -𝕆D, +𝕀D, and -𝕀D. Because the wheel had a constant velocity in this model there is no force, so no work is done unless the wheel is accelerated or decelerated.

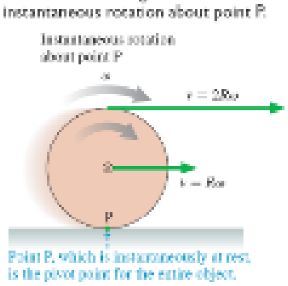
Rotational potential energy and linear kinetic energy

In equation (12.39) the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy are added together. The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy depends on the radius of the wheel with the e𝕒 altitude being the radius. There is also the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation where the e𝕙 height is analogous to the radius.

Summing Pythagorean Triangles

The larger this radius the more atoms in the wheel, that will be more +𝕚d and e𝕙 Pythagorean Triangles and more +𝕚d gravitational mass. It also means there are more protons and so their individual e𝕒 altitudes would be summed to the larger e𝕒 altitude as the radius.

FIGURE 12.41 Rolling motion is an instantaneous rotation about point P.



Kinetic Energy of a Rolling Object

We found earlier that the rotational kinetic energy of a rigid body in pure rotational motion is $K_{rot} = \frac{1}{2}I\omega^2$. Now we would like to find the kinetic energy of an object that rolls without slipping, a combination of rotational and translation motion.

We begin with the observation that the bottom point in FIGURE 12.41 is instantaneously at rest. Consequently, we can think of an axis through P as an *instantaneous axis of rotation*. The idea of an instantaneous axis of rotation seems a little far-fetched, but it is confirmed by looking at the instantaneous velocities of the center point and the top point. We found these in Figure 12.40 and they are shown again in Figure 12.41. They are exactly what you would expect as the tangential velocity $v_t = r\omega$ for rotation about P at distances R and $2R$.

From this perspective, the object's motion is pure rotation about point P. Thus the kinetic energy is that of pure rotation:

$$K = K_{\text{rotation about P}} = \frac{1}{2}I_P\omega^2 \tag{12.38}$$

I_P is the moment of inertia for rotation about point P. We can use the parallel-axis theorem to write I_P in terms of the moment of inertia I_{cm} about the center of mass. Point P is displaced by distance $d = R$; thus

$$I_P = I_{cm} + MR^2$$

Using this expression in Equation 12.38 gives us the kinetic energy:

$$K = \frac{1}{2}I_{cm}\omega^2 + \frac{1}{2}M(R\omega)^2 \tag{12.39}$$

A particle only has impulse

In this model a particle is observed with impulse, its acceleration comes from impulse only. It cannot be simultaneously or in the same position also be measured with work as a wave. A rolling wheel is a mixture of work and impulse, the velocity can move with an E𝕍/-𝕚d inertial impulse as the wheel accelerates. It can also move with -𝕀D×e𝕧 inertial work as the wheel rotates with an increased -𝕀D torque.

A rolling wheel can do work and impulse

This is because the -𝕚d and e𝕧 Pythagorean Triangle as inertia is bound inside atoms with the -𝕠d and e𝕪 Pythagorean Triangles as electrons. The +𝕠d and e𝕒 Pythagorean Triangles as protons do +𝕆D×e𝕒 potential work, these have a larger +𝕆D potential torque than the electrons and their -Od kinetic torque. The -𝕀D inertial torque of the electrons is proportional to this, so the inertia is also rotational here even though the -𝕚d and e𝕧 Pythagorean Triangle is in hyperbolic geometry with this model.

Rotational and linear energy

The shape gives the relative ratios of the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy in Roy electromagnetism, also the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation and ½×e𝕍/-𝕀d ×-𝕚d linear inertia in Biv space-time. Where the center is hollow there is more ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia, the shape then moves with more of a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse than +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work.

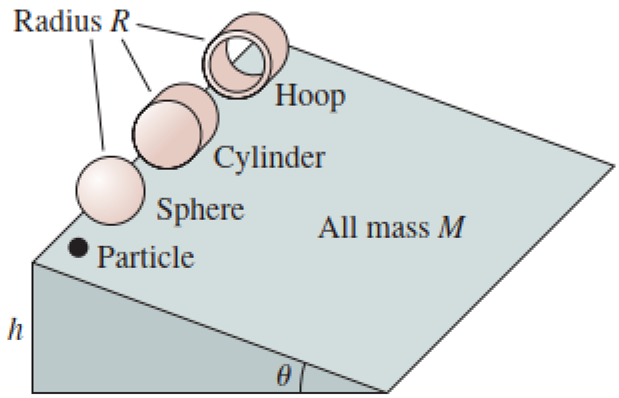
Ratios of work and impulse

They all have the same mass, the hollow hoop moves with a greater -𝕚d inertial mass because the +𝕚d gravitational mass is moving in more of a straight-line with a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. In the center the +𝕚d gravitational mass moves more with +𝕀D×e𝕙 gravitational work, because this has less impulse the straight-line speed of the shape is lower.

This analysis leads us to the conclusion that **the acceleration of a rolling object is less—in some cases significantly less—than the acceleration of a particle.** The reason is that the energy has to be shared between translational kinetic energy and rotational kinetic energy. A particle, by contrast, can put all its energy into translational kinetic energy.

FIGURE 12.43 shows the results of the race. The simple particle wins by a fairly wide margin. Of the solid objects, the sphere has the largest acceleration. Even so, its acceleration is only 71% the acceleration of a particle. The acceleration of the circular hoop, which comes in last, is a mere 50% that of a particle.

FIGURE 12.45 Which will win the downhill race?



Torque is not a vector

In this model the torque is not a vector, the straight Pythagorean Triangle side acts as a vector with a square being its magnitude. Here the torque comes from the +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work of the disk, the +𝕆D potential torque and the +𝕀D gravitational torque are integral fields. This does not like a straight line vector, instead areas can be added together in the Pythagorean Equation.

The cross product

The spin Pythagorean Triangle sides can represent this torque with a cross product, here a would be +𝕠d or +𝕚d. The torque would be induced by the +𝕠d and e𝕒 Pythagorean Triangles as electrons, this can be a straight force as a E𝕐/-𝕠d kinetic impulse such as a rope around a pulley. The E𝕐/-𝕠d kinetic impulse could be represented by a vector as a tangent to the disk as a pulley. This would create the +𝕆D potential torque around the axis. It can also be -𝕆D×e𝕪 kinetic work such as inside an electric motor, the electrons have a -𝕆D kinetic difference because they are still bound to the +𝕆D potential difference of the nuclei.

Direction of torque

The direction of the +𝕆D potential torque and the +𝕀D potential torque would not be represented here by plus or minus, that can create confusion with the positive torque signs. Instead they can be clockwise and counterclockwise. In this model there is a spin direction which comes out of the neutron, this is chaotic and deterministic, so it does not change.

Spin as forward and backward in time

The +𝕠d potential spin moves backwards in time with this model, a positron as the +𝕠d and e𝕪 Pythagorean Triangle also moves backwards in time. The electron as the -𝕠d and e𝕪 Pythagorean Triangle has -𝕠d instead of +𝕠d, because these are opposed signs they are subtracted in the atom to give the different orbitals. If these positive and negative terms were arbitrary then the motion backwards and forwards in time would not be conserved.

Positrons and electrons

In this model the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse are deterministic, the time changes on a clock gauge moving backwards and forwards in time respectively. When the positron and electron meet the positron is moving backwards in time, the electron is moving forwards in time. When they annihilate each other they form e𝕪×-𝕘d photons moving forwards in time and +𝕘d×e𝕒 virtual photons moving backwards in time. This conserves the +𝕠d and -𝕠d signs of the particles.

CPT

In this model there is a spin direction, with CPT or Charge Parity and Time all three are from the spin Pythagorean Triangle sides. The charge comes from +𝕠d as the positive potential magnetic field for the proton, and the -𝕠d kinetic magnetic field of the electron. The electron moves forwards in time, the proton moves backwards in time. Parity is in regard to straight Pythagorean Triangle sides, but here they are connected to the spin Pythagorean Triangle sides. Because they are inverses and have a constant Pythagorean Triangle area, the spin sides also determine Parity.

A rod in a mirror as Parity

For example a rod shown in a mirror can be the e𝕪 straight Pythagorean Triangle side, on one end there is a right angle and the spin Pythagorean Triangle side -𝕠d. The rod can spin around -𝕠d like an axle, the e𝕪 side acts like a phasor or spoke of a wheel. When this is viewed in a mirror the e𝕪 rid reverses, but so does the spin direction of the axle. This is then the same as with Charge and Time, the mirroring of Parity changes the spin Pythagorean Triangle sides from plus to minus and vice versa.

Antimatter

With the Pythagorean Equation the proton is +𝕠d and the electron is -𝕠d, these are added together and squared for the left-hand side of the equation as $(+𝕠d^2 \text{ -}𝕠d^2)^2$ or $(+𝕆D\text{-}𝕆D)^2$. When the spin is flipped this gives antimatter as $(\text{-}𝕆D+𝕆D)^2$, the antiproton is the first term and the positron is the second term. With the right-hand side of the Pythagorean Equation it goes from $(+𝕀D\text{-}𝕀D)^2$ to $(\text{-}𝕀D+𝕀D)^2$, the Time direction, Parity and Spin direction also flip.

Central Pythagorean Triangles

The four central Pythagorean Triangles also flip over, the antiproton moves forward in time so the +𝕘d×e𝕒 photon becomes -𝕘d×e𝕒. The e𝕪×-𝕘d photon becomes virtual as e𝕪×+𝕘d, the +𝕘d×e𝕓 Gravi becomes virtual as -𝕘d×e𝕓, and the -𝕘d×e𝕧 Iner becomes +𝕘d×e𝕧.

Conserved spin

In this model a consistent spin direction is needed to conserve the spin Pythagorean Triangle sides, if they were randomly clockwise and counterclockwise then this would be a measurement of work. When not measured the spin direction is undisturbed, because it cannot be random then it must be deterministic. The spin values change with the emission and absorption of e𝕪×-𝕘d photons, also when free electrons collide with e𝕪/-𝕘d photons, if the spin was not in one direction then electrons would not act the same.

Flipping an electron's spin

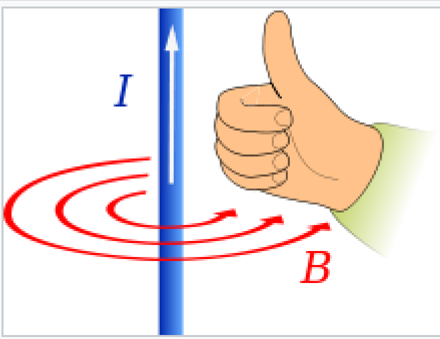
An electron can have its -𝕠d and e𝕪 Pythagorean Triangle flipped over, but this requires a torque as -𝕆D. Then it cannot rejoin a proton to become a neutron unless it is flipped back over and this torque is released, if one electron is flipped over it can make a boson pair in an orbital with this model. It would then need to give up this spin, flipping back over to join with a proton to become a neutron.

Four spin Pythagorean Triangle sides

The four spin Pythagorean Triangle sides form action/reaction pairs, for example if the -𝕠d kinetic magnetic field is clockwise then the -𝕚d inertial mass reacts against this counterclockwise. Then the +𝕚d gravitational mass acts against this clockwise with the +𝕠d potential magnetic field reacting against this counterclockwise. With antimatter this are all reversed.

A current as impulse

In the diagram the current moves from e𝕪 as the kinetic electric charge to e𝕒 as the potential electric charge. Because the electrons are moving outside the atoms this is a E𝕐/-𝕠d kinetic impulse and they act as particles, there is a transverse -𝕠d kinetic magnetic field around the wire. The electrons can still be measured with -𝕆D×e𝕪 kinetic work such as in an electromagnet, then they exhibit quantized behavior such as in the Quantum Hall Effect.



Prediction of direction of field (*B*), given that the current *I* flows in the direction of the thumb

Photons as particles

In this model photons can also move like this, with the e𝕪 phasor being observed with a e𝕐/-𝕘d light impulse. A free electron acts as a particle with E𝕐×-𝕠d, its e𝕪 phasor can interact with the e𝕐/-𝕘d light impulse of a e𝕪/-𝕘d photon in a collision. Measuring the photon as -𝔾D×e𝕪 light work is where it moves as a rolling wheel, then the -𝔾D light torque gives the probabilities of where the photons are.

Interactions with particles

When the electrons move through the wire they can do -𝕆D×e𝕪 kinetic work, absorbing and emitting e𝕪×-𝕘d photons with -𝔾D×e𝕪 light work. They can also collide with e𝕪×-𝕘d photons, this alters the angle θ of the electron and the photon. The electron changes its velocity and the photon its -𝕘d rotational frequency and e𝕪 phasor or wavelength.

Vector addition of charges

The electrons in this model still act as rolling wheels, the e𝕪 kinetic electric charge changes according to the dot product not with plus or minus signs. This would be vector addition, also when the E𝕐/-𝕠d kinetic impulse is observed. Then the vector straight Pythagorean Triangle side would have a squared size, not an area as a -𝕆D field.

Electron orientation

This is a similar orientation to in magnetism, in this model the atoms are oriented as a metal so that some of the electron axles point in the same direction. These have a constructive interference to each other, that attracts more atoms into the same orientation so the magnetism spreads through the material. The stronger the current the more the electron rolling wheels are aligned, that gives a stronger -𝕠d kinetic magnetic field.

Voltage and current

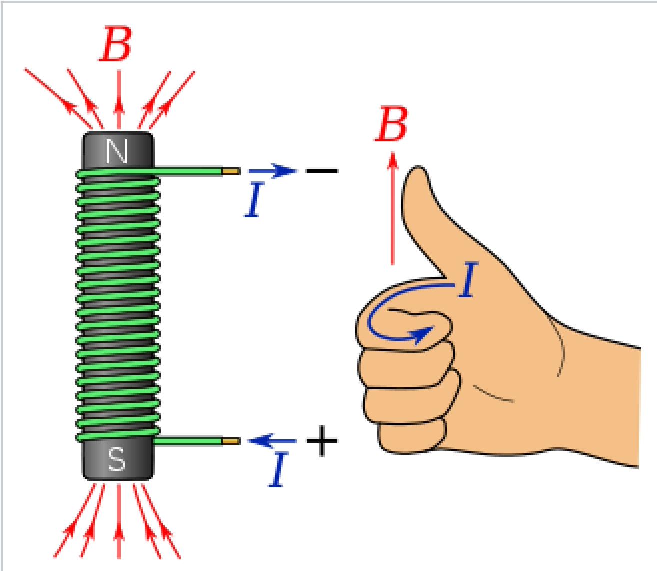
In this model a higher voltage is where the electrons do more -𝕆D×e𝕪 kinetic work, and more like a wave. This has a lower resistance in a wire and so less of the current is lost from resistance. The voltage can be stepped up and down in a transformer, this has a quantized number of coil turns. As the angle θ of the -𝕠d and e𝕪 Pythagorean Triangles changes, the ratio of -𝕆D×e𝕪 kinetic work as voltage and E𝕐/-𝕠d kinetic impulse as current changes inversely.

Electromagnets

The electrons move towards the e𝕒 potential electric charge and so their -𝕠d kinetic magnetic fields add up. When this is measured as -𝕆D×e𝕪 kinetic work the wire can act as an electromagnet. Then the -𝕆D kinetic probability attracts other electrons by their being more probable to be around the wire.

Additional wires in a coil

In this diagram the electron rolling wheels also move through the wire with their axes transverse to the direction of the current. This causes the -𝕠d kinetic magnetic fields to constructively interfere when the -𝕆D×e𝕪 kinetic work is measured, they have the same spin as in neighboring wires so the constructive interference is the same as if they were in an iron magnet. This effect is increased by a magnet being placed in the coil. Because of this constructive interference each electron tends to attract the others into the same orientation, that increase the strength of the magnet.



Finding direction of magnetic field (B) for an electrical coil

Heating a magnet

When the magnet or wire heats up this creates more collisions and E𝕐/-𝕠d kinetic impulse in the wire, that breaks up the -𝕆D×e𝕪 kinetic work and so the magnetic probabilities weaken. This is because e𝕪 acts as the kinetic temperature, a magnet is prone to lose its magnetism when heated because atomic collisions cause some electrons to change their orientation. That causes the constructive interference of the -𝕆D×e𝕪 kinetic work to be increasingly disrupted by different orientations of the electron with a destructive interference.

Weakening a magnet

This causes them to repel each other instead of attracting each other into the same spin. The magnetic effect weakens as the attractions and repulsions, constructive and destructive interference mix together. They can form smaller domains with the same spin from a constructive interference, other domains destructively interfere with a different electron orientation.

The Hall Effect

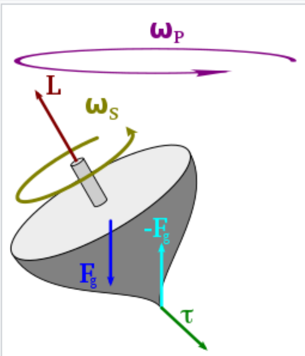
The Hall Effect is where a current passing through a wire also experiences an external magnetic field. This affects the electron rolling wheels, the electrons creating the magnetic field cause there to be a constructive interference on one side of the wire. That causes the electrons to move to that side as the current flows.

Quantized Hall effect

This effect is also quantized because of the -𝕆D×e𝕪 kinetic work, the -𝕆D kinetic probability created by the external magnetic field is the same as in orbitals. That makes integer value orbitals as quantum increments in the -𝕆D kinetic probabilities of what side the electrons are in the current.

Kinetic precession

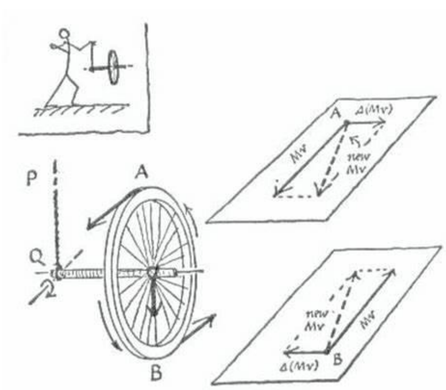
In the diagram a -𝕆D kinetic torque can create a kinetic precession in a material. This happens because of the single direction of the spin in the ground state. On one side of a spinning magnet for example there is a greater probability for the -𝕠d kinetic magnetic field to be there. This causes the electron orbital to tilt in that direction, as the electron standing wave has a changed probability from this added torque it must change. The orbital is quantized and so the number of electrons cannot change, instead it oscillates in a third direction as a kinetic precession. It oscillates because this is -𝕆D×eẏ kinetic work and a force acts as a wave not a particle.



The torque caused by the normal force $-\mathbf{F}_g$ and the weight of the top causes a change in the angular momentum $\mathbf{L}$ in the direction of that torque. This causes the top to precess.

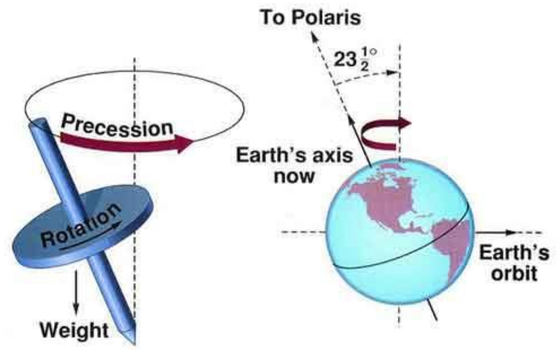
Precession and neutrinos

In this model the neutron would have three orthogonal spin directions, +𝕠d, -𝕠d, and 𝕠d for the antineutrino. Because these are all opposing directions the overall charge of the neutron is neutral. When the antineutrino is emitted this is like a downwards torque on the other two spins, it is similar to a downward push with precession. That would allow the other two spins to separate, the electron spins like a rolling wheel while it revolves around the orbital from precession. In the diagram below the torque on one side of the turning wheel, as the electron, causes it to spin in a circle like the orbital.



Precession and elliptical orbitals

This can also allow for a precession of the +𝕠d potential magnetic field as the axis of the proton. The unbalancing of the neutron from the emission of the antineutrino causes other forces to affect its axis. That allows for elliptical electron orbitals that precess in the +𝕠d potential magnetic field, the oscillations of the electron rolling wheel can be repelled by the circular orbitals. This additional -𝕆D×e𝕪 kinetic work from other electrons would allow the elliptical orbital to form.

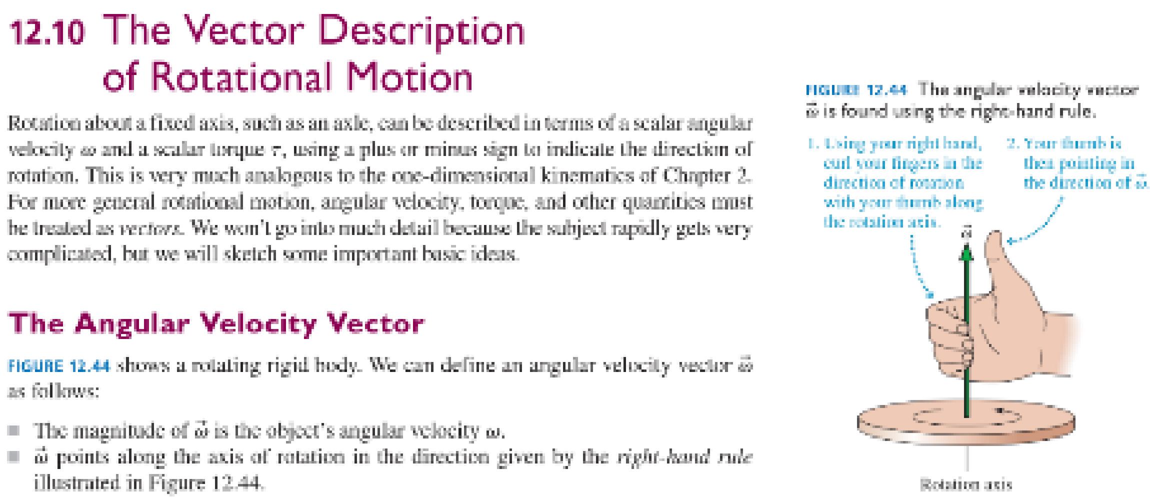


Neutrino mass and magnetic fields

This also happens in Biv space-time where the 𝕠d neutrino magnetic field is proportional to a 𝕚d neutrino mass field. Because this is orthogonal to the +𝕚d gravitational mass and -𝕚d inertial mass it cannot interact with them, neutrinos in this model have spin but no measurable mass. The spin direction has the axis pointing towards or away from the direction of motion, here this is orthogonal to the electron rolling wheel.

Angular velocity

The angular velocity here comes from the rolling wheel model, the a vector shown would be the e𝕒 altitude of a proton. The rotation is the +𝕠d potential magnetic field. The electron also acts like this rolling wheel, but where it would move around the circumference for example as an orbital. The right-hand rule here would give the direction of the innate spin of the proton or electron.


12.10 The Vector Description of Rotational Motion

Rotation about a fixed axis, such as an axle, can be described in terms of a scalar angular velocity ω and a scalar torque τ, using a plus or minus sign to indicate the direction of rotation. This is very much analogous to the one-dimensional kinematics of Chapter 2. For more general rotational motion, angular velocity, torque, and other quantities must be treated as *vectors*. We won't go into much detail because the subject rapidly gets very complicated, but we will sketch some important basic ideas.

The Angular Velocity Vector

FIGURE 12.44 shows a rotating rigid body. We can define an angular velocity vector $\vec{\omega}$ as follows:

- The magnitude of $\vec{\omega}$ is the object's angular velocity ω.
- $\vec{\omega}$ points along the axis of rotation in the direction given by the *right-hand rule* illustrated in Figure 12.44.

FIGURE 12.44 The angular velocity vector $\vec{\omega}$ is found using the right-hand rule.

The cross product

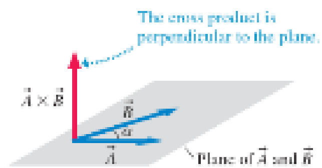
In this model the cross-product vector is set as the spin Pythagorean Triangle side, for example -𝕚d in the -𝕚d and e𝕧 Pythagorean Triangle. A becomes e𝕧 and B becomes ζ as the hypotenuse set to 1. This would give -𝕚d×e𝕧 =e𝕧×ζ×-𝕚d/ζ. The cross product here is not a vector but a field, it is double the integral area of the -𝕚d and e𝕧 Pythagorean Triangle.

The dot product

Taking cosθ instead this would give e𝕧×e𝕧, because e𝕧=-𝕚d as inverses it can be written as e𝕧/-𝕚d or the derivative slope of the Pythagorean Triangle. In this model the dot product acts as a particle, the cross product as an integral. The changing angle θ can then represent a changing velocity of a particle, this gives vector addition as the magnitude of the vector changes also as E𝕍 or e𝕧×e𝕧.

The Cross Product of Two Vectors

FIGURE 12.45 The cross product $\vec{A} \times \vec{B}$, is a vector perpendicular to the plane of vectors $\vec{A}$ and $\vec{B}$.



We defined the torque exerted by force $\vec{F}$ to be $\tau = rF \sin\phi$. The quantity F is the magnitude of the force vector $\vec{F}$, and the distance r is really the magnitude of the position vector $\vec{r}$. Hence torque looks very much like a product of the two vectors $\vec{r}$ and $\vec{F}$. Previously, in conjunction with the definition of work, we introduced the dot product of two vectors: $\vec{A} \cdot \vec{B} = AB\cos\alpha$, where α is the angle between the vectors. $\tau = rF\sin\phi$ is a different way of multiplying vectors that depends on the *sine* of the angle between them.

FIGURE 12.45 shows two vectors, $\vec{A}$ and $\vec{B}$, with angle α between them. We define the **cross product** of $\vec{A}$ and $\vec{B}$ as the vector

$$\vec{A} \times \vec{B} = (AB\sin\alpha, \text{ in the direction given by the right-hand rule}) \qquad (12.46)$$

The symbol $\times$ between the vectors is *required* to indicate a cross product. The cross product is also called the **vector product** because the result is a vector.

The **right-hand rule,** which specifies the direction of $\vec{A} \times \vec{B}$, can be stated in three different but equivalent ways:

Commutative rule

This integral area does not obey the commutative rule, this is because the Pythagorean Triangle can be flipped over so -𝕚d points in the opposite direction. With -𝕀D×e𝕧 inertial work then this would move to the left or right. This also does not commute because the Pythagorean Triangle has a constant area, flipping the -𝕚d and e𝕧 Pythagorean Triangle over here must give a different measured -𝕆D×e𝕪 kinetic work.

Three generations of iotas

In this model there can be three orthogonal Pythagorean Triangles, in the proton there would be three +𝕠d and e𝕒 Pythagorean Triangles and in the electron three -𝕠d and e𝕪 Pythagorean Triangles. These allow for three generations of iotas as particles or fields, the first +𝕠d and e𝕒 Pythagorean Triangle can undergo a +𝕆D potential torque to move +𝕠d into an orthogonal direction and a larger value.

Conserving torque

This is because the +𝕆D potential probability must be conserved, it cannot be contained in the constant Pythagorean Triangle area and so a second larger +𝕠d and e𝕒 Pythagorean Triangle is formed. The first +𝕠d and e𝕒 Pythagorean Triangle has the up and down quarks as +𝕠d, d=2/3 and -𝕠d, d=1/3. When there is +𝕆D×e𝕒 potential work done this causes the quarks to flip orthogonally to become strange and charm quark. A third torque creates a larger +𝕠d and e𝕒 Pythagorean Triangle as top and bottom quarks.

Three generations

Because these are the only three orthogonal Pythagorean Triangles that can fit there are only three generations. When these top and bottom quarks decay they can move back to charm and strange, then up and down. A pair of quarks can cross the generations such as with a meson composed of a top and anti-strange quark. This would give the positive Kaon a +𝕠d value of d=1.

Quaternions

The changing of the spin Pythagorean Triangle side to an orthogonal side is compatible with quaternions, that would move as î to ĵ to k̂. An orthogonal change in direction with spin would need work to be done, when this is positive there is a potential torque or probability of +𝕆D, when negative there is a kinetic torque or probability of -𝕆D. The electron comes from -𝕠d as the down quark, it is a difference of -𝕠d as d=1 when a bottom quark as -𝕠d, d=1/3, flips to a +𝕠d top quark, d=2/3. The difference between these is +1 which becomes the proton, the electron is ejected as -1. The flipping of a quark occurs with a gluon with a boson value of 1 like the photon.

Gluons and photons

A gluon would act as 1 binding together the +𝕠d, d=2/3 and -𝕠d, d=1/3, quarks. This acts like a e𝕪×-𝕘d photon in between a +𝕠d value of a proton and a -𝕠d electron in the changing of an orbital. This would be an increment of 1 as h between orbitals as -𝕠d ×e𝕐/-𝕠d, the change in the -𝕠d×e𝕪/-𝕠d as the kinetic momentum is observed as a E𝕐/-𝕠d kinetic impulse. A jump in an orbital is a change of 1 because the orbitals are quantized, the -𝕆D×e𝕪 kinetic work has -𝕆D as an integer. This is because a fraction would be impulse as a derivative.

The nucleus and waves

Because work only occurs with integer values, not fractions, the nucleus has a more limited ability to act as waves of probability. In this model the gluons can act as ±1 in between the 2/3 and 1/3 quarks, also mesons can have a ±1 value in mediating the strong force.

Three degrees of freedom

Because there are three possible +𝕠d and e𝕒 Pythagorean Triangles orthogonal to each other, this gives different possible gluon interactions. The three Pythagorean Triangles exist as +𝕠d potential probabilities for the 2/3 quarks and -𝕠d kinetic probabilities for the 1/3 quarks. Because there is no force the quarks are not moving to higher generations with torque. Instead there are three different degrees of freedom the +𝕠d and e𝕒 Pythagorean Triangle can be in, the e𝕒 and +𝕠d Pythagorean Triangle sides remain orthogonal in each case. That gives three different +𝕠d and e𝕒 Pythagorean Triangles, then each e𝕒 Pythagorean Triangle side can have two other possible +𝕠d Pythagorean Triangle sides to give nine combinations.

Chromodynamics

Similar combinations are given colors of red, green, and blue in conventional physics, those colors are unrelated to the colors used in this model. They also give the combinations as below, this is called chromodynamics in conventional physics. A flipping of a -𝕠d, d=1/3, bottom quark to a +𝕠d, d=2/3, top quark is a change of 1 like a photon, the gluon would act with a constant Pythagorean Triangle area doing gluon work. It can also be observed as a particle with a gluon impulse.

- red-antired ($r\bar{r}$), red-antigreen ($r\bar{g}$), red-antiblue ($r\bar{b}$)
- green-antired ($g\bar{r}$), green-antigreen ($g\bar{g}$), green-antiblue ($g\bar{b}$)
- blue-antired ($b\bar{r}$), blue-antigreen ($b\bar{g}$), blue-antiblue ($b\bar{b}$)

Each e𝕒 straight Pythagorean Triangle side can then have a +𝕠d spin Pythagorean Triangle side, this gives three possible +𝕠d and e𝕒 Pythagorean Triangles as red, green, and blue. That also gives three possible -𝕠d and e𝕪 Pythagorean Triangles in the nucleus as electrons that can be emitted, these would be -1 and so would be antired, antigreen, and antiblue. Other combinations such as red and antigreen are +1 and -1 as well giving nine in all. The interactions between the +1 and -1 values are the only ones possible for work and probability, fractions can only act as particles in this model. These different probabilities give the color interactions.

The strong force

Because the gluons connect the +𝕠d and -𝕠d Pythagorean Triangle side they are related to the strong force, this is between a neutron and a proton. The difference between the two is -𝕠d, d=1, so neutrons are attracted to protons by sharing the -1 value like an electron between them. This is called a meson. There is also a +1 value as a positive meson, the attractions between protons and neutrons act as ±1, the gluons mediate the difference between the +𝕠d up, charm, and strange quarks with the -𝕠d down, strange, and bottom quarks.

Proton neutron attraction

A neutron would then have one +𝕠d, d=2/3, Pythagorean Triangle side and two -𝕠d, d=1/3, sides. A proton has two +𝕠d sides and one -𝕠d side making it +𝕠d, d=1. The -𝕠d, d=1, in the neutron is then attracted to the proton. In this model that is why neutrons in a nucleus makes it more stable.

Mesons

The strong force is mediated by mesons, these are where +𝕠d, d=2/3 and an antiquark +𝕠d, d=1/3 can act as +1 with a positive pion. There is also a negative pion adding to -1, they act like the proton and electron in exerting a probability on each other. This makes the protons and neutrons more likely to be found together, acting as the strong force. The negative pion as -𝕠d, d=1 can decay into a muon then an electron. The neutral pion can decay as the difference between the positive and negative pion into e𝕪×-𝕘d photons.

Gluons and mesons

In this model the gluons and mesons each have increments of 1, instead of acting as e𝕪×-𝕘d photons they are restricted to interactions between +2/3 and -1/3, or -2/3 and +1/3. These fractions come from derivative slopes, because -𝕆D×e𝕪 kinetic work can only occur with integral whole numbers they cannot be measured as being stable outside the nucleus.

Meson decay

Because of this they decay quickly as particles. They exist for short times on a clock gauge, this acts like moments of time with their impulse. They have no wave nature and so they have no attractions and repulsions as forces outside the nucleus with their ±1 values. That is because one is a difference between quarks that are fractions, not as separate integer values like electron and photons.

Exponential decay and mesons

Meson decay approximately follows an exponential decay curve, this comes from a constant Pythagorean Triangle area and a squared straight Pythagorean Triangle side. The larger this meson impulse the shorter their life on a clock gauge.

The cross product has three important properties:

1. The product $\vec{A} \times \vec{B}$ is *not* equal to the product $\vec{B} \times \vec{A}$. That is, the cross product does not obey the commutative rule $ab = ba$ that you know from arithmetic. In fact, you can see from the right-hand rule that the product $\vec{B} \times \vec{A}$ points in exactly the opposite direction from $\vec{A} \times \vec{B}$. Thus, as FIGURE 12.48a shows,
$$\vec{B} \times \vec{A} = -\vec{A} \times \vec{B}$$
2. In a *right-handed coordinate system*, which is the standard coordinate system of science and engineering, the z-axis is oriented relative to the xy-plane such that the unit vectors obey $\hat{\imath} \times \hat{\jmath} = \hat{k}$. This is shown in FIGURE 12.48b. You can also see from this figure that $\hat{\jmath} \times \hat{k} = \hat{\imath}$ and $\hat{k} \times \hat{\imath} = \hat{\jmath}$.
3. The derivative of a cross product is
$$\frac{d}{dt}(\vec{A} \times \vec{B}) = \frac{d\vec{A}}{dt} \times \vec{B} + \vec{A} \times \frac{d\vec{B}}{dt} \qquad (12.47)$$

Cross product is not a vector

In this model the cross product does not give a vector, this is because it spins rather than moves in a straight Pythagorean Triangle side direction. It is associated with an integral area here as $\vec{A} \times \vec{B}$. The red line would spin like an axle, the straight Pythagorean Triangle side would spin around it like a spoke of a wheel. The hypotenuse would connect the two.

Three different axles

That gives the rolling wheel model of the electron and the e𝕪×-𝕘d photon, it also allows for a corkscrew motion where the spin is along the direction of motion. Then the phasor would spin to the side, the neutrino may be a Marjorana fermion here, that is where it is its own antiparticle. It would be 𝕠d which has no sign, that would means it is neither positive or negative. The proton would have a spin axis like a planet, this is another version of the cross product spin Pythagorean Triangle side.

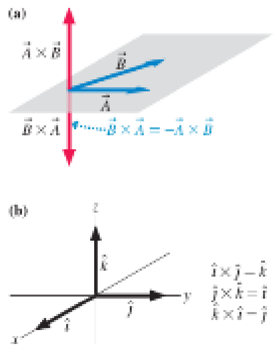
Three cross products

Together these give three orthogonal spin directions and three cross products. These can be regarded as the quaternions î, ĵ, and k̂ when they fit together into a neutron. The quaternions in this model also refer to three generations of quarks and leptons, an additional -𝕆D kinetic torque with the electron would reach a quantized limit.

Precession and three generations

Then it would turn orthogonally as the precession overcome the original spin direction, that gives a second generation lepton as the muon, then again with the tau electron.

FIGURE 12.48 Properties of the cross product.



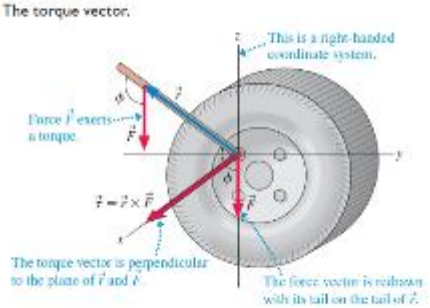
The torque as an axle

In this diagram the torque acts as an axle, the wrench would be the spin Pythagorean Triangle side. When -𝕆D kinetic torque is used, from burning food as fuel, the central -𝕆D kinetic axle has an angular acceleration. This is reacted against by the -𝕀D inertial torque, and by the +𝕆D potential torque of the molecular bonds between the nut and the thread. There would also be a +𝕀D gravitational torque where the handle is pulled downwards by gravity.

Sine and cosine

The angle θ of the -𝕠d and e𝕪 Pythagorean Triangle with the active force -𝕆D is sinθ here. If cosθ then this observes impulse, like pushing on the handle in a straight-line. The straight this push is the smaller the rotational force is, the two Pythagorean Triangle sides change inversely because of the constant Pythagorean Triangle area.

FIGURE 12.49 The torque vector.



You can see that the scalar torque $\tau = rF\sin\phi$ we've been using is really the component along the rotation axis—in this case τ_x—of the vector $\vec{\tau}$. This is the basis for our earlier sign convention for τ. In Figure 12.49, where the force causes a ccw rotation, the torque vector points in the positive x-direction, and thus τ_x is positive.

Angular momentum

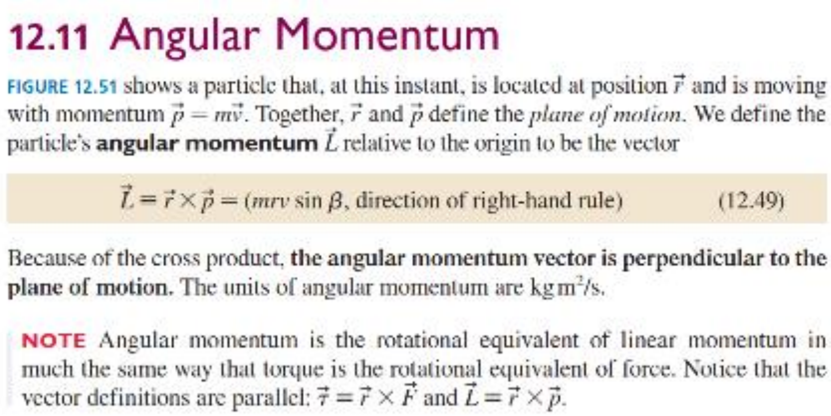
In this model the potential angular momentum is +𝕠d×e𝕒/+𝕠d and the gravitational angular momentum is +𝕚d×e𝕙/+𝕚d. The electron also has a kinetic angular momentum as -𝕠d×e𝕪/-𝕠d because it moves like a rolling wheel, this has an inertial angular momentum as -𝕚d×e𝕧/-𝕚d. The e𝕪×-𝕘d photon has a light angular momentum of -𝕘d/×e𝕪/-𝕘d, the +𝕘d×e𝕓 Gravi has a Gravi angular momentum of +𝕘d×e𝕓/+𝕘d. Each acts like a wheel, the spin Pythagorean Triangle sides as axles.

Angular momentum and circular geometry

In conventional physics the potential and gravitational momentum are referred to as angular momentum, also as rotational dynamics. Inside the atom the +𝕠d potential magnetic field is stronger, this makes the potential angular momentum stronger than the potential linear momentum, in this model they are both +𝕠d×e𝕒/+𝕠d. This allows for the proton to have a E𝔸/+𝕠d potential impulse such as in a particle accelerator. In this model the atom represents circular geometry, the proton captures the electron with its hyperbolic geometry.

Linear momentum and hyperbolic geometry

Outside the atom the linear kinetic momentum dominates, the electron acts more like a particle with a E𝕐/-𝕠d kinetic impulse than doing -𝕆D×e𝕪 kinetic work. Hyperbolic geometry is stronger which leads to Special Relativity as its E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse increase towards c.



12.11 Angular Momentum

FIGURE 12.51 shows a particle that, at this instant, is located at position $\vec{r}$ and is moving with momentum $\vec{p} = m\vec{v}$. Together, $\vec{r}$ and $\vec{p}$ define the *plane of motion*. We define the particle's **angular momentum** $\vec{L}$ relative to the origin to be the vector

$$\vec{L} = \vec{r} \times \vec{p} = (mrv \sin\beta, \text{ direction of right-hand rule}) \qquad (12.49)$$

Because of the cross product, **the angular momentum vector is perpendicular to the plane of motion.** The units of angular momentum are $kg\,m^2/s$.

NOTE Angular momentum is the rotational equivalent of linear momentum in much the same way that torque is the rotational equivalent of force. Notice that the vector definitions are parallel: $\vec{\tau} = \vec{r} \times \vec{F}$ and $\vec{L} = \vec{r} \times \vec{p}$.

Angular momentum is not a vector

In this model the angular momentum is not a vector, it is composed of a straight Pythagorean Triangle side as part of a vector and a spin Pythagorean Triangle side as part of a field. When the derivative of the -𝕚d and e𝕧 Pythagorean Triangle is taken this gives e𝕧/-𝕚d as a vector, the direction of a particle's motion is given by the straight Pythagorean Triangle side. The e𝕧 length of a vector is given in relation to -𝕚d inertial time, this allows for a vector to change with an E𝕍/-𝕚d inertial impulse. The same applies to the other Pythagorean Triangles here.

Angular momentum and a clock face

The angular momentum is composed of the -𝕚d×e𝕧 segment, that gives a field not a particle. Because of this it is not a vector, instead the -𝕚d inertial axle sweeps out an area with the e𝕧 phasor. That comes from the area if the -𝕚d and e𝕧 Pythagorean Triangle, the area is like the face of a clock gauge. With the e𝕧/-𝕚d segment of the inertial momentum this acts as a particle, that is the clock part where the hands rotate to give -𝕚d inertial time.

Kepler's law

Together they give Kepler's Law with a circle or an ellipse, sweeping out an equal integral area as a field in equal times with a particle or clock hand. The sweeping out of areas comes from the potential momentum and the proton, the +𝕠d period of the e𝕒 phasor's motion also gives the +𝕠d potential time of an orbital. The +𝕠d and e𝕒 Pythagorean Triangle then sweeps out a field area +𝕠d×e𝕒 of an orbital with a period e𝕒/+𝕠d as the potential speed.

Momentum is not observed or measured

Together these are called the potential momentum, because it is not observed or measured it can be either. That is because there is no force, when this is measured it is +𝕆D×e𝕒 potential work and when observed it is E𝔸/+𝕠d potential impulse.

Cross product as a change in angle

In the diagram the cross product is shown as the difference in angle of two vectors. With the E𝕍/-𝕚d inertial impulse it can represent a collision of particles and the change in angle θ between them. This is a rotation and so the cross product gives the -𝕀D inertial torque between them.

Dot product as a change in velocity

Conversely the dot product between vectors gives the change in their size, this comes from the E𝕍/-𝕚d inertial impulse. The dot products can be added up as changes in the sizes of vectors, in this model vector addition has no plus and minus signs. That is because only the spin Pythagorean Triangle sides are positive and negative.

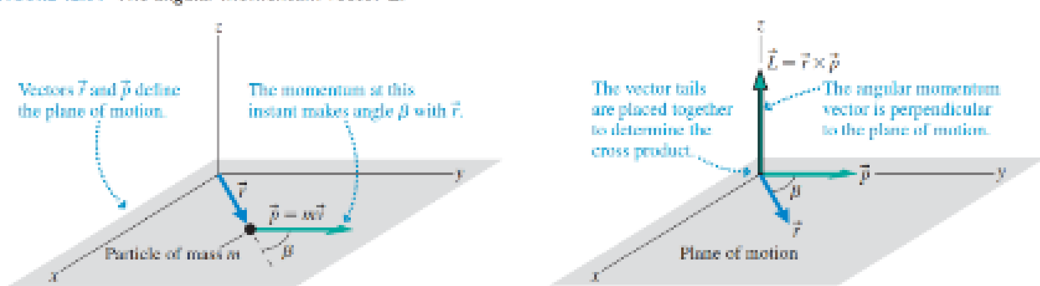
Measuring torque in a collision

The changes in the dot product also have the angle θ but the torque is not measured, instead the change in the E𝕍/-𝕚d inertial impulse gives a change in velocity e𝕧/-𝕚d as a particle. The changes in the cross product are the torque from the collision, this can also change for example between two pool balls where one is spinning. Because of this the -𝕀D inertial torque can be different from the E𝕍/-𝕚d inertial impulse, that is because the ball's spin adds a force to the collision. Then the Pythagorean Triangle areas are no longer conserved.

Cross product and momentum

In this model the cross product is shown as an area, the two vectors are a e𝕧 length as r and a momentum as -𝕚d×e𝕧/-𝕚d. Multiplying these together gives E𝕍 as a vector, but in this model the -𝕀D value would be the inverse of this with a constant Pythagorean Triangle area as 1/-𝕀D. When two balls collide their angles θ after the collision can be observed as the E𝕍 inertial displacement in the E𝕍/-𝕚d inertial impulse, or as the -𝕀D inertial torque in -𝕀D×e𝕧 inertial work.

FIGURE 12.51 The angular momentum vector $\vec{L}$.



Dot product and momentum

The dot product can also be found by taking two vectors, then drawing a line from the end of the longest one as the hypotenuse ζ of the -𝕚d and e𝕧 Pythagorean Triangle. This goes down onto the shorter one as e𝕧 to give a right angle. This can also be regarded as a change in momentum, the larger vector would have a larger velocity and inertial momentum.

Dot product is the inverse of the cross product

This change is the inverse of the cross product after an increase in inertial momentum, this is shown in the diagram above. That is because for the same hypotenuse ζ and a constant Pythagorean Triangle area sinθ as -𝕚d/ζ is the inverse of cosθ as e𝕧/ζ, or e𝕧/-𝕚d is a constant. Increasing the cross product then decreases the dot product inversely and vice versa.

Sinθ and cosθ as inverses

The dot product gets e𝕧 when dropping a line from the end of ζ, that particular case gives the -𝕚d and e𝕧 Pythagorean Triangle. Because this is multiplying the two sides by cosθ, and sinθ is the inverse, then the cross product gives the spin Pythagorean Triangle side as -𝕚d. This applies when the two vectors are not Pythagorean Triangle sides, they can then be broken up into multiple Pythagorean Triangles where the dot or cross products are added up using Pythagoras's Theorem.

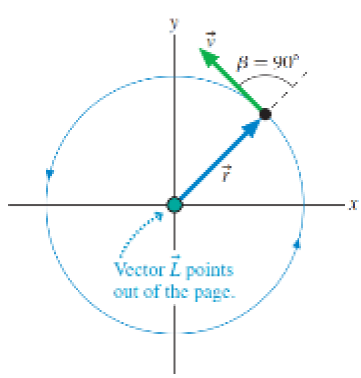
The position of L

In the diagram the +𝕠d and e𝕒 Pythagorean Triangle as the proton is shown, this can also be the +𝕚d and e𝕙 Pythagorean Triangle as gravity. Here the radius would be the straight Pythagorean Triangle side e𝕒 for the proton and e𝕙 for gravity, the L spin Pythagorean Triangle side points out from the page. In this model L would be at the end of the radius where v⃗ is shown, that gives the +𝕠d potential magnetic field and the +𝕚d gravitational field values at that e𝕒 altitudes and e𝕙 height.

L as an axis

The value is the same, when L is at the center it represents the turning axis of the +𝕠d and e𝕒 Pythagorean Triangle proton. It would also represent gravity where a planet revolves around a +𝕚d gravitational axis. That makes these Pythagorean Triangles rolling wheels.

FIGURE 12.52 Angular momentum of circular motion.



Conservation of work

This conserved angular momentum comes from the constant Pythagorean Triangle area. With no net torque in Biv space-time there is no overall -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work. A conservation of linear momentum would be where the E𝕍/-𝕚d inertial impulse and Eℍ/+𝕚d gravitational impulse were conserved.

Conservation of Angular Momentum

A net torque on a rigid body causes its angular momentum to change. Conversely, the angular momentum does *not* change—it is *conserved*—for a system with no net torque. This is the basis of the law of conservation of angular momentum.

> **Law of conservation of angular momentum** The angular momentum $\vec{L}$ of an isolated system ($\vec{\tau}_{net} = \vec{0}$) is conserved. The final angular momentum $\vec{L}_f$ is equal to the initial angular momentum $\vec{L}_i$. Both the magnitude *and* the direction of $\vec{L}$ are unchanged.

Angular momentum and speed

Here L = I as the moment of inertia times the angular velocity is the same format as the potential momentum +𝕠d×e𝕒/+𝕠d and the gravitational momentum +𝕚d×e𝕙/+𝕚d. This is because in this model the moment of inertia acts as a +𝕚d gravitational mass, as +𝕠d the potential magnetic field also acts like a mass. When this is in a derivative then it is like +𝕚d gravitational time and +𝕠d potential time.

Velocity and speed

In conventional physics velocity refers to speed in a particular direction as a vector, in this model that is the straight Pythagorean Triangle side. When the derivative is taken such as e𝕧/-𝕚d then this would be in a straight direction e𝕧 for an inertial time -𝕚d. With a force the velocity would become the E𝕍/-𝕚d inertial impulse. Speed has no particular direction, instead it refers to the time taken.

An integral speed

Speed refers to the spin Pythagorean Triangle side as the time taken, here that relates to an integral field. With inertial momentum for example as -𝕚d×e𝕧/-𝕚d the e𝕧/-𝕚d segment would be velocity, this is from taking the derivative. The -𝕚d×e𝕧 segment can be regarded as speed, a faster speed is where e𝕧 dilates and -𝕚d contracts.

The speed of light

In this model the -𝕚d and e𝕧 Pythagorean Triangle relates to Special Relativity. When -𝕚d×e𝕧 is taken as the inertial speed, this can have the -𝕀D inertial temporal history dilate with a higher speed. That causes e𝕧 to contract as the length of a rocket approaching c. When e𝕧/-𝕚d is taken as a velocity then the E𝕍 inertial displacement history increases approaching c, then the -𝕚d inertial time slows on a clock gauge.

Velocity and speed in Special Relativity

When velocity and speed are separated they can represent two different aspects of Special Relativity, when the inertial speed is a field then the -𝕀D inertial temporal history is a field of probability. When the inertial velocity is a particle then the E𝕍 inertial displacement history is in one direction, then the -𝕚d inertial time slows on a clock.

An orbit has no straight direction

When a satellite is in an orbit then there is no straight direction as a vector, a satellite would move with an orbital period and the e𝕧 lengths would be the circumference of the orbit circle. A larger inertial speed would be closer to the planet, then the -𝕚d inertial period decreases because the satellite would orbit a planet faster.

A changing speed

The -𝕚d and e𝕧 Pythagorean Triangle orbiting a planet would not have e𝕧 as the circumference, instead its e𝕧 length remains constant as does its -𝕚d inertial mass. It is balanced by the e𝕙/+𝕚d gravitational speed from the planet, because the forces are -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work then speed would refer to -𝕚d×e𝕧 and +𝕚d×e𝕙 here.

Speed as an enclosed field

The speed then represents an integral field because it has no direction, it encompasses an area inside the orbit. When the e𝕙/+𝕚d gravitational speed acts on the satellite this is from the +𝕚d gravitational mass or field, this is also an integral area.

Avoiding confusion with speed and velocity

To avoid confusion by redefining velocity and speed, this model refers to e𝕧/-𝕚d as velocity as it is usually referred to. Other fractions such as e𝕒/+𝕠d are the potential speed, because there is no measurement or observation it can also be written as a superposition of +𝕠d×e𝕒 as a time-based positional speed.

> The good news is that the analogy *does* continue to hold in two important situations: the rotation of a *symmetrical* object about the symmetry axis and the rotation of any object about a fixed axle. For example, the axis of a cylinder or disk is a symmetry axis, as is any diameter through a sphere. In these two situations, the angular momentum and angular velocity are related by
>
> $$\vec{L} = I\vec{\omega} \qquad \text{(rotation about a fixed axle or axis of symmetry)} \qquad (12.55)$$
>
> This relationship is shown for a spinning disk in **FIGURE 12.54**. Equation 12.55 is particularly important for applying the law of conservation of angular momentum.

Symmetry and rotation

In this model a Pythagorean Triangle can be rotated without changing its Pythagorean Triangle sides or angle θ, for example the -𝕠d and e𝕪 Pythagorean Triangle as an electron in the ground state with Hydrogen. Because this rotates without changing the Pythagorean Triangle it gives a symmetry, if a circular field has this symmetry then the -𝕠d and e𝕪 Pythagorean Triangle cannot change with a force. With a satellite around a planet the -𝕚d and e𝕧 Pythagorean Triangle also has rotational symmetry when it has no forces.

Rolling wheels and symmetry

This symmetry also comes from the rolling wheel model of the proton as the +𝕠d and e𝕒 Pythagorean Triangle, the electron as the -𝕠d and e𝕪 Pythagorean Triangle, and the neutrino as the 𝕠d and 𝕨 Pythagorean Triangle.

Width

In this model 𝕨 stands for width, but this does not mean in classical mechanics width is created by neutrinos. Instead width is an illusion from the combinations of e𝕙 height from gravity and e𝕧 length from inertia in all directions.

Height, length, and width in the neutron

Inside the neutron there would be these three orthogonal directions, the e𝕒 altitude becomes separated in the proton and is proportional to the e𝕙 height. The e𝕪 kinetic electric charge becomes separated as the electron and is proportional to the e𝕧 length. The 𝕨 width is the third orthogonal direction, this is ejected as the neutrino in the 𝕠d and 𝕨 Pythagorean Triangle.

Three orthogonal gyroscopes

When three gyroscopes are joined orthogonally to each other then they can resist precession in any direction. When only two are joined they can still precess. For example A has a vertical axis, this could precess as shown below. A second gyroscope B is mounted orthogonally, this can act like the electron as a rolling wheel around the proton as A. It is also like a moon acting as a rolling wheel around a rotating planet, each resists precession in some directions but they can both precess in others.

No precession

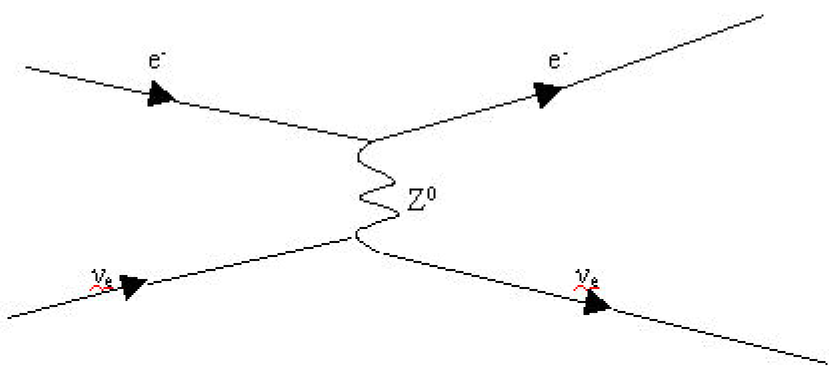
With three gyroscopes there can be no precession, B and C would be mounted so they spin on the equator of gyroscope A. When A tries to precess it is prevented in both directions by B and C, therefore taking B or C vertically the same happens.

No precession in a neutron

In this model the proton as the +𝕠d and e𝕒 Pythagorean Triangle acts as a rolling wheel, so does the -𝕠d and e𝕪 Pythagorean Triangle in an orthogonal direction. The neutrino has the third orthogonal direction with its spin, the neutron then is stable because it resists the forces of precession. When the neutron decays the neutrino is lost, the proton and electron can then precess with the various orbitals. The electron can spin around the proton where both are rolling wheels like a planet and its moon.

The neutrino's forces

This exerts no neutrino torque in this model because it is orthogonal to the other two Pythagorean Triangles, without the neutrino there can be a precession such as in the Hydrogen atom. Because torque here is probability the orthogonal spin directions gives no constructive or destructive interference between a neutrino and the proton or electron. It can collide with particles in some situations with a 𝕠d×ℕ neutrino impulse. This is because outside the atom an iota, such as a proton, electron, and neutrino has more impulse. They rotate less, the proton by itself is less like a wave and so there are no electrons around it.

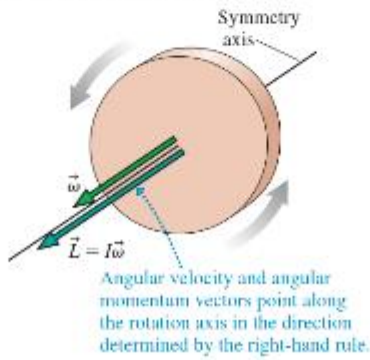


A collision between and electron and a neutrino.

Width and W bosons

The 𝕨 and 𝕎 symbols are not to be confused with the W boson, they represent the third dimension of width orthogonal to height and length.

FIGURE 12.54 The angular momentum vector about an axis of symmetry.



Circular and hyperbolic geometry

In this model the equations below are equivalent, on the left they mainly refer to the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity. These mainly do work because they are in circular geometry, the two on the right are the electron as the -𝕠d and e𝕪 Pythagorean Triangle and inertia as the -𝕚d and e𝕧 Pythagorean Triangle. They are in hyperbolic geometry.

Changing from angular to linear

Each can change sides in different circumstances, the proton can have a E𝔸/+𝕠d potential impulse as linear motion, proportionally there is the Eℍ/+𝕚d gravitational impulse. The electron can act as a wave with a double slit experiment doing -𝕆D×e𝕪 kinetic work with an E𝕍/-𝕚d inertial impulse.

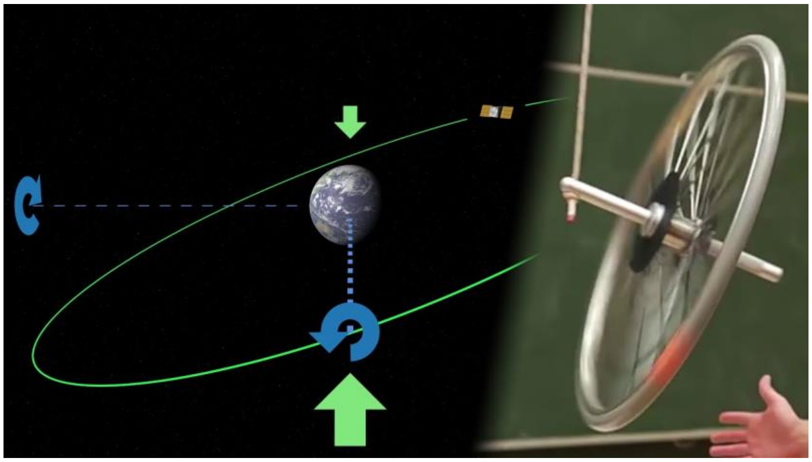
TABLE 12.4 Angular and linear momentum and energy

Angular motion	Linear motion
$K_{rot} = \frac{1}{2}I\omega^2$	$K_{cm} = \frac{1}{2}Mv_{cm}^2$
$\vec{L} = I\vec{\omega}$ *	$\vec{P} = M\vec{v}_{cm}$
$d\vec{L}/dt = \vec{\tau}_{net}$	$d\vec{P}/dt = \vec{F}_{net}$
The angular momentum of a system is conserved if there is no net torque.	The linear momentum of a system is conserved if there is no net force.

*Rotation about an axis of symmetry.

Precession and probability

In this model rotation comes from the spin Pythagorean Triangle sides, torque is equivalent to probability. Precession is created by destructive interference, a gyroscope spins doing -𝕀D×e𝕧 inertial work. In the diagram below the gyroscope is supported on one end, there is then a +𝕀D gravitational probability on one side of it. The gyroscope spins with a -𝕀D inertial probability doing -𝕀D×e𝕧 inertial work.



Orbits and probability

When a satellite is in orbit around a planet it does -𝕀D×e𝕧 inertial work. That is subtracted from the +𝕀D×e𝕙 gravitational work of the planet, the -𝕀D inertial probability is subtracted from the +𝕀D gravitational probability. This gives an overall attraction where the probability is higher with constructive interference, a repulsion where it is lower with destructive interference.

Planetary precession

A planet can also experience precession of its axis, the star it revolves around has a +𝕀D gravitational probability that adds to the -𝕀D inertial probability of the planet's rotation. The planet also has a -𝕀D inertial probability in its orbit around the star.

Relative -𝕀D inertial probability

The planet does -𝕀D×e𝕧 inertial work with its rotation, the part of the planet moving away from the star has a different +𝕀D-𝕀D overall probability than the part moving towards the star as the planet spin. This difference in probability is the same as in throwing a ball in the air, then the +𝕀D gravitational probability makes it more likely the ball will fall. The -𝕀D inertial probability makes it more probable the ball will continue upwards, if this is strong enough the ball can escape orbit. If not, then it will fall in a parabolic trajectory.

Changing inertial probabilities

The sides of the planet also have different -𝕀D inertial probabilities in relation to the star. The side moving towards the star is like a ball falling downwards, its -𝕀D inertial probability is weaker and so that planet side is attracted towards the star like the ball is attracted to the planet. The side of the planet moving away from the star has a stronger -𝕀D inertial probability in relation to the star, because of this the overall +𝕀D-𝕀D probability is weaker on that side.

Axial tilt

This tends to create a +𝕀D gravitational and -𝕀D inertial torque on the planet, the imperfections in its shape would cause one side to tip over creating an axial tilt. This is from +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work so it is quantized, the motion of this tilt usually forms a resonation with other planets and moons. The seasons on the planet are created by this tilt, the poles often precess at around the same rate as the planet's orbit around the star.

Elliptical orbits and precession

This can also create elliptical orbits, the changes in the precession of the planet cause denser areas to be periodically closer to the star. For example, with Mars there are higher areas such as Tharsis, and lower areas such as Hellas. When the higher areas are closer to the star then there is a higher +𝕀D-𝕀D probability for the planet to move closer to it. When the lower areas are closer to the star then the overall +𝕀D-𝕀D probability is lower, the planet can then oscillate back and forward in an ellipse.

Precessing the axis and orbit

The axial tilt can then precess from the +𝕀D×eℍ gravitational work and -𝕀D×e𝕍 inertial work, also the orbit can also become elliptical. This orbit can also precess around the star so the seasons on the planet vary. When a pole is pointing towards a star when closest to it then the summer will be hotter, when the pole is pointing towards a star when further away the summer will be cooler.

Three-body problem

This also acts like a resonation because this is work, the +𝕀D-𝕀D probabilities form regular precessions not chaotic as with impulse. There can be resonations of these probabilities with other planets and moons, if their spins cancel out part of the planet's motion then it can become less quantized and more chaotic. This happens in the three-body problem.

Relativistic precession

A planet would also experience precession from General and Special Relativity, moving towards a star its Eℍ gravitational displacement history and +𝕀D gravitational temporal history increase. That causes the closer parts of the orbit to have a eℍ height contraction and a +𝕚d gravitational time slower than the orbit further away. The slowing of the orbit closer to the star causes that segment to lag behind, the orbit further away precesses faster. That causes the ellipse to also turn around the star.

Displacement and temporal history

The inertial speed of the planet is related to its -𝕀D×e𝕍 inertial work, its velocity to its E𝕍/-𝕚d inertial impulse. When the planet is moving faster towards the star it experience an increase in its E𝕍 inertial displacement and -𝕀D inertial temporal history. That causes a e𝕍 length contraction of the planet and its -𝕚d inertial time slows. This creates an additional precession in the orbit.

Constant areas are relativistic

In this model the constant areas of the +𝕚d and eℍ Pythagorean Triangles and -𝕚d and e𝕍 Pythagorean Triangles are relativistic, when the angles θ are changed in the orbit then this automatically gives the correct eℍ and e𝕍 contraction, also the +𝕚d gravitational and -𝕚d inertial time slowing. By modeling Pythagorean Triangles on different parts of the planet the precessions can also be accurately calculated, also the orbital resonations with other planets and moons.

Proton precession

In this model a proton as the +𝕠d and e𝕒 Pythagorean Triangle can also undergo precession, this allows for elliptical orbitals. External work is done by other electrons on each other, this causes a constructive and destructive interference with the -𝕆D kinetic probabilities. These are subtracted from the +𝕆D potential probabilities of the proton.

Approaching c in an atom

A lower energy level can then be in an elliptical orbital along with circular orbitals, this is the same as in Biv space-time with elliptical and circular orbits of planets and moons. These elliptical orbitals can precess around the proton because of the kinetic velocity e𝕪/-𝕠d and inertial speed e𝕧/-𝕚d of the electron approaches ≈ 1/137 of c as α.

Frame dragging and precession

When closer to the proton there is a +𝕠d potential time slowing, this acts like a frame dragging as in General Relativity.

Atomic resonations and precessions

The different orbitals must also maintain a quantization and resonations between the electrons, these interfere constructively and destructively with each other.

Larmour precession

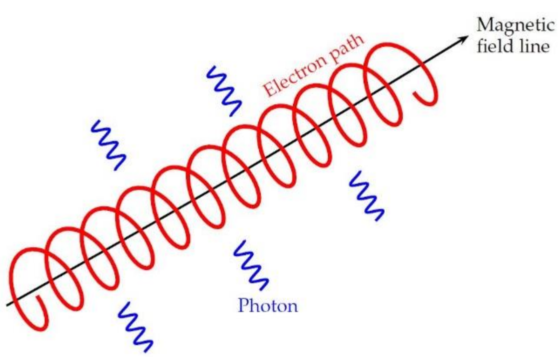
The electron can also precess in an external magnetic field, this is called the Larmour precession and is related to α as an angle.

Kinetic probabilities and interference

The electron has a -𝕠d kinetic magnetic field around it, when measured this gives a -𝕆D kinetic probability from constructive and destructive interferences. These can be like in a Fourier analysis, the different probable positions of the electron cancel out to give a measurement of -𝕆D×e𝕪 kinetic work.

Helical motion

When the electron is in an external magnetic field the different -𝕆D kinetic probabilities change like with the planet and its -𝕀D inertial probability. One side of the electron is rotating away from the magnetic field, this has more of a destructive interference. The other side is rotating towards the magnetic field, that has less of a destructive interference as a repulsion and so the electron curves in that direction. This can create a helical motion as shown in the diagram.



Magnetization and probability

In this model the magnetic field lines come from the e𝕪 Pythagorean Triangle side, the electron in an iron magnet have some of their spins in the same direction as each other. This adds up their spins with constructive interference, that gives a higher -𝕆D kinetic probability of attracting an unmagnetized piece of iron brought closer to the magnet. Then its -𝕆D kinetic probabilities are changed so they line up more with the magnet.

Dampened precession in a magnet

The constructive interference makes it more likely the spins are aligned with each other, precessions are dampened by so many electrons spins reducing the degrees of freedom to a single direction.

Decaying electrons

This is similar to in a neutron with this model, three orthogonal spins dampen the precession from external probabilities preventing the neutron from being broken up. When a lone neutron is no longer shielded in an atom then the precession probabilities can cause the three orthogonal spins to undergo interference. This makes it more probable they would have a different position, that acts as attractive and repulsive forces that cause the neutron to decay.

Magnetic attraction

When two magnets are moved towards each other, a north south alignment is where the electrons are spinning in the same direction for example clockwise. This causes their -𝕆D kinetic probabilities to interfere destructively, the two magnets are then attracted to each other because there is a higher probability of their being together.

Magnetic repulsion

When the north is placed next to north, or south to south, then the electron spins are opposed clockwise to counterclockwise in appearance. This is because a spinning object from underneath appears to have say clockwise spin, but counterclockwise on top of it. These spins in the magnets interfere destructively, this gives a lower -𝕆D kinetic probability of their staying together which pushes them apart.

A lone electron

The lone electron measures the -𝕆D×e𝕪 kinetic work done by the electrons in the magnet, with their spins in one direction say clockwise. The electron can have a different orientation, the -𝕆D kinetic probabilities on the different sides of the electron measure constructive and destructive -𝕆D probabilities.

Inertial mass and precession

This causes the electron to precess, because of its -𝕀D inertial probability the electron oscillates rather than pointing in the same direction as the magnet's electrons all the time. That is because of its -𝕚d inertial mass which is conserved, the electron undergoes an attraction and repulsion from the -𝕆D kinetic probabilities as it overshoots an alignment because of its -𝕀D inertial probability.

Helical motion

The electron would then move in a helix, according to how it was spinning the magnet's -𝕆D kinetic probabilities attract and repel it into the helix trajectory. This is similar to electrons in different orbitals causing each other to precess, the helical motion is the same as a circular or elliptical orbital motion except that it is constrained by the proton's +𝕆D potential probability.

Gyroscopic precession

In the book diagram below one side of the gyroscope is mounted, the other side is attracted more by the +𝕀D gravitational probability and so the gyroscope is attracted downwards. It also spins with a -𝕀D inertial probability, this is subtracted from the +𝕀D gravitational probability so the gyroscope does not fall downwards. The side of the gyroscope moving upwards has a stronger -𝕀D inertial probability, this is like a ball being thrown and moving upward. The side of the gyroscope has a weaker -𝕀D inertial probability, this is like the ball moving downwards after its -𝕀D inertial probability was increasingly lost to the +𝕀D gravitational probability.

Precession direction

This causes a +𝕀D gravitational probability on one side that is stronger, also the -𝕀D inertial probability on that side is weaker. The gyroscope then precesses in that direction. It reacts less with its -𝕀D inertia on that side and so it can move more easily on one side than the other.

Photon precession

A photon also curves around a planet or star because of precession according to this model, its -𝕘d rotational axis is destructively interfered with on one side. This is proportional to a -𝕚d inertial mass and so the e𝕪×-𝕘d photon is surrounded with a -𝔾D light probability. When the photon reaches an atom, its absorption depends on the -𝕀D inertial probability of the electrons in their orbitals.

Light probability

The photon has it moves closer to a star measures a larger +𝕀D gravitational probability and the star's +𝕀D×e𝕙 gravitational work. This interferes destructively with the photon's -𝔾D light probability, that is because it must remain proportional to the -𝕀D inertial probability of the electrons.

Photon probability and absorption

So the photon curves towards the +𝕀D gravitational probability, it is more likely to be found closer to the star. That means when absorbed by an electron the photon has maintained a quantized value with the electron's -𝕀D inertial probability as well as its -𝕆D kinetic probability.

Quantized gravitational temporal history

In this model General Relativity has a +𝕀D gravitational temporal history in between atoms, a e𝕪×-𝕘d photon emitted has this history which must be quantized. That is because a spin Pythagorean Triangle side must be a whole number, otherwise it is a derivative fraction as impulse. This history must be conserved, the e𝕙 height differences in between the starting and final atoms are synchronized with a height contraction.

Quantized inertial temporal history

In this model Special Relativity has a -𝕀D inertial temporal history between the same atoms, the relative inertial speeds of those atoms would mean there is a different e𝕧 length contraction with the electrons emitting and absorbing the photons. Because -𝕀D is quantized then the photon can be absorbed with a e𝕪 kinetic electric charge contraction and e𝕧 length contraction depending on the temporal history.

Quantization and impulse

If this did not happen then photons could not be absorbed in many cases, the changing inertial speeds of the atoms, and -𝕘d rotational frequencies of the photons would no longer be quantized. Also photons might be emitted and absorbed at different e𝕙 heights which also can slow their -𝕘d rotational frequency. This happens with impulse, an electron outside the atom can collide with e𝕪/-

𝕘d photons. This changes the -𝕘d rotational frequency of the photons without quantization, it can give a continuous spectrum.

12.12 ADVANCED TOPIC Precession of a Gyroscope

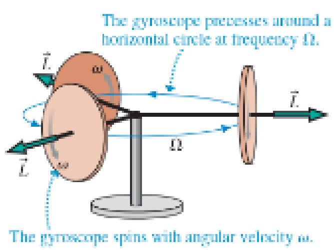
Rotating objects can exhibit surprising and unexpected behaviors. For example, a common lecture demonstration makes use of a bicycle wheel with two handles along the axis. The wheel is spun, then handed to an unsuspecting student who is asked to turn the spinning wheel 90°. Surprisingly, this is *very hard to do*. The reason is that the angular momentum is a *vector*, so the wheel's rotation axis—the direction of $\vec{L}$—is highly resistant to change. If the wheel is spinning fast, a *large* torque is required to turn the wheel's axis.

We'll look at a related example: the precession of a gyroscope. A **gyroscope**—whether it's a toy or a precision instrument used for navigation—is a rapidly spinning wheel or disk whose axis of rotation can assume any orientation. As it spins, it has angular momentum $\vec{L} = I\vec{\omega}$ along the rotation axis. A navigation gyroscope is mounted in gimbals that allow it to spin with virtually no torque from the environment. Once its axis is pointed north, conservation of angular momentum will ensure that the axis continues to point north no matter how the ship or plane moves.

We want to consider a horizontal gyroscope, with the disk spinning in a vertical plane, that is supported at only one end of its axle, as shown in FIGURE 12.57. You would expect it to simply fall over—but it doesn't. Instead, the axle remains horizontal, parallel to the ground, while the entire gyroscope slowly rotates in a horizontal plane. This steady change in the orientation of the rotation axis is called **precession,** and we say that the gyroscope precesses about its point of support. The **precession frequency** Ω (capital Greek omega) is much less than the disk's rotation frequency ω. Note that Ω, like ω, is in rad/s.

You might object that angular momentum is not conserved during precession. This is true. The *magnitude* of $\vec{L}$ is constant, but its *direction* is changing. However, angular momentum is conserved only for an isolated system, one on which there is no net torque. The spinning gyroscope is *not* an isolated system because gravity is exerting a torque on it. Indeed, understanding the relationship between the gravitational torque and the angular momentum is the key to understanding why the gyroscope precesses.

FIGURE 12.57 A spinning gyroscope precesses in a horizontal plane.



Gravitational field and gravitational time

In this model the area around a sun has a +𝕚d gravitational field, this also acts as +𝕚d gravitational time. The angular gravitational speed is e𝕙/+𝕚d where the planet is below, the inverse of this is the e𝕧/-𝕚d inertial speed. This is a speed rather then velocity because the trajectory is curved, it comes from -𝕀D×e𝕧 inertial work not the E𝕍/-𝕚d inertial impulse.

Gravitational speed as an integral

The gravitational angular speed can also be written as an integral area, this is +𝕚d×e𝕙. Because equal areas are swept in equal times this means area/time is a constant, that is e𝕙×+𝕚d/+𝕚d which is a constant for a circle. With an ellipse the gravitational speed varies, when the e𝕙 height increases then the +𝕚d gravitational field decreases inversely.

Gravitational momentum

This formula is the same as the gravitational momentum rearranged as +𝕚d×e𝕪/+𝕚d, in the higher parts of the ellipse the +𝕚d gravitational field weakens in the same proportion as the +𝕚d gravitational time elapsed.

No Eℍ or E𝕍 force

The +𝕚d gravitational time is then smaller in the narrower arc when e𝕙 increases, this maintains the same ratio e𝕙×+𝕚d/+𝕚d. This is a consequence of there being no forces in the elliptical orbit, the +𝕀D×e𝕙 gravitational work done has an inverse with the -𝕀D×e𝕧 inertial work cancelling out the +𝕀D gravitational torque with the -𝕀D inertial torque at that e𝕙 height. There no Eℍ or E𝕍 force because the torque forces are canceled out.

Free fall at a e𝕙 height

A person on a rocket in this elliptical orbit would be in free fall with their E𝕍/-𝕚d inertial impulse and be weightless with their -𝕀D×e𝕧 inertial work. If Kepler's Law was not true then there would be an additional force with e𝕙, that would give the Eℍ/+𝕚d gravitational impulse and the person would feel these forces in the elliptical orbit.

FIGURE 13.1 The elliptical orbit of a planet about the sun.

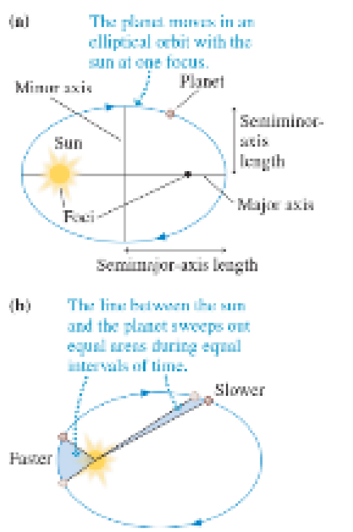
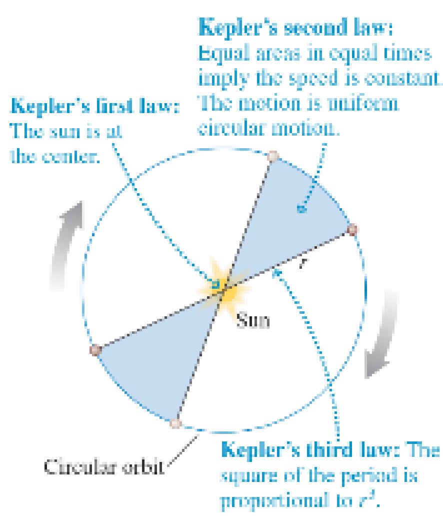


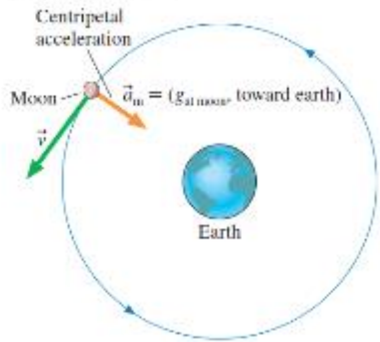
FIGURE 13.2 A circular orbit is a special case of an elliptical orbit.



Free fall and weightlessness

In this model free fall refers to the Eℍ/+𝕚d gravitational impulse, this is because falling is over a distance. Weightlessness is measuring compression on a spring scale, because of this it refers to the +𝕀D×e𝕙 gravitational work here.

FIGURE 13.3 The moon is in free fall around the earth.



Gravitational impulse between two objects

In this model the forces change with the Eℍ/+𝕚d gravitational impulse, this gives the r^2 between the two objects. The Eℍ gravitational displacement is the same between the two objects, the difference is the +𝕚d gravitational time. If one has a larger +𝕚d gravitational mass than the other, such as the planet and moon, then the denominator value as +𝕚d for the moon will be smaller.

Relative gravitational speed

This makes the Eℍ/+𝕚d gravitational impulse fraction have a stronger force for the planet, that has more +𝕚d and e𝕙 Pythagorean Triangles for the same Eℍ gravitational displacement. If both were at rest in space then the moon would move faster towards the planet than vice versa. Because the moon's Eℍ/+𝕚d gravitational impulse has a smaller +𝕚d gravitational mass, then Eℍ as the gravitational displacement is larger and the Moon accelerates faster towards the Earth.

Gravitational work

When there are two masses these are both +𝕚d, multiplied together this gives +𝕀D and the gravitational probability. Because the only force is the attraction between them then the +𝕀D×e𝕙 gravitational work comes from +𝕚d$_1$×+𝕚d$_2$, this gives the gravitational probability that they will come closer together.

This force is the same for the planet and the moon because it is +𝕚d$_1$×+𝕚d$_2$ for both. This equal force is +𝕀D from +𝕀D×e𝕙 gravitational work, this uses a e𝕙 height not the Eℍ height squared so this is not the Eℍ/+𝕚d gravitational impulse.

Impulse as an inverse of gravitational mass

There are then two different forces here in this model, the Eℍ/+𝕚d gravitational impulse causes one object to accelerate more than the other if it has less +𝕚d gravitational mass. This is because the +𝕚d and e𝕙 Pythagorean Triangle has a constant area, when +𝕚d is smaller then e𝕙 and Eℍ are larger with a greater gravitational acceleration.

Work and orbits

The +𝕀D×e𝕙 gravitational work is equal between both objects. This is because the e𝕙 height in +𝕀D×e𝕙 gravitational work is not a force, Eℍ in the Eℍ/+𝕚d gravitational impulse is a force. The +𝕀D gravitational probability is not a straight-line force between the planet and moon like Eℍ, instead it represents the likely orbit between them. The +𝕀D×e𝕙 gravitational work can give the attraction between a planet and a moon in orbit around it. If they are both stationary then the Eℍ/+𝕚d gravitational impulse gives a straight-line motion towards each other, the trajectory would usually be a mixture of both.

Inertial work between blocks

An action/reaction pair here is where there is an active gravitational force and a reactive inertial force. When a planet attracts a moon there is an equal and opposite inertial reaction against this with -𝕀D×e𝕧 inertial work. When block 1 is pushed by block 2 on a flat frictionless surface then the -𝕀D×e𝕧 inertial work done as a reaction against this is -𝕚d_1×-𝕚d_2×e𝕧 where e𝕧 is the length the blocks are pushed. Because there are no other forces between the blocks the -𝕀D×e𝕧 inertial work is a combination of both of them, just as with the +𝕀D×e𝕙 gravitational work between the planet and moon.

Inertial work inside objects

When block 1 is pushed this force also goes through the molecules in both blocks, the push comes from -𝕆D×e𝕪 kinetic work to move the blocks a distance e𝕪 and proportionally a length e𝕧. The electrons also react with -𝕀D×e𝕧 inertial work against this push in all directions, that cancels out the -𝕀D inertial probabilities so there is no net -𝕀D×e𝕧 inertial work in any direction inside a block.

Compression of a block

The exception to this would be if the block was compressed by the push, such as with two sponges. Then -𝕆D×e𝕪 kinetic work can be done in pushing into a block a distance e𝕪, reacting against this would be -𝕀D×e𝕧 inertial work where e𝕧 is the length the block is pushed in by.

Constructive and destructive interference

When these -𝕀D inertial probabilities are opposed, along with -𝕆D kinetic probabilities, they interfere destructively as equal and opposite reactions. Even though the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work are both negative these are opposed, the -𝕆D kinetic probability is destructively interfered with by the -𝕀D inertial probability.

Inertial impulse and velocity

The E𝕍/-𝕚d inertial impulse between the blocks is different to -𝕀D×e𝕧 inertial work, if the two blocks bounce off each other when giving this force then the one with the smallest -𝕚d inertial mass moves faster. This is because a E𝕐/-𝕠d kinetic impulse does not push in a block a distance on a scale, instead it is observed as moments on a clock gauge.

Elastic and inelastic collisions

With no squared spin Pythagorean Triangle side there is no probability, the blocks would bounce apart with an elastic collision. With only -𝕀D×e𝕧 inertial work there is an inelastic collision, then the two blocks would stick together. With a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse the two blocks would tend to collide elastically, as would a planet and moon.

Deep and shallow impacts

This can happen when the moon or an asteroid continues onward after the collision, that is more likely when the force is closer to a straight-line with a shallow impact. With photons a e𝕐/-𝕘d light impulse is also where they bounce off a sheet of glass at a shallow angle, this is related to θ in the glass molecules and the photon frequencies as -𝕘d. The trajectory is closer to a hyperbola and the photons remain in hyperbolic geometry.

Work and impulse with light

When the angle θ is deeper then the light does more -𝔾D×e𝕪 light work with the -𝔾D light torque bending it into the glass. That also makes it more likely to be absorbed by electrons. With a moon approaching a planet at a deep angle θ, then the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work would tend to absorb the moon with an impact to make a larger planet.

Work leading to planetary accretion

With a moon moving faster towards a planet there is a preservation of different velocities with impulse, with work this becomes speed which is no longer in a straight direction. A moon can then retain a speed going around a planet, as e𝕧/-𝕚d then e𝕧 can be regarded as the circumference and -𝕚d as the inertial time for a complete orbit. If the moon inelastically collides then the impact force can be radiated in all directions, that is destructively interfered with by the inertia of the planet and the moon would become part of it.

Relative velocity

When the two blocks collide block 2 might have a smaller -𝕚d inertial mass than block 1. Then the -𝕚d inertial mass in the denominator of the E𝕍/-𝕚d inertial impulse is smaller, the constant area of the -𝕚d and e𝕧 Pythagorean Triangle means E𝕍 as the inertial displacement of block 2 is larger than block 1. After the blocks collide then block 1 has a faster velocity e𝕧/-𝕚d.

Coulomb force and equal charges

This also applies to the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron. In between these two there is the Coulomb force, the charge between them in conventional physics is the same like the -𝕀D gravitational force between the planet and the moon. This comes from the +𝕆D×e𝕒 potential work from the proton and its inverse as the -𝕆D×e𝕪 kinetic work of the electron. In between them there is only one force, this is +𝕠d×-𝕠d which in this model is an attractive force.

The Coulomb force as a constant

Because the work between the proton and electron is +𝕠d_p×-𝕠d_e then this remains a constant, as if d increases by 1 with the proton it decreases by 1 in the electron. That makes the Coulomb force a constant.

Equal charges from the magnetic field

In conventional physics the proton and electron are described as having equal charges to each other. In this model that would come from the magnetic fields not the electric charge. The angles θ in the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse between the proton and the electron must be conserved, that is even though work is the main force between them. The inverse of this constant magnetic field between the proton and electron is the electric charge, which in this model is also a constant.

A consistent history between atoms

The proton and electron act as waves between each other, but the impulse must remain consistent between them. That is because the electron can be ejected from the atom with a E𝕐/-𝕠d kinetic impulse, then the E𝕐 kinetic displacement history must be consistent in its past. For example, the electron may have been captured from another atom and the e𝕪×-𝕘d photons emitted and absorbed must be consistent when also regarded as e𝕐/-𝕘d light impulse.

The electron orbits the proton

Because of this impulse the electron is in an orbital around the proton, they do not rotate around each other equally with this equal charge each has. The electron has a smaller -𝕚d inertial mass compared to the proton, proportionally it has a smaller -𝕠d kinetic magnetic field.

Center of mass

In between the proton's +𝕚d gravitational mass and the electron's -𝕚d inertial mass there is a center of mass, they both orbit about this. That must also be consistent with the electric charges and magnetic fields, if not then there would be a force in a direction opposing this center of mass. The +𝕠d_p×-𝕠d_e is a constant, it is also proportional to the +𝕚d_p×-𝕚d_e.

Height and length to the center of mass

These constants have a center which comes from the straight Pythagorean Triangle sides, in Biv space-time an orbit of a moon around a planet has this +𝕚d_p×-𝕚d_m center of mass, this is a e𝕙 height above the planet and from there a e𝕧 length to the moon. It is also the inverse of +𝕚d_p×-𝕚d_m where e𝕙 is the inverse of +𝕚d_p and -𝕚d is the inverse of -𝕚d_m, it is also called the center of gravity but in this model it is the center between the gravitational and inertial masses.

Center of charge

In the Hydrogen atom the electron can be in an orbital, there is a e𝕙 height and a e𝕧 length between their center of gravitational and inertial mass. There is also a center of charge where e𝕒 as the potential electric charge comes up from the proton and e𝕪 as the kinetic electric charge comes down from the electron. In between two opposing charges it is neutral, that is also seen in electrostatics.

Straight flux

In the diagram below the shapes might have an equal e𝕒 potential electric charge and e𝕪 kinetic electric charge coming in and out of the shapes, this is called an electric straight flux from straight Pythagorean Triangle sides. In Biv space-time around a center of mass, such as a LaGrange point between a planet and moon, it can also be regarded as having a gravitational and inertial straight flux between them.

Proton height and electron length

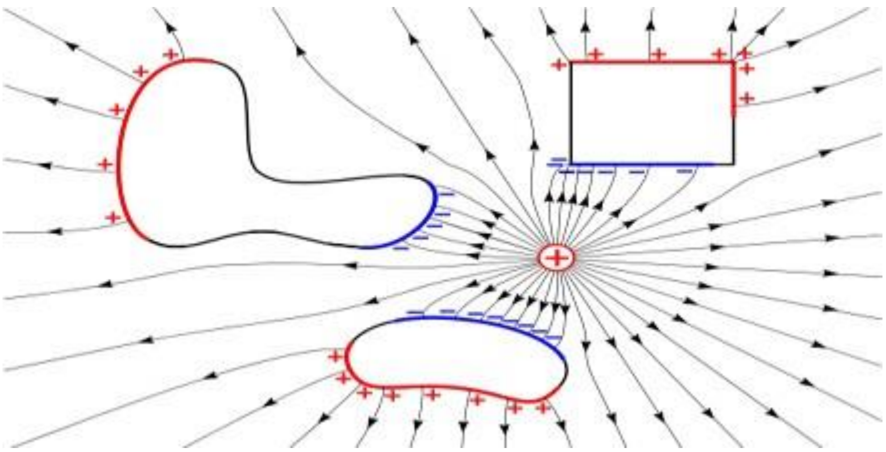
In this model the electron appears as a point particle with no radius, this is because in hyperbolic geometry it has no e𝕙 height only a e𝕧 length. This can be used to observe its E𝕍/-𝕚d inertial impulse, but without a e𝕙 height there is no radius to observe. Instead, there is an increasing uncertainty when it is confined in a smaller e𝕧 length such as a particle in a box. Then the -𝕀D×e𝕧 inertial work makes it act as a wave, the increased -𝕀D inertial probability comes from the uncertainty principle.

Quantization around an electron

Measuring closer to the electron also creates a quantization of -𝕆D as the kinetic probability and -𝕀D as the inertial probability. This makes virtual electrons appear as probabilities around it, α gives the probabilities because it is partially made up of β as 1/√2π from a Gaussian. This is part of the same quantization between a proton and an electron, there the +𝕆D potential probability is added to the electron's -𝕆D kinetic probability.

Spin flux

Also in the diagram there would be a +𝕠d potential magnetic field and -𝕠d kinetic magnetic field orthogonal at each point as a spin flux, also referred to as curl when there is work being done. In Biv space-time there would also be a gravitational and inertial spin flux, here this would be from the wave nature of the spin Pythagorean Triangle sides.



Flux as a flow

Taking the concept of flux as a flow, this implies a connection between the straight and spin Pythagorean Triangle sides. For example a flow might be e𝕧/-𝕚d where e𝕧 is the straight length and -𝕚d is the inertial spin.

Velocity as a straight-line motion

A straight flux would be a velocity, this is where the motion is observed with impulse. There can be a kinetic velocity, a potential speed, an inertial velocity typically just called velocity, and a gravitational velocity. In most cases the line between velocity and speed is not fixed, an electron might have a kinetic velocity from observing its E𝕐/-𝕠d kinetic impulse. It might then have a kinetic velocity in measuring its -𝕆D×e𝕪 kinetic work through a double slit in an experiment. An iota then could not have a velocity and speed in the same time and position.

Speed as a circular motion

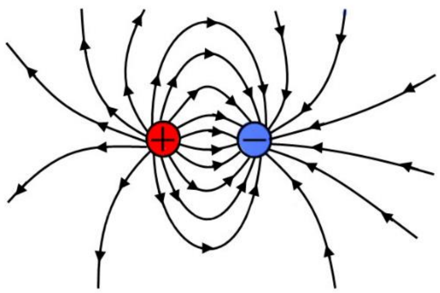
A spin flux would be a speed measured as curl or work, there can be a potential speed, a kinetic velocity, an inertial speed, and a gravitational speed. A speed represents a field, for example a satellite in orbit around a planet has an inertial speed, this is approximately the area bounded by the circumference of the orbit as e𝕧 and the period of the orbit as -𝕚d in inertial time. It can also be regarded as the -𝕚d and e𝕧 Pythagorean Triangle at the satellite with a wave nature in rotating around the planet. There would also be a gravitational speed from the e𝕙 height and the +𝕚d gravitational time, at the satellite this is equal to -𝕚d as the gravitational and inertial period of the orbit.

Lines of flux

In this model they would be Pythagorean Triangle sides, as a Pythagorean Triangle moves it can trace out straight flux lines such as an electric charge from e𝕒 and e𝕪. It can also trace out curl lines from +𝕠d as the potential magnetic field and -𝕠d as the kinetic magnetic field. This is not when they are observed or measured, generally they could be by following these lines.

Flux density

The flux density is where there can be more force, with a proton below there is a concentration of e𝕒 Pythagorean Triangle sides closer to it. With the electron there is a concentration of e𝕪 Pythagorean Triangle sides closer to it. The magnetic flux is orthogonal because there is a right angle between the straight and spin Pythagorean Triangle sides, this makes them denser around the proton and electron. In this model they are where a spin Pythagorean Triangle side might be with a probability in work, also where a straight Pythagorean Triangle side can possibly be in impulse.



Flux density in Biv

There can also be a gravitational and inertial flux density in this model. A gravitational field around a planet makes it more likely a satellite will move to a lower e𝕙 height, if there were many satellites they would be denser there. Orthogonal to each satellite in these lower orbits there would be more +𝕀D×e𝕙 gravitational work being done from this denser +𝕚d gravitational field there.

The history of the flux density

Here e𝕙 is the inverse of +𝕚d so where +𝕚d is small then the corresponding e𝕙 height is higher up, the density at a lower e𝕙 height would come from the Eℍ gravitational displacement history where they had moved lower to this area of higher density. The +𝕀D gravitational temporal history would be where they had moved lower over a +𝕚d gravitational time into this denser region. A flux density in this model can refer to histories, whether the satellites moved into a denser area or where they are not being observed or measured there.

Displacement and temporal history

This comes from the Eℍ/+𝕚d gravitational impulse where Eℍ is the gravitational displacement history but +𝕚d is not being observed, instead it is a series of moments on a clock gauge to make the observation in reference to. With +𝕀D×e𝕙 gravitational work there is a +𝕀D gravitational temporal history of where the satellites came from, this is measured in reference to an unmeasured scale as e𝕙.

Flux in relativity

The distinction is important in relativity, where there is a high Eℍ gravitational displacement history then +𝕚d gravitational time is slowed. This might be near a black hole where the satellites were pulled towards it from larger e𝕙 heights than a planet could do. Also, with a large +𝕀D gravitational temporal history there is a e𝕙 height contraction, then the powerful +𝕚d gravitational field of the black hole also pulled in more satellites than a planet could.

An observed or measured flux

A force in relation to a flux then can give an observation with impulse or a measurement with work. The flux can also exist without being observed or measured, then it has no history but only acts as a scale and clock gauge.

Proportional centers of mass and charge

The center of mass is closer to the proton than the electron, this is because the +𝕆D×e𝕒 potential work done by the proton is stronger than the -𝕆D×e𝕪 kinetic work done by the electron. The +𝕆D potential probability is larger than the -𝕆D kinetic probability, this makes it less likely the electron can move away from the proton. Because the Pythagorean Triangle sides are inverses this means e𝕒 is smaller near the proton, the electron would be closer to it and so would the center of mass and charge.

Schrodinger's equation

This means the electron's E𝕐/-𝕠d kinetic impulse when observed, such as in Schrodinger's equation, must give a motion consistent with having a much smaller -𝕚d inertial mass than the proton's +𝕚d gravitational mass. Because e𝕒×e𝕪 is a constant does not mean they are the same sized charge, just as a planet and moon do not have the same +𝕚d gravitational mass if they attract each other equally.

Static electricity where electrons move

For example, with static electricity a rod can be charged to be positive, in this model that comes from the e𝕒 potential electric charge of the proton having fewer electrons. This attracts a negatively charged balloon to the rod, but the electrons in the balloon move onto the same side as the wand. The protons in the wand do not move more towards the balloon, nor do the protons in the balloon move to the side away from the wand. The proton has a larger e𝕒 potential electric charge than the electron's e𝕪 kinetic electric charge, just as the proton has a larger +𝕚d gravitational mass than the electron's -𝕚d inertial mass.

An electron current moves towards protons

This is the same as the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse between the moon and the planet, the moon moves towards the planet more than vice versa. In Roy electromagnetism the electrons move in a current between a +𝕆D potential difference and a -𝕆D kinetic difference. While there is an equal +𝕠d_p×-𝕠d_e constant between a proton and an electron, they have different velocities.

Modeling electrons as a fluid

In a plasma both the proton and electron would move in opposite directions with a voltage, the electron would move faster. In a metal wire the proton acts more like a solid embedded in molecules, the electron acts more like a liquid. This allows for an electron current to be modeled as a liquid.

The electron moves faster than the proton

The electron moves faster when closer to the proton when in an orbital. A moon moves faster around a planet than a planet does around the moon. This is from the electron's and moon's greater E𝕍/-𝕚d inertial impulse than the proton's and the planet's Eℍ/+𝕚d gravitational impulse. The larger denominator in the proton's and planet's impulse reduces their velocity.

Moving positive charges as a convention

Originally it was thought the positive charges moved, this is still a convention in physics. The electrons have a smaller -𝕚d inertial mass than the +𝕚d gravitational mass of the proton, in this model they have a smaller e𝕪 kinetic electric charge than the e𝕒 potential electric charge of the proton.

Equal inertia

With Biv space-time the gravitational attraction between the planet and moon is equal, this would mean the -𝕀D×e𝕧 inertial work between them is also equal. The planet and the moon then would have the same -𝕀D inertial probability or torque between them as $-𝕚d_m$×$-𝕚d_p$. The planet has a larger -𝕀D inertial probability that drags along the moon with it around the sun. The moon has an E𝕍/-𝕚d inertial impulse larger than the planet so it can move faster to orbit the planet and also follow it.

Equal gravitation and inertia

Because the -𝕀D×e𝕧 inertial work is subtracted from the +𝕀D×e𝕙 gravitational work then these remain equal to each other as inverses. The result is they move in a gravitationally weightless state in relation to each other with +𝕀D×e𝕙 gravitational work. They also move in an inertially weightless state in relation to each other with -𝕀D×e𝕧 inertial work.

Water tides and a tidal bulge

The water tides on a planet come from the Eℍ/+𝕚d gravitational impulse of the moon, these move the water with a faster inertial velocity towards the moon. There can also be a tidal bulge on a moon from the planet's Eℍ/+𝕚d gravitational impulse so that the higher parts of it point continuously towards the planet. This is because the highest parts are closer to the planet, they are observed to have a larger Eℍ/+𝕚d gravitational impulse like in the water tides. These tides can also heat a moon when orbiting a larger planet.

The planet has more gravity and more inertia

In terms of the Eℍ/+𝕚d gravitational impulse these forces are not equal, just as they are unequal with the E𝕍/-𝕚d inertial impulse. The planet has more protons so its +𝕚d gravitational mass is larger, it also has more electrons so its -𝕚d inertial mass is larger as well. The planet then drags the moon along more with a Eℍ/+𝕚d gravitational impulse because it has more +𝕚d gravitational mass. Its path is less affected by the moon because it has more -𝕚d inertial mass. Its e𝕙/+𝕚d gravitational speed is then less affected in its solar orbit than the gravitational speed of the moon.

Equal weightlessness and unequal freefall

With the equal gravitational and inertial weightlessness there is an unequal gravitational and inertial free fall. This is where the moon falls faster towards the planet in free fall than the planet does towards the moon. If this were not so then the planet and moon would orbit each other like they had the same +𝕚d gravitational mass, also the star would orbit them the same way. That would become like a three-body problem where the center of mass between them was at a midpoint.

Different g values

Because of this a ball would fall faster towards the planet than the moon with the Eℍ/+𝕚d gravitational impulse and the E𝕍/-𝕚d inertial impulse. They remain weightless because of the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work between the planet and the moon.

Inertia and g

This gives a different g value, in this model that would also give a proportional inertial value as the different Inertias of the planet and moon. This is because the E𝕍/-𝕚d inertial impulse has to balance the Eℍ/+𝕚d gravitational impulse, or a falling person would experience freefall while moving downwards. Their inertia might then slow their fall or increase the acceleration as it conflicts with g. This inertial value for an object, such as the planet or moon, also has to balance the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work otherwise they would experience a feeling of weight upwards or downwards while falling.

Inertia between planets, moons, and stars

The inertial free fall is also different with the E𝕍/-𝕚d inertial impulse between large masses, the planet has more of an inertial impulse and so the moon is dragged along more with it. They are also both dragged along by the star as it rotates around in the galaxy. This is because a planet reacts more against the gravity of the star if it has a larger -𝕚d inertial mass.

G+ as the gravitational constant

Because +𝕚d_p×-𝕚d_e is also a constant this gives the gravitational constant of G+, this refers to the +𝕚d and e𝕙 Pythagorean Triangles and so larger numbers of them will give different g values. The plus sign in G+ would refer to it as coming from the +𝕚d and e𝕙 Pythagorean Triangle as gravity. The inverse of these would be another constant as e𝕙×e𝕧, a satellite above a planet would change orbits maintaining both constants. This is a square and so it comes from +𝕀D×e𝕙 gravitational work, G is measured in meters /sec^2 as e𝕙/(+𝕚d×+𝕚d) in this model. The other gravitational constant can be called B from +𝕘d×e𝕓 or GB, this is from the Eℍ/+𝕚d gravitational impulse and would be in meters^2/second as the Eℍ/+𝕚d.

G- as the inertial constant

The Inertial constant like G+ would be in meters/second^2 and here can be called G-, the negative sign would come from the -𝕚d and e𝕧 Pythagorean Triangle. The Iner as -𝕘d×e𝕧 has this negative sign, the Inertial constant as G- in between a planet and a moon would be -𝕚d_p×-𝕚d_m. This is approximately equivalent to G+ because the inertial mass is equivalent to the gravitational mass. The second inertial constant would be V from -𝕘d×e𝕧 as VG, the planet and the moon would have this inertial constant as e$𝕧_p$×e$𝕧_m$.

Relativistically invariant

This would also be relativistically invariant, a rocket maintaining an orbit just above an event horizon would have its e𝕧 length contracted from its -𝕀D inertial temporal history. That would maintain the constant e𝕙×e𝕧 proportionally to its e𝕙 height from the +𝕀D gravitational temporal history. The +𝕚d_p×-𝕚d_e constant would also be maintained, the E𝕍 inertial displacement history would slow the rocket's -𝕚d inertia time. The Eℍ gravitational displacement history would slow its +𝕚d gravitational time.

Constants with c as a limit

Because of this the two constants become c as a limit, when these are multiplied together as e𝕙×e𝕧/+𝕚d×-𝕚d then as e𝕙 increases e𝕧 decreases. Also +𝕚d decreases as -𝕚d increases, this gives two limits which are both c.

Slower light in approaching a gravitational well

Near the event horizon c is slowed according to an outside observer, light is bent around a +𝕚d gravitational mass in this way. This is because the photons as rolling wheels have a e𝕧 phasor contraction, also their -𝕘d rotational frequency is slowed. The photons then become like smaller and slower wheels turning towards the gravitational mass.

Slower light in approaching c in a rocket

In Special Relativity a rocket is also slowed in approaching c, its e𝕧 length contracts reducing its measured -𝕀D×e𝕧 inertial work and its -𝕚d inertial time slows reducing its observed E𝕍/-𝕚d inertial impulse. The rocket can then appear to slow down as the light from it slows in its emission.

A length inertial well

This is, according to this model, from a contracted e𝕧 length around the rocket, similar to climbing out of a e𝕙 gravitational well the photons have to climb out of the e𝕧 inertial well. As they do this their velocity increases approaching the normal c value. The photons act like rolling wheels, when emitted they are smaller wheels as the e𝕪 phasor proportional to e𝕧 is shorter as well as having a slower -𝕘d rotational frequency.

The light increases its velocity

Further away from the rocket there is an increased e𝕧 length because the light no longer has the E𝕍 inertial displacement history, its velocity at c is the same as if it was emitted from a stationary rocket. This increases the e𝕪 and e𝕧 phasor size, so the photon again has h as its energy. The rolling wheel then increases in velocity, its -𝕘d rotational frequency also increases as the light is less slowed than on the rocket.

Not an instantaneous change

This would not be instantaneous because the photons have a -𝕘d rotational frequency acting as a clock gauge, the photons have a change in their positions from being emitted on the rocket to being outside it. Also the -𝕚d inertial mass of the rocket is a field, this has no exact position and so must extend outwards around the rocket with a -𝕀D inertial probability.

The photons appear to increase in area

The photons then should increase in velocity as a square like they do moving upwards in a gravitational well. They would have a -𝔾D light torque and an E𝕐 light displacement in moving away from the rocket, their e𝕧 wavelength would increase as well as their rotational frequency. This would only be to an external observer and measurer, the e𝕪 and -𝕘d Pythagorean Triangle itself would not change in area. An observer and measurer on the rocket would not see any difference in the photons emitted by it.

Light moving through the rocket

The photons change their velocity because the E𝕍 inertial displacement history and the -𝕀D inertial temporal history has changed, the photons are no longer on the rocket. For example they may have traveled through the rocket after being emitted, they would then have a length contraction so that the -𝕀D×e𝕧 inertial work shows a e𝕧 length contraction. They would also be slowed with their -𝕘d rotational frequency, this is so the clocks on the rocket also appear to be slowed.

The light history changes

After the light leaves the rocket its history has changed, it is then no different from other photons. It contains the history of the rocket by being redshifted, this gives the velocity of the rocket away from a stationary observer of the e𝕐/-𝕘d light impulse and measurer of the -𝔾D×e𝕪 light work when the photons reach them.

History is not velocity

So it cannot contain this history also in its velocity because velocity is not a force, the rolling wheel then increases its e𝕪 phasor in size and increases its -𝕘d rotational frequency so the histories remain conserved. The photon's velocity then is the scale and clock gauge of those histories until it is observed and measured.

Turning and slowing the rolling wheels

The emission of the photons from the rocket, from -𝕚d and e𝕧 Pythagorean Triangles in an inertial well, have similar properties to those from near +𝕚d and e𝕙 Pythagorean Triangles in a gravitational well. The photons slow in velocity near an event horizon for example, this is because the Eℍ gravitational displacement history slows the photon -𝕘d rotational frequency like a clock gauge. The +Id gravitational temporal history contracts one side of the e𝕪 phasor and e𝕧 as the wavelength, this causes the photon to turn towards the event horizon.

The photosphere and rolling wheels

In the photosphere the photon rolling wheels would have one side contracted, this would cause the wheels to circle near the event horizon. The -𝕘d rotational frequency is also slowed on the event horizon side, it is like a 4 wheeled car where the two wheels on the event horizon side are smaller and rotate slower.

Spiraling upwards from the photosphere

On the upper side of the photosphere this would allow photons to spiral upwards while increasing velocity, their E𝕐 light displacement history and -𝔾D light temporal history changes back towards like it was before it encountered the event horizon. This would restore the original velocity of c and approximately its -𝕘d rotational frequency and e𝕧 wavelength.

General relativity

In General Relativity e𝕙/+𝕚d is the gravitational speed, that reaches its limit at the event horizon of a black hole or the CMB. The +𝕚d and e𝕙 Pythagorean Triangle has a maximum e𝕙 height at the CMB, this maximum e𝕙 height has a minimum +𝕚d gravitational time because of the minimum size of its angle θ. This is e𝕙/+𝕚d as the limit of c. That limit comes from α as the ground state of the electron as ≈ 1/137 of c. Because of this fraction c=1 and is not an infinite speed. Beyond this Biv space-time would exist according to this model but not be measurable, in conventional physics the universe is also believed to exist past the CMB.

The CMB as the limit of ≈ 1/137 c

With this maximum e𝕙 height at the CMB is a minimum +𝕚d, this also acts like gravitational time being slowed as at the event horizon. The CMB then appears to be frozen because beyond it c would have to be faster, then the +𝕚d gravitational time could not be observed in a E‍ℍ/+𝕚d gravitational impulse.

The beginning of space and time

It also acts as the limit of the +𝕀D gravitational temporal history, how far time can be extended back to a beginning. The +𝕚d and e𝕙 Pythagorean Triangle in this model then appears to give a boundary to the universe and its beginning, beyond this there seems to be no Biv space-time. In traveling there this boundary would recede, if the CMB could be reached according to this model it would appear like local space-time.

Before the beginning

In this model time is a rotation, there cannot then be a direction of time or something beyond it. Time can only change its rotational frequency, a direction as a e𝕙 height refers to the limit of the CMB. Because time could no longer be observed with e𝕐/-𝕘d light impulse or measured with -𝔾D×e𝕪 light work then it is like a clock stopping as the beginning of time. This is a relativistic effect, the clock does not actually stop if someone traveled to the CMB.

Observing and measuring the CMB

The boundary comes from the -𝕆D×e𝕪 kinetic work of electrons at the CMB, the e𝕙 limit comes from the +𝕀D gravitational temporal history. The e𝕙 contraction there acts like a photosphere, photons can appear to be trapped or to slowly come out. The redshift means their -𝕘d rotational frequencies are slowed, this reduces the -𝔾D×e𝕪 light work the photons can do when being measured. If the photons could not create enough -𝔾D light torque to move electrons from the ground state then the photons could not be measured. This gives a limit to the e𝕙 height to the CMB. These rolling wheels also rotate too slowly to be observed by free electrons in collisions.

The photosphere as a limit

The photosphere as a limit would have e𝕙 contracted because of the +𝕀D gravitational temporal history approaching a maximum. This is where a rocket would have had a temporal history of falling towards this event horizon from free space. It would also have e𝕧 contracted when the rocket was viewed from far enough outside the e𝕙 gravitational well.

The photosphere as a CMB

With the limit of the +𝕚d and e𝕙 Pythagorean Triangle the CMB would act as a photosphere. With a black hole Eℍ is more contracted because of the +𝕚d gravitational mass of the surrounding galaxy, this reduces the CMB height for an observer outside the galaxy. The event horizon should also appear at ≈ 1/137 of c as the ground state, beyond this the e𝕪×-𝕘d photons could not be measured by electrons absorbing them.

Approaching c appears as approaching being stationary

These would both appear as inverses to their speed approaching c. The rocket would approach a e𝕙/+𝕚d gravitational speed of c so its e𝕙 height contracts and +𝕚d dilates inversely to this. It would also approach a e𝕧/-𝕚d velocity of c so its e𝕧 length contracts and its +𝕚d inertial time dilates appearing as almost at rest.

Electromagnetism and c

In Roy electromagnetism this gives the same constant c as 1/√ϵ_0×μ_0. In this model the ϵ_0 term is e𝕒×e𝕪 in the numerator and μ_0 in its formulation is actually a fraction to give 1/+𝕠d×-𝕠d. The permittivity of free space as ϵ_0 dilates in lower orbitals moving towards the ground state, the permeability would contract as μ_0, this maintains a constant speed of c.

Changing permittivity to permeability ratios

This allows the electron to move faster in lower orbitals, the increased permittivity is proportional to an increase of e𝕧 in e𝕧/-𝕚d as velocity. The permeability would contract has the potential permeability of the +𝕠d and e𝕒 Pythagorean Triangle as the proton increases, conversely the potential permittivity would decrease. This acts like a Roy electromagnetic geodesic around the proton, the electron moves in free fall with this geodesic by the changing ratios of permittivity and permeability.

Permittivity and permeability as constants

In this model ϵ_0 and μ_0 can also appear as constants like with the Coulomb constant and its inverse magnetic consistent. This is from multiplying them together, because c appears to be a constant they do as well. In this model the potential permittivity is added to the kinetic permittivity as vectors, potential permeability is added to the kinetic permeability.

Light speed as an area

In this model c acts like an integral, this is because the e𝕪 phasor sweeps out a circle as an area. That would usually be a square such as E𝕐, here the area comes from -𝕘d×e𝕪 for example. Because these are inverses, they act like a constant area of E𝕐 or -𝔾D as a e𝕐/-𝕘d light impulse or -𝔾D×e𝕪 light work. The axle turns the phasor around so that a smaller e𝕪 phasor gives a larger area because it rotates more. This makes it a constant area, the wheel moves with an inertial speed e𝕧/-𝕚d that is also a constant. This also allows for c to have a particle nature with a e𝕐/-𝕘d light impulse and a Eℍ×+𝕘d Gravi impulse, as well as a wave nature with -𝔾D×e𝕪 light work and +𝔾D×e𝕙 Gravi work.

Roy and Biv limits of c

Together the two constants give e𝕒×e𝕪/+𝕠d×-𝕠d from the +𝕠d and e𝕒 Pythagorean Triangle and the -𝕠d and e𝕪 Pythagorean Triangle, that is proportional to e𝕙×e𝕧/+𝕚d×-𝕚d in Biv spacetime. These can be separated into two values of c as before, that gives the e𝕒/+𝕠d potential speed and the e𝕪/+𝕠d kinetic velocity which can approach c as a limit from 1/√ϵ_0×μ_0.

Observing and measuring increments

These four constants, two in Roy electromagnetism and two in Biv space-time, when observed and measured give increments of change. This is because only one of each pair in the constant can be observed or measured in a time or position. A measurement of +𝕆D×e𝕒 potential work, for example, with the proton can change in increments even though +𝕠d×-𝕠d is a constant.

Planck's constant and increments

This is also why h can act as an increment as -𝕠d ×e𝕐/-𝕠d even though it is also a constant. It comes from the kinetic momentum as -𝕠d×e𝕪/-𝕠d which is subtracted from the potential momentum as +𝕠d×e𝕒/+𝕠d, that has $h_{e\mathbb{a}}$ as +𝕠d×e𝕒/+𝕠d. The two are a mix of constants as +𝕠d×-𝕠d and e𝕒×e𝕪. When this is observed with the E𝕐/-𝕠d kinetic impulse subtracted from the E𝔸/+𝕠d potential impulse it increases by units of this constant because of the square.

Inverse changes in increments

When the electron moves in a quantized orbital this is observed as increments of $h_{e\mathbb{y}}$ as -𝕠d ×e𝕐/-𝕠d. There is a second $h_{e\mathbb{a}}$ constant that changes inversely to this as +𝕠d × e𝔸/+𝕠d. Together they are combinations of the constants e𝕒×e𝕪 and +𝕠d×-𝕠d. Planck's constant comes from the kinetic momentum as -𝕠d×e𝕪/-𝕠d which is subtracted from the potential momentum as +𝕠d×e𝕒/+𝕠d. The two are a mix of constants as +𝕠d×-𝕠d and e𝕒×e𝕪.

Observing the displacement history

When $h_{e\mathbb{y}}$ is observed this is where the electron is a particle, its E𝕐/-𝕠d kinetic impulse becomes a constant increment E𝕐 when the -𝕠d in the numerator and denominator cancel. With +𝕠d × e𝔸/+𝕠d as $h_{e\mathbb{a}}$ the same happens, +𝕠d cancels to give regular increments of E𝔸 as integers. This also happens with $h_{e\mathbb{h}}$ as +𝕚d×Eℍ/+𝕚d and $h_{e\mathbb{v}}$ as -𝕚d×E𝕍/-𝕚d. These are not quantized, instead they observe the change after a quantized change in an orbital.

Measuring the temporal history

In this model there is also regular increments of the Boltzmann Constant as k, that has a similar formula to Planck's Constant as h. Here -𝕠d ×e𝕪/-𝕆d is the same as k in conventional physics using dimensional analysis. Because e𝕪 is the inverse of -𝕠d this can be written as 1/e𝕪 × e𝕪/-𝕆D where e𝕪 cancels as -𝕠d does in h to give 1/-𝕆D which is measured as the Gaussian. This leaves 1/-𝕆D as the e𝕪 factors cancel out, that measures the -𝕆D kinetic temporal history.

Roy and Biv Gaussians

That gives -𝕠d ×e𝕪/-𝕆d as $k_{-\mathbb{o}d}$ for the electron, here the -𝕆D kinetic probability is measured which is why k gives a Gaussian distribution such as in gasses. For the proton this is +𝕠d×e𝕒/+𝕆D as $k_{+\mathbb{o}d}$ as the inverse to give +𝕠d×-𝕠d as the constant again. In Biv space-time this is $k_{e\mathbb{h}}$ as +𝕚d×e𝕙/+𝕀D and $k_{e\mathbb{v}}$ -𝕚d×e𝕧/-𝕀D, together they also give +𝕚d×-𝕚d as the gravitational constant.

In between circular geometries

In Roy electromagnetism the atom is in circular geometry, similar to spherical geometry but in this model there are only areas not volumes. In Biv space-time there is the +𝕚d and e𝕙 Pythagorean Triangle as gravity also in circular geometry. In between these circles is hyperbolic geometry, that acts and reacts to convey changes in between the circular geometry dominated areas. An electron might leave an atom in hyperbolic geometry, it acts more like a particle with a E𝕐/-𝕠d kinetic impulse until it goes into another atom with circular geometry doing -𝕆D×e𝕪 kinetic work.

Gravity and curved space

The CMB is the limit of Biv circular geometry, outside this cannot be observed or measured. That makes gravity different from the -𝕠d and e𝕪 Pythagorean Triangle with the electron, General Relativity primarily acts in curved space from the spin Pythagorean Triangle sides. The e𝕙 straight Pythagorean Triangle side extends directly out from a +𝕚d gravitational mass and is not curved. An increased e𝕙/+𝕚d gravitational velocity becomes straighter in its trajectory because this is a derivative slope from the Eℍ/+𝕚d gravitational impulse. A slower gravitational speed e𝕙×+𝕚d becomes more curved in the geodesic with a limit as a circular orbit.

Inertia and curved space

In this model the -𝕚d and e𝕧 Pythagorean Triangle can also be measured in curved space, this is in hyperbolic geometry so a faster e𝕧/-𝕚d inertial velocity has a greater E𝕍/-𝕚d inertial impulse and is a straighter hyperbola. There is always some gravitational influence up to the CMB so there is no straight trajectory. This inertial curved space is not directly observable and measurable, only by subtracting it from the +𝕚d and e𝕙 Pythagorean Triangle as gravity or reacting against the -𝕠d and e𝕪 Pythagorean Triangle as the electron. When an iota moves more slowly this becomes an inertial speed e𝕧×-𝕚d with a limit as an orbit.

Inertial geodesic

In this model the +𝕀D×e𝕙 gravitational work around a planet can be regarded as a gravitational geodesic. Subtracted from this is -𝕀D×e𝕧 inertial work as an inertial geodesic, this acts like a Higgs field in giving iotas a -𝕚d inertial mass. Further from a planet the -𝕚d inertial mass is larger because the +𝕚d gravitational field is smaller, a rocket would tend to move more in a straight-line with an E𝕍/-𝕚d inertial impulse.

Gravitational and inertial geodesics

On approaching a planet the -𝕀D×e𝕧 inertial work is subtracted from the +𝕀D×e𝕙 gravitational work of the planet, this makes a gravitational and inertial geodesic together. Light moves through this inertial geodesic which gives it momentum, as this is subtracted from the gravitational geodesic the photons can curve towards a planet.

Potential and kinetic geodesics

In Roy electromagnetism there is a potential geodesic around an atom, this is proportional to its +𝕚d gravitational mass. An electron has a kinetic geodesic, it can actively orbit in this potential geodesic. This is like in Biv space-time where a satellite with its inertial geodesic can orbit in a gravitational geodesic of a planet.

The ground state and c

In this model c can act as an integral, α is the speed in the ground state as ≈ 1/137. This is a derivative, it represents the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle with an angle as the tangent of α. Here this is not a cosine but a tan angle, the two are close to the same value. That divides the e𝕧 length by the -𝕚d inertial mass. The limit of this fraction is ≈ 137 times this as c, it is also ≈ 1×137.

Fractions of c as derivatives

Each orbital has a derivative slope of the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle, for example it might be a slower velocity in a higher orbital as 1/200 of c. Taken as an integral this means c is 200 times this velocity, also it is 1×200 as a constant which is also c like ≈ 1×137. This is because the Pythagorean Triangles have a constant area, if 1/200 is the derivative slope then 1×200 is the integral.

Changes in rolling wheels

A photon can collide with an electron outside the atom, then it acts as a particle with a e𝕐/-𝕘d light impulse. The ratio of e𝕪/-𝕘d acts like a velocity and so it can change the velocity of the electron, that also changes the e𝕪/-𝕘d ratio of the photon like its velocity. The speed remains the same at c because of the constant area of the e𝕪 and -𝕘d Pythagorean Triangle.

Roy and Biv combined constants

In this model +𝕠d×-𝕚d, e𝕒×e𝕧, +𝕚d×-𝕠d, e𝕙×e𝕪 are also constants because they combine Roy electromagnetism and Biv space-time. For example the +𝕠d would decrease inversely to the increase in the -𝕚d inertial mass of the electron as it moves to a higher orbital. The e𝕒 potential electric charge would increase inversely to the slower e𝕧 length in the velocity of an electron in a higher orbital. The +𝕚d gravitational mass would decrease inversely to the -𝕠d kinetic magnetic field of the electron in a higher orbital. The e𝕙 height would increase inversely to the reduced e𝕪 kinetic electric charge in a higher orbital.

Action/reaction constants

There are also constants where an action has an equal and opposite reaction. A E𝕐/-𝕠d kinetic impulse would have an equal and opposite E𝕍/-𝕚d inertial impulse reaction according to Newton. This would also happen with -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. A e𝕪 kinetic electric charge then has an equal and opposite reaction from inertia as e𝕧, a -𝕠d kinetic magnetic field with a reaction from the -𝕚d inertial mass.

Gravity and the proton

Gravity also forms an action/reaction pair in this model with the proton, the Eℍ/+𝕚d gravitational impulse then is reacted against equally by the E𝔸/+𝕠d potential impulse. The +𝕀D×e𝕙 gravitational work is reacted against equally by the +𝕆D×e𝕒 potential work. That gives another two constants.

A constant c

In this model light transmits the difference between the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron, its emission comes from the +𝕠d×-𝕠d and e𝕒×e𝕪 constants. It is absorbed into another atom with the same constants, the photons then need to maintain a constant Pythagorean Triangle area which is observed as Planck's constant.

Photons and constants

When the -𝕘d rotational frequency increases then the e𝕪 kinetic electric charge and e𝕧 wavelength decreases inversely to maintain this constant. The velocity is also usually a constant but is subject to interactions with other Pythagorean Triangle sides. When a photon approaches a planet its -𝕘d rotational frequency is inversely proportional to the e𝕙 height of the +𝕚d and e𝕙 Pythagorean Triangle.

Constants as constant area Pythagorean Triangles

When there are constants with one straight Pythagorean Triangle side and one spin Pythagorean Triangle side these act like Pythagorean Triangles themselves with a constant area. They can square the straight Pythagorean Triangle side with impulse or the spin Pythagorean Triangle side as work. The photon then acts as a particle with Eℍ×-𝕘d impulse, also as a wave with e𝕙×-𝔾D.

A blueshift then a redshift

The photon has its -𝕘d rotational frequency increase as it moves downwards with a blueshift. Conversely in moving up and out of a gravitational well the e𝕙 height increases and the -𝕘d rotational frequency decreases inversely. The e𝕧 wavelength of the photon proportional to e𝕪 is also proportional to e𝕙, the photon becomes redshifted as it moves upward.

The CMB as the limit of the light constants

The CMB is the limit of the +𝕚d and e𝕙 Pythagorean Triangle with photons like this. In climbing to the maximum e𝕙 height from the CMB the -𝕘d rotational frequency reaches its minimum to maintain this constant. Then the photon cannot be absorbed by an electron in the ground state, it can no longer by measured beyond this e𝕙 height.

Redshift and kinetic torque

The other constant is e𝕪×+𝕚d, the photon has its e𝕪 kinetic electric charge decreased as the +𝕚d gravitational mass increases. Conversely with its moving out of the gravitational well e𝕪 dilates with a redshift, the -𝕘d rotational frequency of the photon decreases. In this model a photon increases the -𝕆D kinetic torque of an electron in moving up to a higher orbital, when the photon is highly redshifted this -𝕘d rotational frequency is smaller and so the photon cannot increase the electron’s kinetic torque as much.

Slowing of photons in an atom

Inside the atom these constants with light and Gravis must also have a constant area. Because the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron have constant areas, then these also act like Pythagorean Triangles. When an electron changes with a quantized orbital then the slowing of photons in lower orbitals must be consistent with these quantized values. If not then the photons could disrupt the quantization in an atom.

Relativistic constants and photons

In this model there is a relativistic contraction of straight Pythagorean Triangle sides from an increased spin history. The history of iotas as particles or waves must be conserved here as a consequence of the conservation of matter and energy.

Relativistic constants and length contraction

When a photon moves closer to a planet its -𝔾D light temporal history increases like in -𝔾D×e𝕪 light work, its e𝕪 kinetic electric charge contracts and proportionally its e𝕧 wavelength contracts. This is the same as in the light measured from a rocket approaching c, the -𝔾D×e𝕪 light work has a history of coming from a rocket moving away at a higher velocity near c. Because of this the e𝕪 Pythagorean Triangle side is contracted in that it would show a contracted rocket length as e𝕧.

Measuring the photon or the photon's information

This is not the same as the photon wavelength itself, but that the photon history must show the rocket to be contracted. The photon would have a e𝕧 wavelength that is redshifted because the rocket is moving away from the observer and measurer in a stationary reference frame. Photons have information about their source as a group, the e𝕪 and -𝕘d Pythagorean Triangle itself has different but related information about an individual electron that emitted it.

Photon constants and inertial time slowed

The rocket also has a higher E𝕍 inertial temporal history, the photons then must also be observed to have a slower -𝕘d rotational frequency. This is not the photon's own frequency, but then they must show the events of slow clocks on the rocket.

Photon constants and a height contraction

When photon move closer to a large planet their -𝔾D light temporal history also increases, with the constant -𝕘d×e𝕙 as the photon moves downwards the -𝕘d rotational frequency increases. When the photons climb out of the gravitational well they are measured with -𝔾D×e𝕪 light work, then the -𝔾D light temporal history is larger when the photons are emitted from a smaller e𝕙 height. This gives a e𝕙 height contraction in that the photons must show to have a consistent -𝔾D light temporal history.

Photon constants and gravitational time slowing

With the increased E𝕐 light displacement history the photons are also observed to have a slower -𝕘d rotational frequency deeper in the gravitational well. The clocks appear to be slower there in the information the photons show, this is not the same as the -𝕘d rotational frequency of the photons themselves.

Photon constants approaching c

The constants as straight Pythagorean Triangle sides and spin Pythagorean Triangle sides, such as -𝕘d×e𝕙 and +𝕚d×e𝕪 are maintained in both Special and General Relativity in this model approaching c. Each would have limits of the angle θ otherwise a Pythagorean Triangle side could become zero or infinite.

Gravis and gravitational waves

The Gravis as gravitational waves are also bent like this, in higher orbitals the +𝕚d gravitational field of the nucleus is smaller. The constants here are e𝕙×-𝕠d and +𝕘d×e𝕪, the Gravis instead of being pulled towards the circular geometry of an atom or planet or moved away by hyperbolic geometry.

Gravis concentrate rather than radiate

The Gravis as waves must fit in with the quantization inside atoms to be measured as +𝔾D×e𝕙 Gravi work or gravitational waves. The Gravi moves backwards in time so that these gravitational waves need to have the same quantized orbitals as from Roy electromagnetism. If not then gravity would tend to move electrons out of their quantized orbitals into a gravitational quantization. If the Gravis were acting as a Eℍ×+𝕘d Gravi impulse then this would act against quantization, this is because +𝕘d is not squared as a quantized orbital.

The Pythagorean Equation

In this model the Pythagorean Equation balances the interactions between Roy electromagnetism and Biv space-time. When an electron drops an orbital a e𝕪×-𝕘d photon is emitted, to balance this a Gravi is received. This is balanced by the photons going forwards in time to be absorbed by future electrons, they emit a Gravi which travels backwards in time to be absorbed when the photon is emitted.

Two Hydrogen atoms

This can be modeled as two Hydrogen atoms, a e𝕪×-𝕘d photon is emitted from an electron in a higher orbital, forwards in time it is absorbed by a second Hydrogen atom which raises its electron up an orbital. In Biv space-time this means the second Hydrogen atom has the electron's -𝕚d inertial mass increased. The +𝕚d gravitational mass of the proton loses some strength, it implies then that Roy electromagnetism can be converted into a gravitational change.

Conservation of mass and energy

This can be regarded as the conservation of mass and energy, in this model the electron has a higher -𝕚d inertial mass in a higher orbital as it absorbs the energy from the e𝕪×-𝕘d photon. Here the proportions of this change are the same as with $e=mc^2$.

Energy versus gravity

In this model there are two other variables, the proton has a +𝕚d gravitational mass that has weakened its influence on the electron. Also, it has a +𝕠d potential magnetic field which is weakened with the electron moving to a higher orbital. This creates an imbalance where as time moves forward photons appear to drive change against gravity.

Gravis balancing with photons

This imbalance is resolved here by Gravis as gravitational waves moving backwards in time, the difference in the proton's +𝕚d gravitational field is offset by the emission of a Gravi along with the photon. This Gravi travels back in time to the first Hydrogen atom and is absorbed. When this happens the electron is pulled down to a lower orbital which coincides with the emission of the photon going to the second Hydrogen atom.

Two active Pythagorean Triangles

There are then two active Pythagorean Triangles in this model which oppose each other. This is seen in conventional physics where kinetic energy, here from the -𝕠d and e𝕪 Pythagorean Triangle as the electron, acts against the gravitational potential energy which here is the +𝕚d and e𝕙 Pythagorean Triangle.

Reversing a movie

The two active Pythagorean Triangles approximately reverse their actions by running a movie in reverse. Then gravity with Gravis move forward in time, they seem to be absorbed and cause objects to move up in the air instead of falling. Conversely kinetic energy seems to become attractive like gravity, an example would be a rocket burning fuel. The gravitational field seems to move the rocket upwards when it is moving forwards in time. The kinetic energy from burning fuel is then moving backwards in time, it pulls the rocket down like gravity.

Gravity moves towards the CMB

In this model then gravity moves backwards in time towards the CMB and the appearance of a big bang, it appears like the big crunch referred to in conventional physics. This is where the kinetic energy of matter is overcome by gravity, the universe would then shrink down to a singularity. The two forces are then opposed in conventional physics, the difference here is this opposition is balanced by photons moving forwards in time and Gravis moving backwards in time.

Two black holes

This is consistent with observations and measurements in conventional cosmology, two black holes might be spiraling in towards each other and emit gravitational waves. In this model the Gravis are being absorbed into the event horizons and this moves them closer to each other.

The cosmological constant

In this model the cosmological constant is where the universe appears to be contracting towards the CMB not expanding away from a big bang. Balanced against this is the kinetic energy from photons moving forwards in time. Because the CMB represents the limit of gravity, outside this would be like where an electron has enough energy to leave the atom.

Inside the CMB

The matter inside the CMB then is in circular geometry, it tends to clump together into stars and galaxies. That allows for local areas where the +𝕚d and e𝕙 Pythagorean Triangles give a greater gravitational attraction, that causes stars and galaxies to form. In between those the -𝕚d and e𝕧 Pythagorean Triangles with inertia extend to the limit of γ in the cosmological constant.

Mach's Principle and Gravis

With kinetic energy the photons move outwards into hyperbolic geometry moving forwards in time. Because of this, the other stars and galaxies would possibly absorb these photons in the future. With Gravis the timeline is reversed, the gravitational waves come from the future and so that future is changing the present. This is the opposite of the photons where in being emitted from the present they change the future.

Mach's principle

That leads to Mach's Principle where the gravitational forces from other stars and galaxies can be affecting matter locally. Instead of moving forwards in time into a distant future, before there could be any interaction, this time has already been traversed from the future. This maintains order in stars and galaxies, for example in a solar system planets and moons can orbit with a resonance because they remain quantized in the future with +𝕀D×e𝕙 gravitational work.

Gravity and kinetic energy

Against this is the -𝕆D×e𝕪 kinetic work done by electrons moving forwards in time, as well as -𝕀D×e𝕧 inertial work reacting against this. The protons do +𝕆D×e𝕒 potential work moving backwards in time proportional to the +𝕀D×e𝕙 gravitational work between the planets and a star.

Newton's rotating bucket

With Newton's rotating bucket experiment then the other stars and galaxies are acting on it, the kinetic energy from turning the bucket radiates forwards in time with photons to balance the Gravis.

The resonations between planets and a star occur with +𝕀D×eℍ gravitational work and -𝕀D×e𝕍 inertial work in this model. Outside of an atom however electrons move more deterministically with a E𝕐/-𝕠d kinetic impulse, atoms appear more as particles while gravity and inertia appear as waves. Inside the atoms there is +𝕆D×e𝕒 potential work and +𝕀D×eℍ gravitational work proportional to the +𝕀D×eℍ gravitational work and -𝕀D×e𝕍 inertial work in Biv space-time.

Conserving probability

Inside the atom the Gravis act more like gravitational waves just as photons act more like -𝔾D×e𝕪 light work as waves in transmitting changes between electrons. The present must then have this +𝔾D Gravi probability consistent with future events. The e𝕪×-𝕘d photons have a -𝔾D light probability that must balance this as they move outwards into the future.

An uncertain future and a deterministic past

Because these are both probabilities this allows for an uncertain future, the +𝔾D×eℍ Gravi work done in the present acts on the past so that is conserved with the e𝕪×-𝕘d photons coming forwards to the present as the past's future. Gravity acts with a +𝕀D gravitational probability on the past, but this appears more deterministic because Roy electromagnetism is observed more as particles. The past is observed less as the result of chance and more as deterministic collisions in Newton's clockwork universe. This is conserved by the +𝕀D×eℍ gravitational work going backwards in time, work being the inverse of the E𝕐/-𝕠d kinetic impulse going forwards.

Iners and the Higgs field

Iners act as a Higgs field in this model, they give electron a -𝕚d inertial mass. This extends forward in time as a reaction against the Gravis, the motions of a planet and moon would radiate -𝔾D×e𝕍 reluctance work which interacts as the constants -𝕘d×e𝕒 and e𝕍×+𝕠d with the proton.

Electrons with impulse outside the atom

In this model gravity extends much further than the potential of the proton. Because of this electrons can reach the ionization level of an atom, when their -𝕀D kinetic probability is larger than the +𝕀D potential probability they can leave the atom. When this happens electrons move with a E𝕐/-𝕠d kinetic impulse, and photons with a e𝕐/-𝕘d light impulse can collide with them. The electron can no longer absorb a photon.

The limit of gravitational waves

Because the limit of gravity is so much further with the +𝕚d and eℍ Pythagorean Triangle, this means +𝕀D×eℍ gravitational work is done rather than a Eℍ/+𝕚d gravitational impulse. In the macro world there can appear to be a gravitational impulse, in general relativity the +𝕀D×eℍ gravitational work means there is curved Biv space-time. The Eℍ/+𝕚d gravitational impulse and gravitons may not appear until the limit of the +𝕚d and eℍ Pythagorean Triangle is reached, this is like the ionization level in Roy electromagnetism.

Photons and Gravis

With the four central Pythagorean Triangles there is the e𝕪×-𝕘d photon going forward in time, the +𝕘d×e𝕒 virtual photons reacts against this going backwards in time. The +𝕘d×eℍ Gravi has the -𝕘d×e𝕍 Iner as an equal and opposite reaction, the Gravi goes backwards in time and the Iner goes forwards.

Observing photons and gravis

When observed as particles the photons and Gravis are a derivative observable as an impulse. They move as rolling wheels, the photon has a e𝕪 phasor or spoke with a -𝕘d axle, when they rotate this can be regarded as an integral e𝕪×-𝕘d or a derivative e𝕪/-𝕘d. As a derivative, light acts like a velocity lower than c, this has a minimum and maximum value. This only happens when the photon collides with a particle, when it interacts with a wave such as an electron it is absorbed as part of that wave like beats as waves combining.

Light as an integral or derivative

When light moves between atoms the e𝕪 and -𝕘d Pythagorean Triangle can be regarded as an integral field with light momentum or a derivative particle with an inertial velocity, that is because it is not being observed or measured. This inertial velocity is fixed because of α as ≈ 1/137 of c, if this fraction changed then α would no longer be related to the quantized orbitals in an atom.

α reduces proportionally to c under gravity

The tangent of the angle 1/α is ≈ 1/e, when e𝕪×-𝕘d photons go into a gravitational well c is slower because the angles θ change in the +𝕚d and e𝕙 Pythagorean Triangle with a lower e𝕙 height. This reduces the inertial velocity c, it then also reduces 1/α so the orbitals become closer together in atoms as gravity becomes stronger with +𝕀D×e𝕙 gravitational work.

α changes according to the angle θ

In this model α changes according to the angle θ of a Pythagorean Triangle, with the proton as the +𝕠d and e𝕒 Pythagorean Triangle a change in the altitude of an orbital e𝕒 is like a distance in +𝕆D×e𝕒 potential work. This exponent is a multiple of $e^{+\mathbb{O}D}$ as 1/α, so as this distance or altitude increases then the +𝕆D potential probability decreases with D as multiples of α.

Higher powers of α

With the -𝕠d and e𝕪 Pythagorean Triangle as the electron, this changes inversely so with higher orbitals there is $e^{-\mathbb{O}D}$ doing -𝕆D×e𝕪 kinetic work. The -𝕆D kinetic probability or kinetic torque increases as a square with higher orbitals in multiples of α. When α is a higher power such as squares, cubes, etc in quantum electrodynamics, this is the same as a higher exponent. So α×α id $e^{-\mathbb{O}D} \times e^{-\mathbb{O}D} = e^{2\times-\mathbb{O}D}$ where D is incremented by 1. This can act as a kinetic probability for the decay of iotas, also with e𝕪×-𝕘d photons emitted in a discrete spectrum where an electron can drop to a lower orbital in increments of α.

Gravity and α

With gravity, the +𝕚d and e𝕙 Pythagorean Triangle is proportional to the +𝕠d and e𝕒 Pythagorean Triangle as the proton. This means as e𝕪×-𝕘d photons move closer to a planet the +𝕚d gravitational field is proportional to the +𝕠d potential magnetic field. This causes the photons to bend towards the planet as α values change at various e𝕙 heights.

α and e with hyperbolic geometry

This comes from the definition of α in this model as $e^{+\mathbb{I}D}$ proportionally with gravity. Because this is a ratio of e it is related to the integral area under a hyperbola for 1. The electron as the -𝕠d and e𝕪 Pythagorean Triangle, and inertia as the -𝕚d and e𝕧 Pythagorean Triangle, are Pythagorean Triangles that move under a hyperbola with a constant area. Because α is a fixed ratio of e then as it changes so does hyperbolic geometry itself. In this model circular geometry with the +𝕚d and e𝕙

Pythagorean Triangle and +𝕠d and e𝕒 Pythagorean Triangle change inversely to hyperbolic geometry.

α and π with circular geometry

This means that the changes in α as different orbitals are proportional to different e𝕙 heights in gravity. It also means the different Roy electromagnetic energy levels change the curvature of Biv space-time itself. An electron in the ground state has an inertial velocity e𝕧/-𝕚d of ≈ 1/137 as α. This sets it as 1 in $e^{-\mathbb{O}D}$, the +𝕠d potential magnetic field in circular geometry curves like a geodesic as a proportion of α.

α and conic sections

This is because e and π are derived from conic sections, and so are inverses of each other. The hyperbola is a vertical conic section with an integral area of e for a distance of 1. The circle is a horizontal conic section with an integral area of π for a diameter distance of 1. Here α is connected directly to e as its base, this has a fixed relationship also to π when the circular electron orbitals are measured.

α maintains a ratio with e and π

When Biv space-time is distorted, such as with gravity around a planet or inertia with a rocket approaching c, the values of α must also change to maintain these ratios. A rocket approaching c is measured to have its e𝕧 length contracted, this comes from its -𝕀D×e𝕧 inertial work and also from the atoms having α itself being compressed. When this is observed as E𝕍/-𝕚d inertial impulse then the -𝕚d inertial time is slowed, this also comes from $e^{-\mathbb{I}D}$ where D reduces to maintain the ratios with e and π.

Inertial geodesic

The atoms then change with hyperbolic geometry in special relativity, this is like an inertial geodesic that changes the e𝕧 lengths, the -𝕚d inertial time, and the values of α. The slower inertial time leads to the twin paradox where one stays on a planet, the other goes on a rocket journey and returns younger.

Gravitational geodesic

With gravity there is also a gravitational geodesic as in general relativity. At lower e𝕙 heights there is a e𝕙 height contraction in +𝕀D×e𝕙 gravitational work, also a slower +𝕚d gravitational time with the E𝕳/+𝕚d gravitational impulse. This causes $e^{+\mathbb{O}D}$ and $e^{+\mathbb{I}D}$ to contract, +𝕚d gravitational time then runs slower on the surface of a planet. The curvature of Biv space-time occurs with an inertial geodesic and a gravitational geodesic, each changes inversely with α inversely compared to the other.

Maintaining c

When two rockets each have an inertial velocity of over ½ of c, this would be over c between them. Because α is a fixed fraction of c, this means the hyperbolic geometry and circular geometry of the rockets must change to maintain c between them. This is because e𝕪×-𝕘d photons from the first rocket must be measured by the atoms of the second rocket, to know it is there. This light would be blueshifted and so the -𝔾D×e𝕪 light work done by it is higher with its e𝕧 wavelength being contracted.

Hyperbolic geometry changes to maintain α

Because α is a fixed ratio, corresponding to an exponent of 1, it cannot change with e changing. For this to occur hyperbolic geometry must itself become distorted in this inertial geodesic, then α can maintain a value of 1 as the base e changes size. When atoms are at rest relative to each other, e𝕪×-𝕘d photons are emitted and absorbed as -𝔾D×e𝕪 light work between them. This is because α is approximately the same in each atom, ignoring their small relative inertial velocities and gravitational fields.

Raman scattering

When a e𝕪×-𝕘d photon does too much -𝔾D×e𝕪 light work the extra can be emitted as -𝔾D×e𝕪 light work with Raman radiation. When the photons don't do enough -𝔾D×e𝕪 light work then they cannot be absorbed because of these α changes. That reduces to the values of 1 in the exponent, when under 1 the photon cannot be absorbed. When over 1 the extra value can be emitted as a e𝕐/-𝕘d light impulse with a continuous spectrum.

Proportional mass and charge

While $e^{+\mathbb{O}D}$ and $e^{+\mathbb{I}D}$ are proportional to each other, they still differ in a constant component of D. For example if D was a thousand times larger with $e^{+\mathbb{O}D}$ then this would be a stronger force in Roy electromagnetism. However the proportions of the nucleus with its +𝕠d potential mass or magnetic field and its +𝕚d gravitational mass would remain the same. If not then larger nuclei would not have a constant mass ratio compared to smaller nuclei.

Rockets are based on the same conic sections

When the rockets approach each other, the α values must be maintained or else they each have different functioning conic sections. So because they are each based on the same values of e and π, the α value which is itself an inertial velocity as a constant, means c as ≈ 137 times α is also a constant. If not then each would have different exponents as their ground states than $e^{-\mathbb{O}D}$. When this happens it is impulse, e𝕪/-𝕘d photons can have a continuous spectrum and there are continuous inertial velocities rather than quantized values from α.

Impulse and work must remain inverses

The E𝕍/-𝕚d inertial impulse must be the inverse of -𝕀D×e𝕧 inertial work to maintain a constant Pythagorean Triangle area, so even though impulse is not quantized it must retain this inverse ratio to work. If it did not then work could not exist in this model, it would be like a Newtonian clockwork universe where relativity could not exist. There would be no fields without work, so without the characteristics of this quantized field there would be no constant motion in Biv space-time.

Sound wave with a constant inertial velocity

This can be seen with sound waves, they have a constant inertial velocity with -𝕀D×e𝕧 inertial work, they move like c with this constant inertial velocity. The characteristics of the atoms in a gas give this inertial velocity, if the gas pressure or composition changes then so does the inertial velocity. This comes from the Boltzmann constant, in this model that is a measurement of work and so it fits on a normal curve. If work did not exist then the atoms would move chaotically, the sound waves would have continuous velocities that changes in different areas of the gas.

Light waves as probability which is quantized

In this model c is a normal inertial velocity, it acts like it is quantized because α is quantized as a proportion of it. That connects c to a probability curve, because of this -𝔾D×e𝕪 light work can move as a probability wave that is emitted as a quantized frequency as a multiple of α. It is absorbed as another multiple of α, this inertial velocity c only changes when the hyperbolic and circular geometry changes to maintain the α value.

A constant velocity maintains work

The e𝕪/-𝕘d photons can also act as particles with a e𝕐/-𝕘d light impulse, such as in colliding with electrons with the E𝕐/-𝕠d kinetic impulse. The inverse values of -𝔾D×e𝕪 light work must be maintained with these collisions or else the constant Pythagorean Triangle areas would not be maintained. So the derivative slopes of the e𝕪/-𝕘d photons change with these collisions, the photon can change its -𝕘d rotational frequency or light time on a light clock gauge. If these collisions change the light velocity, that would change the quantization between atoms and -𝔾D×e𝕪 light work would no longer exist as quantized.

The twin paradox

With the twin paradox one goes on a rocket moving at near c, the other stays behind on a planet. With the rocket's acceleration -𝕆D×e𝕪 kinetic work is done, that changes its angles θ in its -𝕠d and e𝕪 Pythagorean Triangles as electrons and -𝕚d and e𝕧 Pythagorean Triangles as inertia. This also changes the α values, or conversely to maintain the same α values the rocket's circular and hyperbolic geometry must change. That causes its -𝕚d inertial time to slow and its e𝕧 length to contract.

Contracting height or length

When α contracts this reduces the -𝕆D×e𝕪 kinetic work done by the electrons in orbit, also their -𝕀D×e𝕧 inertial work. That makes the electron move closer to the nucleus in the direction of travel. With this model the +𝕆D×e𝕒 potential work is not changed by the inertial velocity and special relativity. With general relativity there is $e^{+\mathbb{O}D}$ and $e^{+\mathbb{I}D}$ with α, at a lower e𝕙 height the e𝕒 altitude and e𝕙 height contracts with this α value.

Lower c speed with gravity

That causes the light speed c to decrease around a gravitational body to match the compressed α values. Here c is referred to as a speed in circular geometry and a velocity in hyperbolic geometry. The strong force in the nucleus is also proportional to α, so this changes the strong force in between the protons and neutrons. That moves the electrons down into a lower orbital which becomes more elliptical, the α values are not compressed orthogonally to e𝕙.

A satellite and α

Under the influence of general relativity, a satellite would measure this e𝕙 height contraction in +𝕀D×e𝕙 gravitational work. It would also observe a slowing of the +𝕚d gravitational time with the Eℍ/+𝕚d gravitational impulse. This would slow the electrons in their orbitals like with special relativity, moving them closer to the nucleus like a slower inertial velocity did.

Orthogonal α changes

That is because in the ground state the -𝕆D×e𝕪 kinetic work done is proportional to $e^{-\mathbb{O}D}$ as α, the inverse of this with the +𝕆D×e𝕒 potential work is $e^{+\mathbb{O}D}$ also as 1. These proportional remain the same, as the -𝕆D kinetic torque or probability increases in higher orbitals the +𝕆D potential torque or probability decreases inversely to this. Under stronger gravity the circular orbitals are contracted to form an ellipse in eℍ height but not e𝕍 length or width. When traveling close to c the circular orbitals again contract with a e𝕍 length into an ellipse. This has the same effect of slowing time and contracting a distance orthogonally to each other.

Width is not contracted

This is like with a rocket approaching c, the e𝕍 length is contracted but not the width. In this model width is not associated with a Pythagorean Triangle, so it is not contracted by either gravity or inertia. The width is where the spin Pythagorean Triangle sides are according to this model, for example the electron as a rolling wheel would have the -𝕠d kinetic magnetic field as an axle. The photons would have the -𝕘d rotational frequency as a transverse axle like a width. This can then rotate more slowly rather than the width contracting.

Contracting potential work

This is like changing a circle in a conic section to an ellipse, rotating it but the radius in one direction only contracts to form the minor axis. This reduces the +𝕆D×e𝕒 potential work of the orbital under gravity, the integral area of the orbital is reduced. This conserves the energy of e𝕪×-𝕘d photons for example that bend towards a planet, when absorbed they would do more -𝔾D×e𝕪 light work and so would emit the extra -𝔾D×e𝕪 light work with Raman radiation.

Elliptical contraction in special relativity

With a rocket approaching c there is also an elliptical contraction of the e𝕍 length in a circular orbital. This occurs in the direction of travel, the -𝕆D×e𝕪 kinetic work done in the orbital is reduced as e𝕪 contracts and the -𝕆D kinetic probability also contracts. This makes the orbital contract in one direction as well, it also reduces the -𝕆D kinetic torque to be slower in the direction of travel. That causes the electron to be slower with its inertial velocity in both the e𝕍 length and the -𝕚d inertial time.

Conserving energy in special relativity

This means energy is lost in propelling the rocket to near c, it is regained when the rocket slows down. The change also causes the occupants of the rocket to return younger than those that stayed behind on the planet earlier.

α and history

This change in α is consistent with the E𝕍 inertial displacement history and -𝕀D inertial temporal history of the rocket, as E𝕍 increases then the -𝕚d inertial time slows, when -𝕀D increases the e𝕍 length contracts. These changes come from the -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse of the rocket as both forces are used in the kinetic acceleration to near c.

Space and time expansion

The change in the Eℍ gravitational displacement history and the +𝕀D gravitational temporal history is also consistent with the changes in α. Going backwards in +𝕚d gravitational time it slows while the e𝕙 height contracts. This appears as a e𝕙 height expansion of space as time goes forward from the big bang. That causes some galaxies to appear to be moving faster than c, the e𝕙 height expansion going forward means the universe appears to be larger in e𝕙 height compared to the +𝕚d gravitational time since the limit of the +𝕚d and e𝕙 Pythagorean Triangles as the big bang.

Expansion of inertial space-time, contraction of gravitational spacetime

When this is run backwards the +𝕚d gravitational time is slowing towards an event horizon, the e𝕙 height contraction appears as Biv space-time contracting inversely to its apparent expansion after the big bang. The gravitational speed of light is slowing as e𝕙/+𝕚d, conversely it appeared to go faster than c with the expansion of Biv space-time after the big bang. This is because the -𝕚d and e𝕧 Pythagorean Triangles change inversely to the +𝕚d and e𝕙 Pythagorean Triangles, the higher the e𝕙 height the further back towards the big bang with a contraction of the angles θ.

Faster than c with inertial velocity

This is not the same as +𝕀D×e𝕙 gravitational work with a e𝕙 height contraction, it occurs from the e𝕙 height approaching its limit. So as this e𝕙/+𝕚d gravitational speed slows the e𝕧/-𝕚d inertial velocity appears to increase. The size of the universe contracts backwards in time in terms of the e𝕙 height, conversely the e𝕧 length increases. Galaxies with the highest doppler shifts can then appear to exceed the inertial velocity of light, this in the inverse of the slower gravitational speed of light going backwards in time.

The Doppler shift and α

The increasing e𝕙 height causes the angles θ in the gravitational -𝕚d and e𝕧 Pythagorean Triangles to contract. This causes the e𝕙 height contraction and slower +𝕚d gravitational time in stars and galaxies of these different heights. The effect is the same as in a gravitational well, e𝕪×-𝕘d photons as they rise up slow their -𝕘d rotational frequency and can do less -𝔾D×e𝕪 light work with a redshift. This is measured as an increasing redshift over a distance as the e𝕙 height because work is measured over a distance.

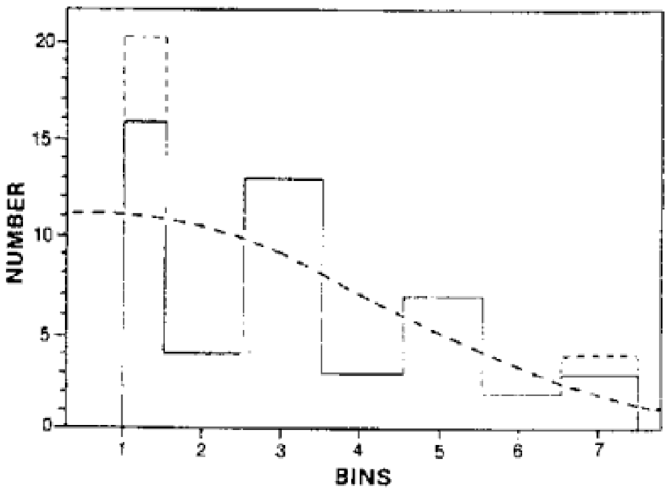
Relativistic Doppler shifts

As this distance increases there is more of a relativistic change, the Doppler shift itself is affected by this contraction of Biv space-time going into the past. This appears as a faster expansion of Biv space-time initially which slowed towards more recent times. The formula for this uses the Einstein equation where γ is the relativistic contraction of e𝕙 and +𝕚d.

Quantized Doppler shifts

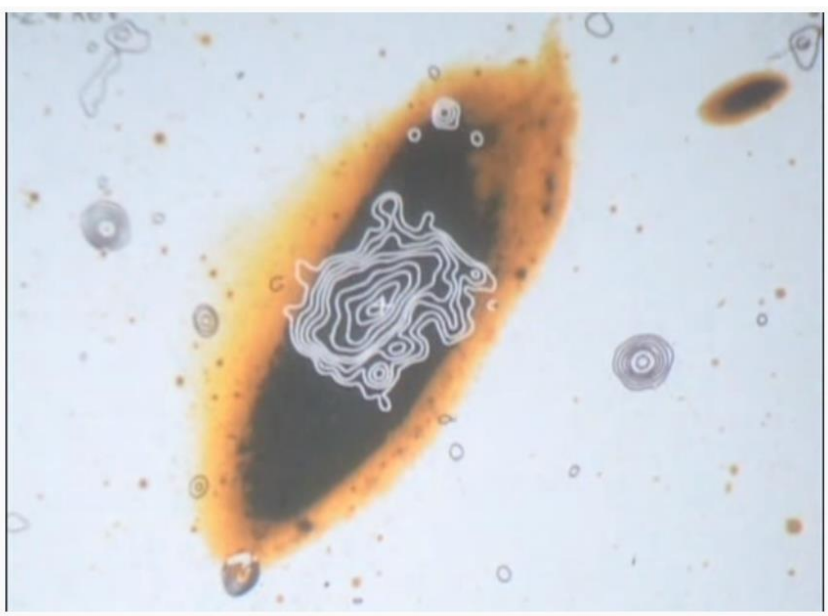
These Doppler shifts may also be quantized from the +𝕀D×e𝕙 gravitational work, also their relationship to $\alpha_{e\mathbb{h}}$. Doctor Tuft and Halton Arp proposed this, that galaxies may be arranged in quantized values of about ½ of 45 miles/second.

Redshift differences for double galaxies. Instead of following the expected distribution (dotted line), they tend to fall into bins separated by 72-km/sec. (Tifft, William G., and Cocke, W. John; "Quantized Galaxy Redshifts," *Sky and Telescope*, 73:19, 1987.)



Quantization inside galaxies

There are also signs of a quantization inside galaxies according to Tuft, and later with Halton Arp. That would be consistent with this model, a galaxy might not be modeled by a depression in a flat sheet. This is often used in illustrating general relativity, instead it would be like steps going into a depression where each has a slightly different Doppler shift from the +𝕀D×e𝕙 gravitational work. This is analogous to the quantized +𝕆D×e𝕒 potential work with orbitals in an atom. Because the two kinds of work are proportional, that would give different -𝕘d rotational frequencies from each step.



Halton Arp Intrinsic Red Shift

MOND and dark matter

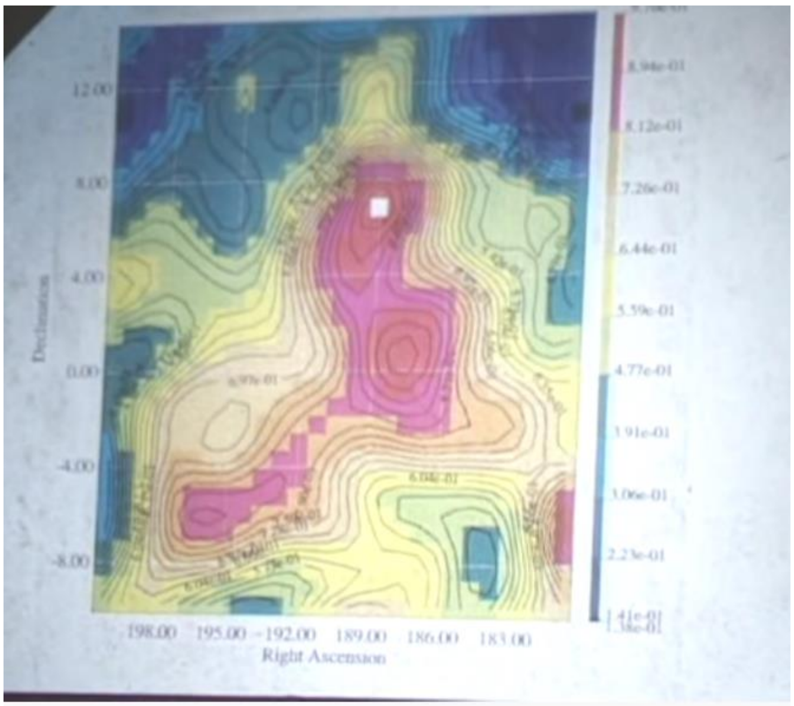
In this model +𝕀D×e𝕙 gravitational work would form a logarithmic spiral, the outside of the spiral is tending towards a circle. An exponential spiral would be from -𝕀D×e𝕧 inertial work, the outer stars would have more inertia and more centrifugal force. These two are proportional to each other and so a single spiral shape is formed.

Logarithmic and exponential spirals

With a constant Pythagorean Triangle area, when one side is squared as the +𝕀D gravitational torque, and the other is linear as e𝕙 height, this gives the logarithmic or exponential spiral. The squared force in the Eℍ/+𝕚d gravitational impulse acts like Newtonian gravity, but this must also maintain the constant +𝕚d and e𝕙 Pythagorean Triangle to give the exponential spiral.

Quantized steps and modified gravity

With quantized steps in the +𝕀D×e𝕙 gravitational work, that can also act like modified gravity. When stars are on a step then they cannot move further outwards with a centrifugal force or -𝕀D×e𝕧 inertial work. This would be proportional to the logarithmic spiral. In this Halton Arp image there are steps of quantization. The outer step would tend to be held in more from the stars escaping.



n Arp Intrinsic Red Shift

A cosmic web like molecular bonds

The galaxies would then tend to bind together into a kind of cosmic web, a similar process to that from the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work in molecules. In between them there might be a single step of +𝕀D gravitational probability, that would prevent them from drifting apart.

Entanglement and α

When two photons are entangled, their -𝕘d rotational frequencies are opposed as clockwise and counterclockwise. With α this is $e^{-\mathbb{O}D}$ with two possible spin directions of clockwise and counterclockwise. Because of this the α value is canceled out between the two photons, when they move far apart a first photon might be measured for its spin orientation with -𝔾D×e𝕪 light work. With an α value of zero between them then c must also be zero, the spin of the second photon is then measured with -𝔾D×e𝕪 light work to be opposite that of the first photon.

Bosons and α

When two electrons have opposing spins then they can both fit into the ground state, they both have the same α value of $e^{-𝕠d}$, they are entangled. Because of this they act as a boson, they have a lower -𝕆D kinetic torque and probability to a single electron as a fermion.

Superconductivity and α

In superconductivity two electrons are forced together with opposing spins as a Cooper pair or boson. They each have this ground state value of $e^{-𝕠d}$, they are compressed together by the lattice of atoms they are in. There is also a low temperature e𝕪, this reduces the E𝕐/-𝕠d kinetic impulse of electrons so the Cooper pair can move as a quantized wave with no collisions. As a wave they move with no friction, resistance from the +𝕠d and e𝕒 Pythagorean Triangles in the lattice is removed because they remain in the ground state.

Below the ground state and α

Below the ground state of a hydrogen atom, there is the +𝕠d and e𝕒 Pythagorean Triangle as the proton. In the ground state as $e^{-𝕆D}$ with the electron, going below this would invert the exponent into a fraction. This appears as a square +2/3 and -1/3.

The neutron and the ground state

There is +𝕆D×e𝕒 potential work done by the positive 2/3 and -𝕆D×e𝕪 kinetic work done by the negative 1/3, these can combine together into a neutron with two -1/3 and one +2/3. This contains the $e^{+𝕆D}$ value where D is one for α, also the $e^{-𝕆D}$ value for D is one for the electron. When the neutron decays these separate to give the proton and electron values for α, the electron rises up to the ground state.

The coefficient as impulse

In the ground state the -𝕆D×e𝕪 kinetic work is $e^{-𝕆D}$ as α, the inverse of this is e^{ev}. When the derivative is taken of this with respect to E𝕍 this gives E𝕍e^{ev}, in conventional physics this coefficient is a force that pushed the particle on a vector as an observation. In this model that would be the E𝕐/-𝕠d kinetic impulse, it appears to be quantized because it is the inverse of a quantized value -𝕆D.

Collapse of the wave function and h

The wave function then as -𝕆D connects to α, this is also a probability such as for an electron to decay to a lower orbital. This probability can be measured, but it cannot be observed as a particle. The collapse of the wave function in this model is where this can be observed as a particle. Here -𝕠d ×e𝕐/-𝕠d is h in dimensional analysis, the E𝕐/-𝕠d kinetic impulse is being observed with this even though impulse itself is not quantized.

A quantized observation

In an orbital then h can observe the quantized electron as the -𝕠d and e𝕪 Pythagorean Triangle, the different observation can give the -𝕆D kinetic probability as the wave function. This happens because the exponent is the inverse of α. The value of h comes from the area of the e𝕪 and -𝕘d Pythagorean Triangle as the photon.

A probability density and impulse

When $e^{-𝕆D}$ is regarded as an inverse of this exponent E𝕍, there is 1/-𝕆D in the exponent for different squared values as D. In this model all spin Pythagorean Triangle sides when inverses and squares give the integral normal curve. That gives the probability values of D, these can give different probability densities rather than the exact normal curve. The coefficient derivative gives a vector which is an acceleration, that has a relationship to the -𝕠d kinetic mass. If the observation is heavier then the -𝕚d kinetic time can determine how long before it decays back into -𝕆D×e𝕪 kinetic work for example. It can also determine how long before the electron drops down to another orbital.

Deriving e and π from α

In the ground state $e^{+𝕆D}$ has D=1, this can refer to a potential integral area bounded by the orbital. The inverse of this is e^{ea} so that this altitude is also 1, then the area of this integral is πr^2 or π. With the $e^{-𝕆D}$ exponent this is an area under the hyperbola with a value of e, as an integral area of -𝕆D×e𝕪 kinetic work it is in hyperbolic geometry. The circular geometry value is π, so 1 in the exponent gives both π and e. The value of α connects and generates both e and π in the ground state, as α is compressed it causes the circular geometry of the +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the -𝕠d and e𝕪 Pythagorean Triangle as the electron to change shape. From this comes the changes in general and special relativity.

α and δ

In this model δ is the first Fiegenbaum number, this connects to α as a limit. 1/√(2π) is close to the second Fiegenbaum number 2.5029, so $\delta^2 \approx 1/(2\pi) \times 1/\alpha$ or $\delta^2 \times \beta^2 \approx 1/\alpha$.

$$\delta' = (1/2\pi\alpha))^{1/2} = 4.670114 \approx \delta = 4.669201609$$

$$\delta' - \delta = 0.000912$$

Cosine 1/α

The cosine of 1/α is ≈ 1/e so that connects α to e, the second Fiegenbaum number connects it to π. This comes from α as the first Fiegenbaum number connects these two together. In this model there is a quantization from the cosine 1α, in between this there are two chaotic values as δ and β which approach this quantization. This is α as radians, here a radian is 1 as the radius of a unit circle. Taking α as a circumference this would have a radius of α/β^2. α comes from e𝕍/-𝕚d as the inertial velocity of the electron in the ground state, e would be 1 and d ≈ 137.

Chaos in between quantization

Because of this there can be chaotic changes and cascades in between the quantized α orbitals and probabilities. The coefficient E𝕍 can then have chaotic vector forces of impulse with a limit of the next quantized values. The particle can then be observed with a E𝕐/-𝕠d kinetic impulse, it becomes a wave function again with -𝕆D×e𝕪 kinetic work so the particle spreads out again as this probability wave.

Tines and quantized values

The second Fiegenbaum number as 2.5092 approaches √(2π) as 2.50662, so when the integral area of the normal curve comes from the α exponents it can multiply them to give a probability of 1. That is why according to this model, 1/√(2π) is used in the normal curve equation. In between these values of D there are tines of chaos, these act like quantized values. In between them there can be chaotic changes that approach these regular quantized whole numbers.

δ, β, and κ

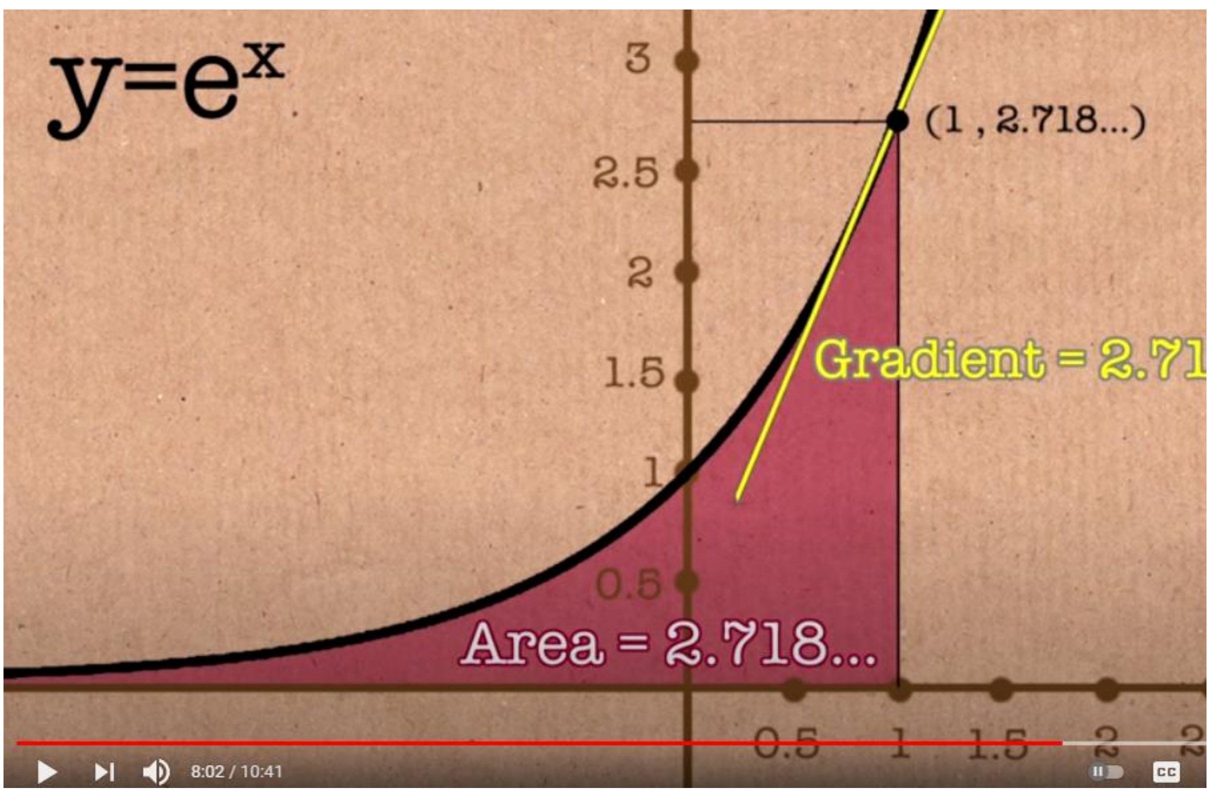
The cascades from the first Fiegenbaum number are shapes like parabolas, this connects to the parabolic constant. That connects the circular geometry of π, the hyperbolic geometry of e, to the universal parabolic constant referred to as κ or kappa here as 2.295587... The first Fiegenbaum constant δ is 4.669201, when half of the latis rectum is used then κ is doubled as 4.591174. This is close to δ, the chaotic cascade of these parabolas can jump to κ.

Circular to parabolic geometry

This value of κ is consistent with comparing the radius of a circle to a half circumference. This would occur in a conic section, at 45° to this the half of the latis rectum is like this radius and the arc of the parabola is like half of the circle. In this model then the change from circular to parabolic geometry moves through elliptical geometry to this change of the constant from π to κ.

Hyperbolic geometry

Here e is associated with the integral area, that would be related to work. It is also derived from the gradient or slope, that can be regarded as an -ꝏd and eẙ Pythagorean Triangle for example with sides proportionally of 1 and 2.718… as e.



Fourier Analysis, work and observations

This can be seen by adding together waves in Fourier Analysis, that is because the different -𝕆D values interfere constructively and destructively. That gives a probable outcome where at a given instant the work can be observed as an impulse, then it becomes work and a wave again. The work probability waves are then added up in Fourier Analysis, the inverse of this is an amplitude as the observation of impulse.

Cerenkov radiation

This is where iotas in a nuclear reactor are emitted near the inertial velocity of c. When they go through a denser medium, where this is the probability density of +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work in matter, the inertial velocity c needs to slow. This is because it is closer to a +𝕚d gravitational field, the gravitational geodesic around these atoms has a larger angle θ as the e𝕙 height decreases.

Exponential decrease with α

That is like lower orbitals of an atom, the +𝕠d and e𝕒 Pythagorean Triangle has a larger angle θ there as the e𝕒 altitude decreases. This remains proportional to α and c because α is an exponent. It can then decrease exponentially as a square when the distance or e𝕒 altitude changes linearly. This exponential decrease can then cause the matter from the reactor to decelerate.

The inertial velocity and gravitational speed c remains consistent

The inertial velocity e𝕧/-𝕚d of light decreases near a gravitational field, proportionally it also decreases near a +𝕠d potential magnetic field. When the matter from the reactor is moving near c, it must decelerate quickly because the +𝕚d gravitational time is slower. This also decreases the -𝕚d inertial time and the matter's e𝕧 length is contracted, that is because the $\alpha_{e𝕪}$ from the -𝕠d and e𝕪 Pythagorean Triangle must remain consistent to the from the +𝕠d and e𝕒 Pythagorean Triangle nucleus.

$\alpha_{e𝕒}$ and $\alpha_{e𝕪}$ must remain consistent

If it did not then the exponents $e^{-𝕆D}$ and $e^{+𝕆D}$ would not remain consistent. This then causes the matter from the reactor to decelerate to under c in the heavy water, that causes it to emit e𝕪×-𝕘d photons with the blue Cerenkov radiation.

Blue light rotates more with -𝔾D×e𝕪 light work

When white light is refracted through a prism this is bent in different paths, that comes from the denser medium. Because the path is different there is a larger e𝕧 length contraction where the higher -𝕘d rotational frequency is rotated more. These higher frequency photons would come from the higher orbitals of an atom, that is where there is a higher -𝕆D kinetic probability or torque.

Blue light slows down more

These photons also slow down more in the prism's medium, this is because of α where the exponent is larger with these higher orbitals. This is a relativistic effect from the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, there is a e𝕧 length contraction in the light rotated more slowing it down. The effect is similar to a muon going further in a planet's atmosphere, it has a e𝕧 length contraction in its path and so it is as if it traveled a shorter e𝕧 length.

Newton's law of gravity If two objects with masses m_1 and m_2 are a distance r apart, the objects exert attractive forces on each other of magnitude

$$F_{1 \text{ on } 2} = F_{2 \text{ on } 1} = \frac{Gm_1 m_2}{r^2} \qquad (13.2)$$

The forces are directed along the straight line joining the two objects.

Inverse square law and parabolas

In this model the inverse square law comes from +𝕀D×e𝕙 gravitational work, this is because it refers to the +𝕚d gravitational field not a particle. With the Eℍ/+𝕚d gravitational impulse this uses the parabola in this model, the difference is a particle is needed to define the trajectory of the parabola.

Slope and integral

The change in the slope of the parabola comes from the changing angle θ of the +𝕚d and e𝕙 Pythagorean Triangle, this changes the observation of the Eℍ/+𝕚d gravitational impulse. The integral area around matter does not change in time because the +𝕚d gravitational time is squared as the +𝕀D gravitational probability.

A timeless geodesic of probability

That makes a gravitational geodesic timeless in Biv space-time, +𝕚d gravitational time becomes a dimension in General Relativity in the sense that it is not passing as moments of force on a +𝕚d timeline as with the Eℍ/+𝕚d gravitational impulse. Instead matter is attracted and repelled by the changing +𝕀D gravitational probabilities to move and accelerate. Here the term moments is used as in conventional physics, to denote torque as a force. For linear values such as +𝕚d these would be gravitational instants or fluxions.

Balancing gravitational and inertial work

In this model the +𝕀D×e𝕙 gravitational work between the two masses below is the same, as described above. The +𝕀D×e𝕙 gravitational work is an inverse square force because +𝕀D is a square, this changes inversely to the e𝕙 height between the masses. When two gravitational masses in the diagram below are slowly orbiting each other, this balances their +𝕀D×e𝕙 gravitational work and their -𝕀D×e𝕧 inertial work.

Center of gravitational and inertial mass

Gravity is in circular geometry, because of this there is a center of +𝕚d gravitational mass they orbit around. The +𝕀D gravitational probabilities are balanced, similar to how they would be inside a planet around this center of gravitational mass. The inertial mass -𝕚d is also balanced around this center of inertial mass though it is in hyperbolic geometry, this is because the +𝕚d and e𝕙 Pythagorean Triangle as gravity and the -𝕚d and e𝕧 Pythagorean Triangle as inertia are inverses of each other. The two masses have a tendency to fly apart in a hyperbola from inertia, also to orbit each other with gravity.

Free fall and weightlessness

A similar process happens with a heavier and a lighter gravitational mass falling towards an airless planet. This does not separate the gravitational masses, nor does it tend to tear apart the masses unless there are strong tidal effects. There must then be an equal force in between each mass and the planet, if not then one would drop faster than the other. They are in free fall according to the

Eℍ/+𝕚d gravitational impulse, weightless according to the +𝕀D×e𝕙 gravitational work. There is also a center of gravitational and inertial mass between the proton and the electron in an atom.

Action/reaction pairs

The forces in between the two masses are an action/reaction pair, as an example m_1 might have 10 times the +𝕚d gravitational mass of m_2. With m_1 its D value of its +𝕀D×e𝕙 gravitational work is 10 times larger, but this can only act on the -𝕀D×e𝕧 inertial work and the -𝕚d inertial mass of -𝕚d×e𝕧/-𝕀D. This is like with an atom, there must be a proton with its +𝕠d potential mass or potential magnetic field to balance the -𝕠d kinetic mass or kinetic magnetic field of an electron.

Charge imbalance and gravitational/inertial imbalance

If there are more electrons than protons then those electrons will leave the atom instead of all of them moving to higher orbitals. The protons will not be able to attract more electrons. Conversely if there are more protons than electrons then those electrons are not attracted more, down to lower orbitals. The interactions between the mass then occur between the +𝕚d gravitational mass and the -𝕚d inertial mass. These also balance because they are equivalent.

Gravity attracts inertia not other gravity

If m_1 has 10 times the +𝕚d gravitational mass compared to the -𝕚d inertial mass of -𝕚d×e𝕧/-𝕀D, only 10% if it is used as with the proton. With m_2 this has 10% of the +𝕚d gravitational mass, but it can only attract the same amount of m_1, so the actual interactions are the same. In this model the +𝕚d gravitational mass of m_1 from the protons is attracting the -𝕚d inertial mass of -𝕚d×e𝕧/-𝕀D in its electrons. It is not attracting the +𝕚d gravitational mass or +𝕠d potential mass of -𝕚d×e𝕧/-𝕀D, and vice versa.

FIGURE 13.4 The gravitational forces on masses m_1 and m_2.

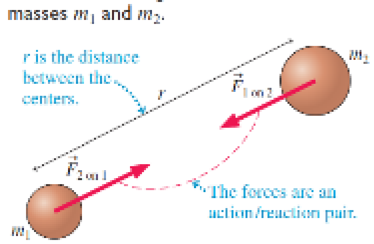
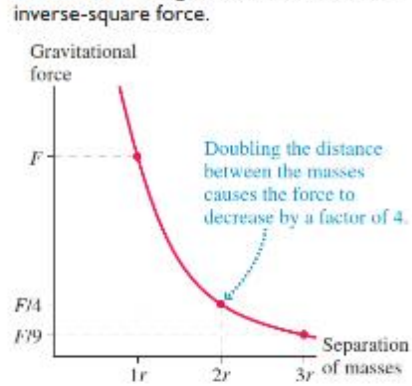


FIGURE 13.5 The gravitational force is an inverse-square force.



Two kinds of acceleration

With gravity there is the +𝕚d gravitational mass, this can also be written as F=ma. That becomes +𝕚d×e𝕙/+𝕀D, the Eℍ/+𝕚d gravitational impulse as meters²/second is classically approximate to e𝕙/+𝕀D as meters/second². The Eℍ/+𝕚d gravitational impulse is observed in (13.4) below, Eℍ is the radius squared or r^2. That is equivalent to in F=ma where the acceleration squares the -𝕚d inertial time instead of using -𝕚d/E𝕍 which is the same in dimensional analysis as with gravity.

Inertia as a reaction

In this model inertia is a reaction force only, in an accelerating car for example people observe and measure a tendency to react against a change in their velocity. This happens when they are increasing their velocity, they are pushed back in their seats with -𝕀D×e𝕧 inertial work. When braking they are pushed forward also with -𝕀D×e𝕧 inertial work. This is work in F=ma because the denominator has the square as -𝕀D.

Gravity as an action

Gravity is an active force, because of this there is no reaction against another force. A rocket can then fall weightless with +𝕀D×e𝕙 gravitational work and in free fall with an E𝕍/-𝕚d inertial impulse. The -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse of the rocket would be subtracted from the +𝕀D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse, for example in going past a planet a heavier rocket might not be captured by its gravity.

Inertia and kinetic energy

In both cases the rocket remains weightless and in free fall, the reaction forces of inertia are subtracted from gravity. This is because in Biv space-time the +𝕚d and e𝕙 Pythagorean Triangle with a +𝕚d gravitational mass is opposed by the -𝕚d inertial mass. With an accelerating car there is the active -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse, because this has a negative sign the -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse reacts against this in an opposite direction.

The Principle of Equivalence

Newton's law of gravity depends on a rather curious assumption. The concept of *mass* was introduced in Chapter 5 by considering the relationship between force and acceleration. The *inertial mass* of an object, which is the mass that appears in Newton's second law, is found by measuring the object's acceleration a in response to force F:

$$m_{\text{inert}} = \text{inertial mass} = \frac{F}{a} \qquad (13.3)$$

Gravity plays no role in this definition of mass.

The quantities m_1 and m_2 in Newton's law of gravity are being used in a very different way. Masses m_1 and m_2 govern the strength of the gravitational attraction between two objects. The mass used in Newton's law of gravity is called the **gravitational mass.** The gravitational mass of an object can be determined by measuring the attractive force exerted on it by another mass M a distance r away:

$$m_{\text{grav}} = \text{gravitational mass} = \frac{r^2 F_{M \text{ on } m}}{GM} \qquad (13.4)$$

Acceleration does not enter into the definition of the gravitational mass.

These are two very different concepts of mass. Yet Newton, in his theory of gravity, asserts that the inertial mass in his second law is the very same mass that governs the strength of the gravitational attraction between two objects. The assertion that $m_{\text{grav}} = m_{\text{inert}}$ is called the **principle of equivalence.** It says that inertial mass is *equivalent to* gravitational mass.

Inertial speed and orbits

When standing on a planet, the surface also moves with an inertial speed like in an orbit. If the planet was spinning fast enough then matter on the surface would begin to rise up with -𝕀D×e𝕧 inertial work. This would be because the -𝕀D×e𝕧 inertial work was greater than the +𝕀D×e𝕙 gravitational work of the planet.

Gravitational work to the CMB

In this model +𝕀D×e𝕙 gravitational work is the main force of gravity out to the CMB, this is because the +𝕚d and e𝕙 Pythagorean Triangle reaches its limit there. Just as an electron can have enough of a E𝕐/-𝕠d kinetic impulse to escape an atom's +𝕆D×e𝕒 potential work, matter at the CMB can escape the limit of the +𝕚d and e𝕙 Pythagorean Triangle's maximum height by moving with a velocity away from the local observer and measurer.

Moving through the CMB

This would make them disappear because photons from them would be too redshifted to be measured, they could not raise an electron from the ground state. In this model then +𝕀D×e𝕙 gravitational work is mainly used rather than the E𝕙/+𝕚d gravitational impulse in (13.7). They are classically approximate, but using the E𝕙/+𝕚d gravitational impulse has +𝕚d gravitational time as moments on a clock gauge.

A clock gauge with no force

Because they act as a gauge there is no force, this gives a Newtonian clockwork universe where clocks are presumed to not have their hands accelerate as a force. Instead the acceleration and other forces occur by squaring the straight Pythagorean Triangle sides as vectors.

Clock hands accelerating and decelerating

In General Relativity a clock can slow down at a lower e𝕙 height, this is a deceleration of the spin of the clock hands. In Special Relativity increasing the velocity of a rocket also decelerates the spin of clock hands on it, in both cases time is squared in this model as a force.

Gravity stronger than inertia

Because gravity is always stronger than inertia out to the limit of the +𝕚d and e𝕙 Pythagorean Triangle, then this remains in circular geometry. The CMB appears as a sphere or a circle in all directions, inside this +𝕀D×e𝕙 gravitational work dominates where time accelerates and decelerates. This would be the limit of e𝕪×-𝕘d photons like a photosphere around an event horizon.

To illustrate the connection between Newton's law of gravity and the familiar $F_G = mg$, **FIGURE 13.6** shows an object of mass m on the surface of Planet X. Planet X inhabitant Mr. Xhzt, standing on the surface, finds that the downward gravitational force is $F_G = mg_X$, where g_X is the free-fall acceleration on Planet X.

We, taking a more cosmic perspective, reply, "Yes, that is the force *because* of a universal force of attraction between your planet and the object. The size of the force is determined by Newton's law of gravity."

We and Mr. Xhzt are both correct. Whether you think locally or globally, we and Mr. Xhzt must arrive at the *same numerical value* for the magnitude of the force. Suppose an object of mass m is on the surface of a planet of mass M and radius R. The local gravitational force is

$$F_G = mg_{surface} \qquad (13.5)$$

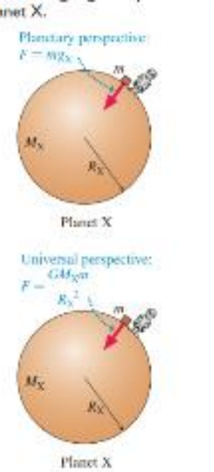
where $g_{surface}$ is the free-fall acceleration at the planet's surface. The force of gravitational attraction for an object on the surface ($r = R$), as given by Newton's law of gravity, is

$$F_{M\,on\,m} = \frac{GMm}{R^2} \qquad (13.6)$$

Because these are two names and two expressions for the same force, we can equate the right-hand sides to find that

$$g_{surface} = \frac{GM}{R^2} \qquad (13.7)$$

FIGURE 13.6 Weighing an object of mass m on Planet X.



Changing g

Here g decreases with the square of the distance as Eℍ. The Eℍ/+𝕚d gravitational impulse decreases with the square of the distance, as Eℍ increases then +𝕚d as the gravitational field decreases linearly. In (13.8) this is written with Eℍ in the denominator to give +𝕚d/Eℍ. Because the force g varies with the change in height the factor e𝕙 is included, this is proportional to -𝕚d in F=ma. That gives e𝕙 × +𝕚d/Eℍ in the same form as F=ma, with the spin and straight Pythagorean Triangle sides swapped over. That leaves +𝕚d/e𝕙 which decreases as e𝕙 increases in the denominator.

History and changing g

Eℍ in this model is the gravitational displacement history, as a planet forms there is an increased Eℍ displacement towards it as matter is attracted downwards. As Eℍ increases as a displacement, then g also increases.

Decrease of g with Distance

Equation 13.7 gives $g_{surface}$ at the surface of a planet. More generally, imagine an object of mass m at distance $r > R$ from the center of a planet. Further, suppose that gravity from the planet is the only force acting on the object. Then its acceleration, the free-fall acceleration, is given by Newton's second law:

$$g = \frac{F_{M\,on\,m}}{m} = \frac{GM}{r^2} \qquad (13.8)$$

This more general result agrees with Equation 13.7 if $r = R$, but it allows us to determine the "local" free-fall acceleration at distances $r > R$. Equation 13.8 expresses Newton's discovery, with regard to the moon, that g decreases inversely with the square of the distance.

Balancing gravitational and inertial work

The value g changes with the Eℍ height squared, but it can also be measured as the change in e𝕙/+𝕚d gravitational speed in an orbit. When the e𝕙 height increases then +𝕚d as the gravitational time decreases inversely. When a satellite is in orbit it has inertia from its -𝕚d inertial mass, its -𝕀D×e𝕧 inertial work is balanced against the +Id×e𝕓 gravitational work at a e𝕙 height. This is because the +𝕚d gravitational field weakens with a greater height, a satellite orbits where this balances its inertial speed as e𝕧/-𝕚d.

Gravitational and inertial torque

When the +𝕀D×e𝕙 gravitational work is measured then +𝕀D weakens as a gravitational torque on the satellite according to an inverse square law. With a greater e𝕙 height the satellite slows its e𝕧/-𝕚d inertial speed because -𝕚d increases proportionally to e𝕙, and e𝕧×e𝕙 as well as +𝕚d×-𝕚d are constants. The -𝕀D×e𝕧 inertial work of the satellite has a -𝕀D inertial torque, this reacts against the +𝕀D gravitational torque. That reduces the +𝕀D gravitational work so the satellite spins around more slowly and at a greater e𝕙 height.

TABLE 13.1 Variation of g with height above the ground

Height h	Example	g (m/s^2)
0 m	ground	9.83
4500 m	Mt. Whitney	9.82
10,000 m	jet airplane	9.80
300,000 m	space station	8.90
35,900,000 m	communications satellite	0.22

Gravitation and the potential

In this model the gravitational forces are proportional to those of the proton, it can be referred to as a combination of gravitational and potential force. In (13.12) this is shown as work, there is +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work. There is also a E𝔸/+𝕠d potential impulse and E𝕀/+𝕚d gravitational impulse, work is more common because both the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity are in circular geometry.

Captured into circular geometry and work

It is more common for electrons to be captured by protons and do -𝕆D×e𝕪 kinetic work in orbitals. With a planet it can capture moons with its +𝕀D×e𝕙 gravitational work. Because their trajectories are mainly curved then the force come from the spin Pythagorean Triangle sides squared as work.

Gravitational and potential impulse

The proton can also move with a E𝔸/+𝕠d potential impulse, for example in a particle collider. A planet can move with a Eℍ/+𝕚d gravitational impulse when attracted towards other matter. In an asteroid belt there can be a mixture of +𝕀D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse. The rings of a planet can be quantized to some degree, the asteroids can also move chaotically by colliding with each other.

The body problem

There can also be three body relationships where two asteroids might have opposing +𝕚d gravitational spins, they can approach each other so that two are orbiting more clockwise and the other counterclockwise. This cancels some of the +𝕀D×e𝕙 gravitational work allowing for a more straight-line motion with a Eℍ/+𝕚d gravitational impulse.

Chaos and π

In this model chaos occurs because the second Fiegenbaum constant approaches √1/2π, that is associated with the radius of a circle. When circular orbits are not reached then asteroids can move chaotically, avoiding trajectories associated with π.

Gravitational work and probability

In Figure 13.9 the +𝕀D×e𝕙 gravitational work comes from a +𝕀D gravitational probability over a distance r as e𝕙. This is not the same as with Newton's equation for gravity, there r as e𝕙 becomes r^2 as Eℍ. This makes it the Eℍ/+𝕚d gravitational impulse not +𝕀D×e𝕙 gravitational work.

F=ma measures work

With F=ma this measures work in this model because in f=-𝕚d×e𝕧/-𝕀D an iota is moved a length e𝕧 with a reactive force of -𝕀D as the inertial probability.

Observing h as a force

This equation can begin with the inertial momentum as -𝕚d×e𝕧/-𝕚d, in this model h as -𝕠d ×e𝕐/-𝕠d is also -𝕚d×e𝕍/-𝕚d. This is where e𝕧 is observed as the E𝕍 length displacement, that is proportional in h to E𝕐 as the kinetic electric displacement. These forces would change with increments of h as photons colliding with the object accelerated.

A continuous quantization

It is still quantized in the sense that individual photons can collide with the atoms in a car for example, the changes give a continuous spectrum because the collisions change the angles θ in the e𝕪 and -𝕘d Pythagorean Triangles as the photon. This is because, as in Compton scattering where a photon collides with an electron, the change in velocity of the electron occurs by the -𝕘d rotational frequency of the photon being changed.

Boltzmann's constant

The equation can also be -𝕠d ×e𝕪/-𝕆d and -𝕚d×e𝕧/-𝕆D, these are both the same as F=ma with dimensional analysis. In this model they also act as Boltzmann's constant in an atom, the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work are being measured and so there is a Gaussian with probability. With F=ma this also refers to probability, in a gas the collision between molecules occurs on a normal curve with -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. In this case F=ma would give the changes in velocity of the gas molecules as they collide with each other.

Straight-line forces

In this model to make F=ma impulse, the same format as the gravitational equation, then it would be like h as -𝕠d ×e𝕐/-𝕠d and -𝕚d×e𝕍/-𝕚d. This would be straight-line forces, the same format in the Eℍ/+𝕚d gravitational impulse observed the motion of two amounts of matter directly towards each other.

13.5 Gravitational Potential Energy

Gravitational problems are ideal for the conservation-law tools we developed in Chapters 9 through 11. Because gravity is the only force, and it is a conservative force, both the momentum and the mechanical energy of the system $m_1 + m_2$ are conserved. To employ conservation of energy, however, we need to determine an appropriate form for the gravitational potential energy for two interacting masses.

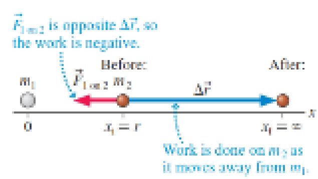
The definition of potential energy that we developed in Chapter 11 is

$$\Delta U = U_f - U_i = -W_c(i \rightarrow f) \quad (13.12)$$

where $W_c(i \rightarrow f)$ is the work done by a conservative force as a particle moves from position i to position f. For a flat earth, we used $F = -mg$ and the choice that $U = 0$ at the surface $(y = 0)$ to arrive at the now-familiar $U_G = mgy$. This result for U_G is valid only for $y \ll R_e$, when the earth's curvature and size are not apparent. We now need to find an expression for the gravitational potential energy of masses that interact over *large* distances.

FIGURE 13.9 shows two particles of mass m_1 and m_2. Let's calculate the work done on mass m_2 by the conservative force $\vec{F}_{1\text{ on }2}$ as m_2 moves from an initial position at distance r to a final position very far away. The force, which points to the left, is opposite the displacement; hence this force does *negative* work. Consequently, due to the minus sign in Equation 13.12, ΔU is *positive*. A pair of masses *gains* potential energy as the masses move farther apart, just as a particle near the earth's surface gains potential energy as it moves to a higher altitude.

FIGURE 13.9 Calculating the work done by the gravitational force as mass m_2 moves from r to ∞.



Changing from impulse to work

Here the gravitational force is +𝕀D×eh gravitational work, where two +𝕚d gravitational masses are multiplied together. In (13.14) the equation using r^2 as Eℍ is the Eℍ/+𝕚d gravitational impulse, by taking the integral of this they get r or eh. In this model that means the eh height is no longer a squared force, the integral of work acts as an area or field.

Two forces and uncertainty

In (13.13) there are the two masses multiplied together, which in this model is a squared force, then this is divided by r^2. Here this is not allowed because there are two forces in one +𝕚d and eh Pythagorean Triangle, the uncertainty principle forbids an observation of impulse in an instant and a measurement of work in the same position.

Observing and measuring together

Instead, the +𝕚d and eh Pythagorean Triangle can have a Eℍ/+𝕚d gravitational impulse, it is an inverse square law where r^2 or Eℍ is the force. It is not possible with certainty to convert from the Eℍ/+𝕚d gravitational impulse to the +𝕀D×eh gravitational work because Eℍ cannot be observed as a position because it is an interval. Also +𝕀D in +𝕀D×eh gravitational work cannot be measured as an instant because it is a duration of time.

Calculus and forces

The reason the Eℍ/+𝕚d gravitational impulse can be converted into +𝕀D×eh gravitational work in conventional calculus is that impulse is a derivative of the Pythagorean Triangle slope. Work is the integral of the Pythagorean Triangle area. That allows them to be changed from one to another with calculus, in this model that cannot be done with certainty because there is a change of force.

Gravitational work as a wave function

The +𝕀D×eh gravitational work acts like a wave equation in this model because the +𝕚d gravitational field has a wave nature. This makes it similar to -ψ or -𝕠d for the electron, related to kinetic energy.

Using ψ^2 as probability

This can be referred to as +ϕ to use a similar nomenclature to that of quantum mechanics using ψ, then $+\phi^2$ would be +𝕀D as the gravitational probability. The -𝕠d kinetic magnetic field here is squared to give the -𝕆D kinetic probability which is $-\psi^2$, that is the same as in the wave function in Schrodinger's equation.

The clockwork universe and wave functions

In this model there would be no direct conversion from the inverse square law to work, that is because it introduces uncertainty. In the Newtonian clockwork universe there is only the Eℍ/+𝕚d gravitational impulse and so +𝕚d gravitational time acts as moments on a clock gauge. To convert this to +𝕀D×eh gravitational work is a second force, the impulse has an uncertainty because it is chaotic here.

No randomness in impulse

For example, when particles collide there is no randomness, each path of a particle could be observed forwards and backwards in time. With no randomness there is no probability, so there cannot be a direct conversion to a probability as a wave function in this model. Instead, there can be a second force as a measurement which squares the +𝕚d gravitational time, it becomes a +𝕀D gravitational probability.

Unobserved and unmeasured

In Biv spacetime the +𝕚d and e𝕙 Pythagorean Triangle is gravity and the -𝕚d and e𝕧 Pythagorean Triangle is inertia. It is not necessary in this model to observe the Eℍ/+𝕚d gravitational impulse and then change that into +𝕀D×e𝕙 gravitational work. Instead, the +𝕀D×e𝕙 gravitational work measurement is done from the +𝕚d and e𝕙 Pythagorean Triangle, that has no forces before the measurement. These Pythagorean Triangles exist when not being observed or measured, this is for conservation and symmetry because often nature has no forces.

Conserving the intervals between forces

For example, a photon in space is not interacting with anything, otherwise it would be absorbed or colliding with atoms. Hydrogen atoms in space have few interactions because they are so widely spaced. If forces were needed for conservation, then there would not be consistent forces when they did interact.

Fluxions and intervals

The difference comes from the idea of infinitesimals and fluxions in calculus, they are assumed to be nonzero but have no size. In conventional physics and this model, the e𝕪 and -𝕘d Pythagorean Triangle has a size, this is the conventional term of energy in a photon. Because there are no infinitely small quantities in conventional physics then calculus is an approximation. In converting from the Eℍ/+𝕚d gravitational impulse to +𝕀D×e𝕙 gravitational work there is some uncertainty, this comes from the calculus Pythagorean Triangle not shrinking to be infinitely small.

Observing and measuring photons

To observe a photon in this model there is the e𝕐/-𝕘d light impulse, that is where the e𝕪 kinetic electric charge of the photon is squared as a force. But then the photon is changed, in a collision with an electron it would have a different -𝕘d rotational frequency and e𝕪 wavelength. It is not possible to then convert this photon into a measurement of -𝔾D×e𝕪 light work, the angle θ of the photon is changed.

Gravis and photons

In this model the same happens with gravity, when the Eℍ/+𝕚d gravitational impulse is observed the +𝕚d and e𝕙 Pythagorean Triangle is very small but not infinitely so. After this observation of the impulse the +𝕚d and e𝕙 Pythagorean Triangle has changed like the e𝕪×-𝕘d photon, then it cannot be directly converted with calculus back into +𝕀D×e𝕙 gravitational work. This is mediated with Gravis as +𝕘d×e𝕙 Pythagorean Triangles, they act like photons.

Observing and measuring in calculus

In observing the slope of a calculus Pythagorean Triangle there is no force, it is assumed this observation can be done without changing it. That is because it is calculated on paper and uses diagrams. In this model the observation changes the angle θ of the calculus Pythagorean Triangle, so that it has a different slope. One a second derivative is taken, then it can no longer be converted back into a second integral without a loss of certainty.

Measuring an integral then changing to a second derivative

Conversely if the second integral of a curve is measured, then the Pythagorean Triangles making up the top of this area must be changed in this measurement. It is not then possible to observe the slope of the curve with derivatives after this without some uncertainty.

The Newtonian clockwork universe and calculus

In the Newtonian clockwork universe impulse and work could be directly converted into each other. This is because Newton assumed there were infinitesimals and fluxions, with no size these could be squared to give instantaneous conversion in the same positions. In this model the infinitesimals, from the straight Pythagorean Triangle sides, and the fluxions, from the spin Pythagorean Triangle sides, exist but are not observable and measurable.

We can establish a coordinate system with m_1 at the origin and m_2 moving along the x-axis. The gravitational force is a variable force, so we need the full definition of work:

$$W(\mathrm{i} \rightarrow \mathrm{f}) = \int_{x_i}^{x_f} F_x \, dx \tag{13.13}$$

$\vec{F}_{1 \text{ on } 2}$ points toward the left, so its x-component is $(F_{1 \text{ on } 2})_x = -Gm_1m_2/x^2$. As mass m_2 moves from $x_i = r$ to $x_f = \infty$, the potential energy changes by

$$\Delta U = U_{\text{at } \infty} - U_{\text{at } r} = -\int_r^{\infty} (F_{1 \text{ on } 2})_x \, dx = -\int_r^{\infty} \left(\frac{-Gm_1m_2}{x^2} \right) dx$$
$$= +Gm_1m_2 \int_r^{\infty} \frac{dx}{x^2} = -\frac{Gm_1m_2}{x} \Bigg|_r^{\infty} = \frac{Gm_1m_2}{r} \tag{13.14}$$

Path and path integrals

In work the path does not matter, changing it does not require a force because the +𝕀D×e𝕙 gravitational work uses e𝕙 not Eℍ. This is like the path integral with the -𝕠d and e𝕪 Pythagorean Triangle, the path an electron or photon takes in a double slit experiment is not observable. This is because it would have to change to a E𝕐/-𝕠d kinetic impulse from -𝕆D×e𝕪 kinetic work and then the wave function would disappear.

Impulse and paths

It is when the electron or photon are observed as a particle with impulse that the path is known. If the electron or photon here acted with a E𝕐/-𝕠d kinetic impulse and e𝕐/-𝕘d light impulse respectively, then the paths would be observable with collisions as particles. The work and probabilities would not be measurable, then there would be no quantization of orbitals or interference through the double slits.

Force though fields not vectors

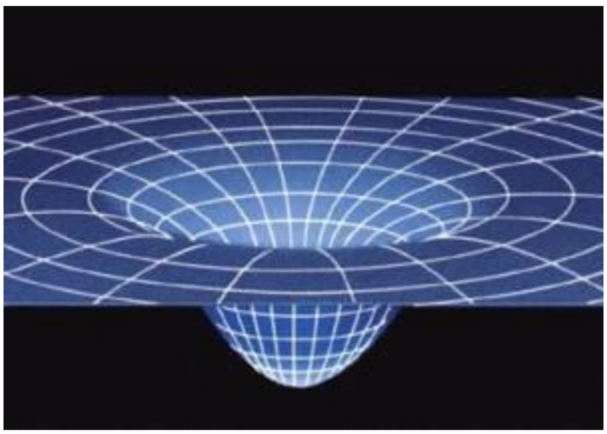
The +𝕀D×e𝕙 gravitational work is a field, so changing directions as vectors is only with the Eℍ/+𝕚d gravitational impulse. In this model the +𝕀D×e𝕙 gravitational work has a +𝕀D gravitational torque, the force is in a curved direction. If a planet and moon approach each other with +𝕀D×e𝕙 gravitational work, then this is a curved trajectory as the +𝕀D gravitational torque changes the moon's orbit.

Vectors only with impulse

This is why vectors should only used with impulse in this model. A vector denotes a path and a position with its orientation. In this model vectors are only used with impulse, an integral field is used for work that has no vector like path. Instead a work force is a squared area that goes on the sides of a Pythagorean Triangle, the areas can then be added up in the Pythagorean Equation.

Gravity without a field

If a planet and moon approach each other directly then this would be a E𝕳/+𝕚d gravitational impulse, there would be no +𝕀D gravitational torque and no work. That would be path dependent because the path has the observable impulse force. Generally the motion of a planet and moon has work and impulse, but the +𝕀D×e𝕙 gravitational work dominates. In terms of a geodesic there is no curved space, the planet moon approach each other directly like rolling straight down the sides of a depression.



Infinity and Biv spacetime

In this model there is no force when Pythagorean Triangles were infinitely far apart. The limit of the +𝕚d and e𝕙 Pythagorean Triangle for an observation of the E𝕳/+𝕚d gravitational impulse, or a measurement of +𝕀D×e𝕙 gravitational work, is the CMB. Beyond this the model proposes Biv space-time is unending, but at any position there will be the limit of the area of the +𝕚d and e𝕙 Pythagorean Triangle at a CMB. In that sense there would be no observable or measurable gravity at ∞.

A constant C in integration and derivatives

The integral area of the +𝕚d and e𝕙 Pythagorean Triangle has a constant C as in integration, this means the path integral can change with some uncertainty by the integral field area expanding and contracting. The +𝕀D×e𝕙 gravitational work around a planet can then encompass a larger integral field with this constant C, the integral is still the same as a square. In this model the derivative slope of the E𝕳/+𝕚d gravitational impulse also has a constant C, this allows the E𝕳 force to be different according to the height without changing the derivative equation.

A changing constant C as a force

In this model adding a constant C to an integral is a classical approximation only, the area represents a force itself. Because of this the curve must change, for example further out from a planet the +𝕀D×e𝕙 gravitational work would give a passing asteroid a different trajectory. This is because there would be a different +𝕀D gravitational torque as the constant C changed. With the

E𝕳/+𝕚d gravitational impulse the asteroid would curve differently in its trajectory as well, this is because the constant C would change its velocity differently.

NOTE We chose to integrate along the x-axis, but the fact that gravity is a conservative force means that ΔU will have this value if m_2 moves from r to ∞ along *any* path.

To proceed further, we need to choose the point where $U = 0$. We would like our choice to be valid for any star or planet, regardless of its mass and radius. This will be the case if we set $U = 0$ at the point where the interaction between the masses vanishes. According to Newton's law of gravity, the strength of the interaction is zero only when $r = \infty$. Two masses infinitely far apart will have no tendency, or potential, to move together, so we will *choose* to place the zero point of potential energy at $r = \infty$. That is, $U_\infty = 0$.

This choice gives us the gravitational potential energy of masses m_1 and m_2:

$$U_G = -\frac{Gm_1m_2}{r} \qquad (13.15)$$

This is the potential energy of masses m_1 and m_2 when their *centers* are separated by distance r. **FIGURE 13.10** is a graph of U_G as a function of the distance r between the masses. Notice that it asymptotically approaches 0 as $r \to \infty$.

Energy as impulse

In this model energy generally refers to impulse not work. The E𝕳/+𝕚d gravitational impulse would be where a planet and a satellite were separated, for example with a rocket firing directly upwards. This would have a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, that comes from the E𝕐/-𝕠d kinetic impulse.

When the satellite moves upwards in an exponential spiral this is from the -𝕆D×e𝕪 kinetic work being done. That is orthogonal to the e𝕙 height above the planet. Both of these are described by the diagram below, but the motion is very different.

FIGURE 13.10 The gravitational potential-energy curve.

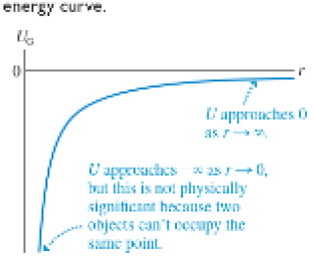
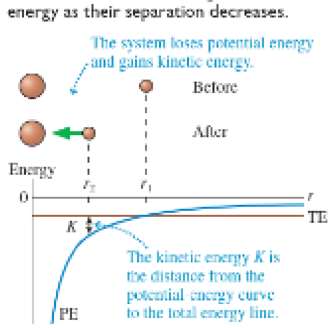


FIGURE 13.11 Two masses gain kinetic energy as their separation decreases.



Elliptical orbitals and Pythagorean Triangle area

Because the +𝕚d and e𝕙 Pythagorean Triangle as gravity, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia are inverses of each other when a straight Pythagorean Triangle side increases the other decreases. With a greater e𝕙 height the +𝕚d gravitational field at that height decreases to maintain a constant Pythagorean Triangle area.

Slower velocities at greater heights

At that height the increase of e𝕙 leads to an inverse contraction of e𝕧 as the length. The -𝕚d and e𝕧 Pythagorean Triangle then has its -𝕚d inertial time dilate to maintain a constant Pythagorean Triangle area. That makes e𝕧/-𝕚d as slower inertial speed at a greater height.

No forces in orbit

This can be written as mv^2/r, in terms of the +𝕚d and e𝕙 Pythagorean Triangle this would be +𝕚d×Eℍ/+𝕀D × 1/e𝕙. This uses the gravitational speed of e𝕙/+𝕚d where e𝕙 is the height and +𝕚d is the gravitational field or time. This can also represent the +𝕚d orbital period as a classical approximation. This equation reduces down to e𝕙/+𝕚d when the terms are cancelled out. That is because the orbit has a constant height and period, there are no observable and measurable forces.

Weightlessness and work

In this model then there is no force in the orbit from gravity, because of this a person on the satellite would be weightless. The equation can also be written in terms of the -𝕚d and e𝕧 Pythagorean Triangle as -𝕚d×E𝕍/-𝕀D × 1/e𝕧 because e𝕧 is the inverse of e𝕙. This reduces down to the inertial speed of e𝕧/-𝕚d, here it is referred to as a speed because there is no straight-line motion.

Orbit does not depend on mass

The e𝕙/+𝕚d gravitational speed and e𝕧/-𝕚d inertial speed do not depend on the mass of the satellite, this is because it moves where the +𝕚d gravitational mass and -𝕚d inertial mass have the same d value. The +𝕚d Pythagorean Triangle side in this model is the gravitational mass in an integral, and gravitational time in a derivative, then the change of time in a lower orbit is equivalent to this mass.

Time and mass equivalence

Equation (13.21) contains the +𝕚d gravitational mass and the -𝕚d inertial mass because it contains the +𝕚d gravitational and -𝕚d inertial time. To get into this orbit requires different amounts of +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, an asteroid with a larger -𝕚d inertial mass would go into a higher orbit than a smaller asteroid.

Inverse mass and time

The +𝕚d gravitational mass is larger in a lower orbit, and faster as gravitational time. A satellite would revolve faster around a planet like a clock speeding up, this is the inverse where the -𝕚d inertial time is contracted and the e𝕧 length is dilated.

13.6 Satellite Orbits and Energies

Solving Newton's second law to find the trajectory of a mass moving under the influence of gravity is mathematically beyond this textbook. It turns out that the solution is a set of elliptical orbits, which is Kepler's first law. Kepler had no *reason* why orbits should be ellipses rather than some other shape. Newton was able to show that ellipses are a *consequence* of his theory of gravity.

The mathematics of ellipses is rather difficult, so we will restrict most of our analysis to the limiting case in which an ellipse becomes a circle. Most planetary orbits differ only very slightly from being circular. The earth's orbit, for example has a (semiminor axis/semimajor axis) ratio of 0.99986—very close to a true circle!

FIGURE 13.16 shows a massive body M, such as the earth or the sun, with a lighter body m orbiting it. The lighter body is called a **satellite,** even though it may be a planet orbiting the sun. For circular motion, where the gravitational force provides the centripetal acceleration v^2/r, Newton's second law for the satellite is

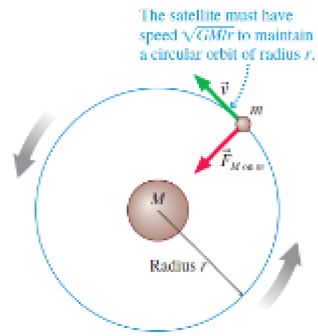
$$F_{M \text{ on } m} = \frac{GMm}{r^2} = ma_r = \frac{mv^2}{r} \qquad (13.21)$$

Thus the speed of a satellite in a circular orbit is

$$v = \sqrt{\frac{GM}{r}} \qquad (13.22)$$

A satellite must have this specific speed in order to have a circular orbit of radius r about the larger mass M. If the velocity differs from this value, the orbit will become elliptical rather than circular. Notice that the orbital speed does *not* depend on the satellite's mass m. This is consistent with our previous discovery, for motion on a flat earth, that motion due to gravity is independent of the mass.

FIGURE 13.16 The orbital motion of a satellite due to the force of gravity.



Kepler's law with derivatives and integrals

In this model Kepler's third law is derived from the integral and derivative of an orbit. With the e𝕙/+𝕚d gravitational speed this would sweep out an area in +𝕚d gravitational time. This integral area would be +𝕚d×e𝕙 for a circle or an ellipse, the e𝕙/+𝕚d gravitational speed at each point would be according to the integral of a small arc in that orbit.

No forces in ellipses

For an ellipse a small arc is swept out as +𝕚d×e𝕙, the gravitational speed there is e𝕙/+𝕚d which becomes less uncertain as this goes to a smaller arc. The satellite would be accelerating in an ellipse, but in this model there is still no force. This is because in the equation +𝕚d×Eℍ/+𝕀D × 1/e𝕙 the e𝕙 height varies in an ellipse, and so the gravitational speed is also changing.

Equal areas in equal times

This equation can be rearranged to become (+𝕚d×e𝕙)/(+𝕚d×e𝕙)× e𝕙/+𝕚d, the change in different integral areas is the same as the change in the gravitational speed. Taking equal areas is classically equivalent to the constant area of the +𝕚d and e𝕙 Pythagorean Triangle, so when the ellipse is higher in one area then it would be a shorter time associated with that height. The areas swept out by the satellite can be approximately of equal integral areas, because this approaches the +𝕚d and e𝕙 Pythagorean Triangle itself then the derivative also approaches it.

Gravitational speed and area

The derivative has the +𝕚d gravitational time in the denominator, the area has the +𝕚d gravitational field in the numerator. Because these are the same for a constant area, then the e𝕙/+𝕚d gravitational speed of the satellite increases when the integral area is higher and less wide from the +𝕚d gravitational field. This gravitational speed is the inverse of the inertial speed or velocity of the satellite.

Pythagorean Triangle angles and ellipses

As the angle θ changes in an ellipse the higher points have a smaller angle, that makes the gravitational speed faster. The inertial speed is the inverse to this as e𝕧/-𝕚d, so a higher point has an inversely smaller e𝕧 length in the inertial speed. It also then has a dilated -𝕚d inertial time in the denominator, inverse to the +𝕚d gravitational field.

Proportional height and inertial time

The +𝕚d gravitational mass or time sweeps out the arcs from an elliptical focus, the inverse to this is the -𝕚d inertial time from the inertial speed of the satellite. Each is bound by the constant areas of their Pythagorean Triangles. If the e𝕙 height is regarded as sweeping out the arcs then this changes proportionally to the -𝕚d inertial time, if it sweeps out double the area then -𝕚d also doubles. So the satellite would sweep out equal areas in equal times.

Adding G to the equation

This can be written in (13.24) as e𝕙/+𝕚d = 2×π × e𝕙/+𝕚d to give a full rotation. Squaring both sides gives Eℍ/+𝕀D = 4×π²×Eℍ/+𝕀D which becomes +𝕀D=(4π²)×Eℍ/Eℍ ×+𝕀D. Because G has meters³ divided by kilograms and seconds² then G becomes Eℍ×e𝕙/+𝕚d×+𝕀D. That allows for (13.24) to be rearranged as +𝕀D×+𝕚d=4π²/G ×Eℍ×e𝕙. Rearranging again gives (+𝕀D×+𝕚d)/(Eℍ×e𝕙)=k as a constant. Because 4π² is a constant then so is G, that is because when Eℍ×e𝕙 expands in G then the kilograms +𝕚d times the seconds² as +𝕀D contract inversely. This maintains the value as a constant from the constant area of the +𝕚d and e𝕙 Pythagorean Triangle.

Kepler's Third Law

An important parameter of circular motion is the *period*. Recall that the period T is the time to complete one full orbit. The relationship among speed, radius, and period is

$$v = \frac{\text{circumference}}{\text{period}} = \frac{2\pi r}{T} \qquad (13.23)$$

We can find a relationship between a satellite's period and the radius of its orbit by using Equation 13.22 for v:

$$v = \frac{2\pi r}{T} = \sqrt{\frac{GM}{r}} \qquad (13.24)$$

Squaring both sides and solving for T give

$$T^2 = \left(\frac{4\pi^2}{GM}\right) r^3 \qquad (13.25)$$

The International Space Station appears to be floating, but it's actually traveling at nearly 8000 m/s as it orbits the earth.

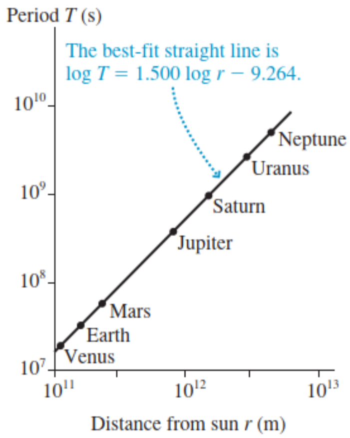
A changing +𝕚d gravitational mass

In this graph below G acts like a constant and so the time squared as +𝕀D changes with the cube of the e𝕙 height. In this model the +𝕚d gravitational mass of the planet also factors into this, when the planet is moved to different e𝕙 heights its +𝕚d gravitational mass weighed in relation to the sun changes. If for example they were not orbiting then they would have a weight as the sun pulled them downwards, this changes so that there are two cubes as +𝕀D×+𝕚d and Eℍ×e𝕙.

The gravitational mass does not change the orbit

The size of the +𝕚d gravitational mass does not change the orbit, this is because the planets have an inverse -𝕚d inertial mass there. If the e𝕙 height of a planet's orbit was increased, then the +𝕚d gravitational mass would decrease inversely. If it was on a spring scale then it would depress the spring less. Inverse to this is the -𝕚d inertial mass, with a greater e𝕙 height the denominator of the e𝕧/-𝕚d inertial speed changes proportionally to this. The change in the gravitational mass does not affect the orbit because a satellite there is weightless, if it did then there would be a weight measured in a direction. This is because it is balanced by the inverse as the -𝕚d inertial mass.

FIGURE 13.17 The graph of $\log T$ versus $\log r$ for the planetary data of Table 13.2.



The logarithm of the Pythagorean Triangles

This takes the logarithm to give 3/2, but in this model the proportions would be 3/3 or 1 with the changes in the +𝕚d gravitational mass.

Taking the logarithm of both sides of Equation 13.25, and using the logarithm properties $\log a^n = n \log a$ and $\log(ab) = \log a + \log b$, we have

$$\log T = \frac{3}{2}\log r + \frac{1}{2}\log\left(\frac{4\pi^2}{GM}\right)$$

In other words, theory predicts that the slope of a $\log T$-versus-$\log r$ graph should be exactly $\frac{3}{2}$. As Figure 13.17 shows, the solar-system data agree to an impressive four significant figures. A homework problem will let you use the y-intercept of the graph to determine the mass of the sun.

Gravitational and inertial angular momentum

In this model the gravitational angular momentum is +𝕚d×e𝕙/+𝕚d, the inertial angular momentum is -𝕚d×e𝕧/-𝕚d. These can be referred to as angular momentum because the planet is orbiting in circular geometry, if the planet was moving through free space then it would have a gravitational velocity. The Eℍ/+𝕚d gravitational impulse would be the main force as it was attracted to a planet for example it was not orbiting.

An ellipse from a conic section

An ellipse in this model comes from a conic section, the +𝕚d and e𝕙 Pythagorean Triangle from a circle then has its e𝕙 height increase and decrease. Its +𝕚d gravitational field changes inversely to the height. At the highest points on the ellipse e𝕙 is larger, so the +𝕚d gravitational field is weaker. The inertial momentum is the inverse, so where e𝕙 is largest e𝕧 is smallest. Where +𝕚d as gravitational time is smallest then the -𝕚d inertial time is largest and so the planet moves at its slowest.

A constant area Pythagorean Triangle

In (13.27) the triangle would have a constant area in this model, this comes from the constant areas of the +𝕚d and e𝕙 Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle. Kepler's law refers to constant areas so this is the same as the model here. The rate at which the area is swept is ΔA/Δt which here is +𝕚d×e𝕙/+𝕚d, the same as the gravitational momentum. That becomes L/2m which gives L as +𝕀D×2×e𝕙/+𝕚d or 2×+𝕚d×e𝕙, that is the constant area of the +𝕚d and e𝕙 Pythagorean Triangle. Because this is a constant in this model the rate is also constant.

L as a constant

Here L=mrv or -𝕚d×e𝕙×e𝕧/-𝕚d, that gives e𝕙×e𝕧 which is a constant because they are inverses of each other. When e𝕙 is larger then -𝕚d is also larger as they are proportional to each other, that gives e𝕧/-𝕚d as the slowest inertial speed where -𝕚d is at its maximum. That can be written as +𝕚d×e𝕙 as the gravitational momentum and -𝕚d×e𝕧 as the inertial momentum, also constants. In this model the momentum is an integral, the velocity or speed is a derivative.

Momentum and dimensional analysis

With dimensional analysis +𝕚d×e𝕙/+𝕚d is the conventional gravitational momentum, this combines the gravitational momentum of this model and the gravitational speed e𝕙/+𝕚d. The two exist like a superposition here because there is no observation of an impulse or measurement of work.

Observing and measuring a superposition

While in a superposition they are separated when observed and measured separately, the velocity can be observed with an E𝕍/-𝕚d inertial impulse. For example, a ball's velocity as e𝕧/-𝕚d can be observed by its impulse in hitting a racket. In measuring the -𝕀D×e𝕧 inertial work the -𝕚d inertial mass gives the reactive force, the velocity cannot be measured in the same time and position because of the uncertainty principle.

Kepler's second law

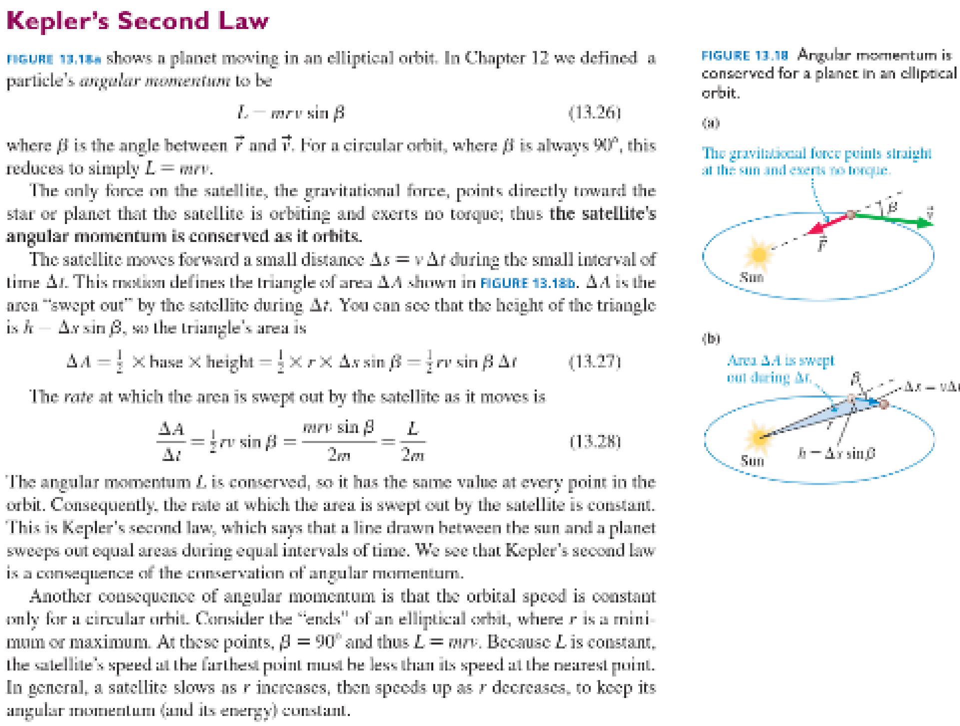
In this model the gravitational angular momentum is +𝕚d×e𝕙/+𝕚d, at higher points in the ellipse e𝕙 is larger and +𝕚d is inversely smaller. The +𝕚d gravitational mass is also smaller and in the denominator the +𝕚d gravitational time is smaller. That makes the gravitational speed or brevity larger as e𝕙/+𝕚d, inversely to this the e𝕧/-𝕚d velocity is slower. The -𝕚d and e𝕧 Pythagorean Triangle has a constant area and so this sweeps out an area, when e𝕙 is larger then the time it sweeps is inversely smaller. For a given time then the area of the -𝕚d and e𝕧 Pythagorean Triangle must also be constant.

Angular momentum

The gravitational angular momentum here as $L_{e\mathbb{h}}$ is +𝕚d×e𝕙×e𝕧/-𝕚d. This is not a constant in this model because if the e𝕙 height doubles for example then e𝕧 halves, that also means -𝕚d doubles with the slower velocity and +𝕚d halves with a smaller gravitational mass. This would be the same with the potential angular momentum $L_{e\mathbb{a}}$ as +𝕠d×e𝕒×e𝕪/-𝕠d. In (13.28) this is divided by 2m, in this model that can be made a mass constant as +𝕚d/-𝕚d.

Time and space as a relativistic constant

This is consistent with general and special relativity, for example a rocket orbits close to the event horizon of a black hole. The +𝕚d gravitational time dilates, to maintain the orbit the rocket moves at close to c which also dilates the -𝕚d inertial time by the same amount. The rocket would observe a e𝕙 height contraction, when this is divided by a e𝕧 length contraction moving close to c this remains a constant. That can be altered by frame dragging if the black hole is spinning.



Kepler's Second Law

FIGURE 13.18a shows a planet moving in an elliptical orbit. In Chapter 12 we defined a particle's *angular momentum* to be

$$L = mrv \sin\beta \tag{13.26}$$

where β is the angle between $\vec{r}$ and $\vec{v}$. For a circular orbit, where β is always 90°, this reduces to simply $L = mrv$.

The only force on the satellite, the gravitational force, points directly toward the star or planet that the satellite is orbiting and exerts no torque; thus **the satellite's angular momentum is conserved as it orbits.**

The satellite moves forward a small distance $\Delta s = v\,\Delta t$ during the small interval of time Δt. This motion defines the triangle of area ΔA shown in FIGURE 13.18b. ΔA is the area "swept out" by the satellite during Δt. You can see that the height of the triangle is $h = \Delta s \sin\beta$, so the triangle's area is

$$\Delta A = \tfrac{1}{2} \times \text{base} \times \text{height} = \tfrac{1}{2} \times r \times \Delta s \sin\beta = \tfrac{1}{2} rv \sin\beta\,\Delta t \tag{13.27}$$

The *rate* at which the area is swept out by the satellite as it moves is

$$\frac{\Delta A}{\Delta t} = \tfrac{1}{2} rv \sin\beta = \frac{mrv \sin\beta}{2m} = \frac{L}{2m} \tag{13.28}$$

The angular momentum L is conserved, so it has the same value at every point in the orbit. Consequently, the rate at which the area is swept out by the satellite is constant. This is Kepler's second law, which says that a line drawn between the sun and a planet sweeps out equal areas during equal intervals of time. We see that Kepler's second law is a consequence of the conservation of angular momentum.

Another consequence of angular momentum is that the orbital speed is constant only for a circular orbit. Consider the "ends" of an elliptical orbit, where r is a minimum or maximum. At these points, $\beta = 90°$ and thus $L = mrv$. Because L is constant, the satellite's speed at the farthest point must be less than its speed at the nearest point. In general, a satellite slows as r increases, then speeds up as r decreases, to keep its angular momentum (and its energy) constant.

FIGURE 13.18 Angular momentum is conserved for a planet in an elliptical orbit.

Orbital energetics

Here is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, this is proportional to the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. There is also the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy which comes from the proton, that is the inverse of the electron's ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. The ½×eℍ/+𝕀d ×+𝕚d linear gravitation is the inverse of the ½×e𝕍/-𝕀d ×-𝕚d linear inertia.

Change of sign

In this model the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy or potential energy U is positive not negative. This gives the same answer because the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy becomes negative. If the total energy is positive then this is a bound system, when a rocket fires in this model it does work to raise the orbit. This is because the -𝕀D inertial torque is increased, this raises the rocket's e𝕙 height like an exponential spiral.

Orbital Energetics

Let us conclude this chapter by thinking about the energetics of orbital motion. We found, with Equation 13.24, that a satellite in a circular orbit must have $v^2 = GM/r$. A satellite's speed is determined entirely by the size of its orbit. The satellite's kinetic energy is thus

$$K = \frac{1}{2}mv^2 = \frac{GMm}{2r} \tag{13.29}$$

But $-GMm/r$ is the potential energy, U_G, so

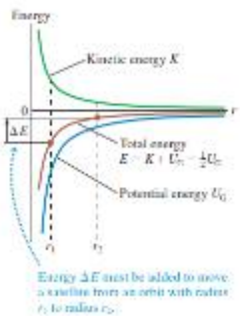
$$K = -\frac{1}{2}U_G \tag{13.30}$$

This is an interesting result. In all our earlier examples, the kinetic and potential energy were two independent parameters. In contrast, a satellite can move in a circular orbit *only* if there is a very specific relationship between K and U. It is not that K and U *have* to have this relationship, but if they do not, the trajectory will be elliptical rather than circular.

Equation 13.30 gives us the mechanical energy of a satellite in a circular orbit:

$$E_{mech} = K + U_G = \frac{1}{2}U_G \tag{13.31}$$

FIGURE 13.19 The kinetic, potential, and total energy of a satellite in a circular orbit.



The gravitational potential energy is negative, hence the *total* mechanical energy is also negative. Negative total energy is characteristic of a **bound system,** a system in which the satellite is bound to the central mass by the gravitational force and cannot get away. The total energy of an unbound system must be ≥ 0 because the satellite can reach infinity, where $U = 0$, while still having kinetic energy. A negative value of E_{mech} tells us that the satellite is unable to escape the central mass.

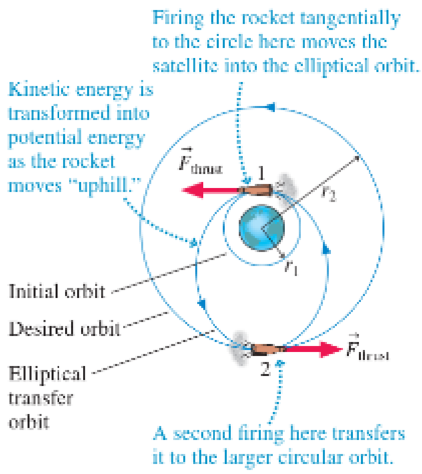
FIGURE 13.19 shows the energies of a satellite in a circular orbit as a function of the orbit's radius. Notice how $E_{mech} = \frac{1}{2}U_G$. This figure can help us understand the energetics of transferring a satellite from one orbit to another. Suppose a satellite is in an orbit of radius r_1 and we'd like it to be in a larger orbit of radius r_2. The kinetic energy at r_2 is less than at r_1 (the satellite moves more slowly in the larger orbit), but you can see that the total energy *increases* as r increases. Consequently, transferring a satellite to a larger orbit requires a net energy increase $\Delta E > 0$. Where does this increase of energy come from?

Artificial satellites are raised to higher orbits by firing their rocket motors to create a forward thrust. This force does work on the satellite, and the energy principle of Chapter 10 tells us that this work increases the satellite's energy by $\Delta E_{mech} = W_{ext}$. Thus the energy to "lift" a satellite into a higher orbit comes from the chemical energy stored in the rocket fuel.

Changing orbit with work and impulse

In the diagram below the rocket is fired to do -𝕆D×e𝕪 kinetic work, because here this is in one direction that also has a E𝕐/-𝕠d kinetic impulse. This creates an elliptical orbit because the orbital conic section is tilted towards a greater e𝕙 height. Then the rocket is fired with a second E𝕐/-𝕠d kinetic impulse to make a circular orbit. It could also do this with -𝕆D×e𝕪 kinetic work only by continuously changing the direction in an exponential spiral.

FIGURE 13.20 Transferring a satellite to a larger circular orbit.



Relativity

Reference frames

In this model there are no infinite reference frames, instead these frames have a constant area as a Pythagorean Triangle. The +𝕚d and e𝕙 Pythagorean Triangle as gravity in general relativity extends outward beyond the CMB, as the e𝕙 height increase then relativistic effects create a redshift.

No at rest

Also in this model there is no at rest, the Heisenberg uncertainty principle means an object cannot be completely stationary. If it was then its -𝕚d and e𝕧 Pythagorean Triangle for example would have a velocity of e𝕧/-𝕚d with e=0, then the Pythagorean Triangle could not exist. Instead observers can have a small relative motion to the particles being observed with their impulse.

Position and time are used to measure and observe

A measurement is of a wave or probability, because it has no fixed position then it can act like a gravitational geodesic in general relativity. The Eℍ/+𝕚d gravitational impulse has no fixed +𝕚d gravitational time, this can slow down on a clock gauge. That means a position is not itself measured, it is used to measure work. A time is not observed, instead it is used to observe impulse. Biv space-time then can be regarded as a combination of a scale and gauge.

Attempting to measure a position or observe time

When a position is attempted to be observed it becomes a starting and final position or displacement which is no longer a position. When time is attempted to be observed it becomes a duration with a starting to a final instant. This leads to the uncertainty principle, trying to measure a position of an iota in a box leads to that becoming work as a wave. Trying to observe an instant leads to an uncertain position, for example a tennis ball hitting a racket is decelerating. An instant implies the tennis ball is stationary but there is a force being applied by the racket. This is similar to Zeno's arrow, where in an instant an arrow appears to be not moving so no arrow can move.

Gravity as probability

In Biv space-time the geodesic around a planet for example acts like a wave function. Satellites might be attracted towards the planet, in this model that is an increased probability they will be found closer to the planet. Gravity is the active force then and inertia reacts against that.

Wave functions in quantum mechanics

This reverses the concept of the wave function in quantum mechanics and Roy electromagnetism, there the -𝕆D×e𝕪 kinetic work is the wave function and -𝕆D is the kinetic probability of where an electron will be found. In Biv space-time the wave function is the +𝕀D×e𝕙 gravitational work and +𝕀D gives the gravitational angular probability of where objects will be measured. A satellite orbiting a planet can have a gravitational angular probability in relation to the shape of its orbit. When the orbit is circular the gravitational probability is approximately constant.

A geodesic as an integral

For a given e𝕙 height the -𝕀D gravitational probability in the +𝕀D×e𝕙 gravitational work is an integral area. The satellite gives the boundary of this integral, the shape of the orbit can also become an ellipse, parabola or hyperbola.

Probabilities as squares

In this model much of quantum mechanics can be adapted directly to model general relativity, with the +𝕚d and e𝕙 Pythagorean Triangle. The +𝕀D gravitational probability is a square like the -𝕆D kinetic probability is a square, each gives the probability of an object being at a distance. In +𝕀D×e𝕙 gravitational work this is the e𝕙 height and in -𝕆D×e𝕪 kinetic work this is the e𝕧 length.

Displacement and position, duration and instants are different

In this model a displacement is from a starting to a final position, this is different from a position itself. Where there is no displacement there is only one position, then there is no displacement or impulse force. A duration of time is from a starting to a final instant or fluxion on a clock gauge. The duration is different from the instant, if there is no duration there is only one instant and so there is no work force.

Uncertainty in relativity

A reference frame here is a separate Pythagorean Triangle to the Pythagorean Triangle being observed or measured. Because of this the e𝕧 length between the Pythagorean Triangles, or the -𝕚d inertial time with for example the -𝕚d and e𝕧 Pythagorean Triangle, creates uncertainty and inaccuracies in these observations and measurements.

Time dilation and contracted distances

In this model iotas refer to either particles or waves, depending on whether they are observed or measured. When iotas are moving they have a e𝕧 length contraction, when near a gravitational body they have a e𝕙 height contraction. A rocket traveling near c would have its -𝕚d inertial time slowing, a planet would have its +𝕚d gravitational time slowed.

Biv space-time uncertainty

Biv space-time has some uncertainty like with the Heisenberg uncertainty principle. When there is a e𝕧/-𝕚d inertial velocity then the e𝕧 length can be contracted and the -𝕚d inertial time can be slowed. This makes it more difficult to measure the -𝕀D×e𝕧 inertial work and observe the E𝕍/-𝕚d inertial impulse as the scale and clock gauge respectively are themselves changing. Also with a planet there is a e𝕙 height contraction and a slowing of +𝕚d gravitational time. Measuring the +𝕀D×e𝕙 gravitational work and observing the Eℍ/+𝕚d gravitational impulse is also uncertain, without knowing how dense the matter is this contraction and slowing is harder to measure and observe.

Relativity and angle changes

In this model +𝕚d gravitational time and -𝕚d inertial time are relative, they can be measured as +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work. There is no absolute value because the angle θ opposite the spin Pythagorean Triangle side changes when a force is observed or measured. The angle must then be changed to observe or measure, this makes them relative. To go from an observation such as the Eℍ/+𝕚d gravitational impulse to a gravitational reference frame, this requires a gravitational force. First there is one kind of force as impulse, then it must become another kind of force as work.

Reference frames as Pythagorean Triangles

The reference frames in this model are Pythagorean Triangles, the Cartesian coordinates for inertia would be in meters as e𝕧 and seconds as -𝕚d inertial time. The two values would be connected by a hypotenuse so that the area of the -𝕚d and e𝕧 Pythagorean Triangle remains constant. These Cartesian coordinates then contain -𝕀D×e𝕧 inertial work as measuring the -𝕚d×e𝕧 area of the -𝕚d and e𝕧 Pythagorean Triangle, also E𝕍/-𝕚d inertial impulse where the slope is measured as a e𝕧/-𝕚d velocity or an acceleration.

> An object does not have a "true" speed or velocity. The very definition of velocity, $v = \Delta x/\Delta t$, assumes the existence of a coordinate system in which, during some time interval Δt, the displacement Δx is measured. The best we can manage is to specify an object's velocity relative to, or with respect to, the coordinate system in which it is measured.
>
> Let's define a **reference frame** to be a coordinate system in which experimenters equipped with meter sticks, stopwatches, and any other needed equipment make position and time measurements on moving objects. Three ideas are implicit in our definition of a reference frame:
>
> - A reference frame extends infinitely far in all directions.
> - The experimenters are at rest in the reference frame.
> - The number of experimenters and the quality of their equipment are sufficient to measure positions and velocities to any level of accuracy needed.

Impulse increases with velocity

Because a reference frame is a Pythagorean Triangle, then each changes its angle θ with a force. When the -𝕠d and e𝕪 Pythagorean Triangle as the electron is accelerated, then its kinetic velocity e𝕪/-𝕠d increases. e𝕪 increases and -𝕠d decreases, it can have a higher E𝕐/-𝕠d kinetic impulse and does less -𝕆D×e𝕪 kinetic work. An electron then acts more like a particle in an accelerator.

Kinetic displacement and temporal history

This kinetic velocity also causes changes with special relativity, e𝕪 contracts and -𝕠d as kinetic time slows or dilates as it approaches c. This happens because the electron has a kinetic displacement history and kinetic temporal history. In this model the kinetic velocity refers to the first derivative with respect to e𝕧, the kinetic momentum is -𝕠d×e𝕪 as the first integral with respect to -𝕠d. This momentum does -𝕆D×e𝕪 kinetic work, the electron moves more as a wave such as in diffracting through a double slit.

History must be conserved

When the electron is accelerated it has a E𝕐 displacement history that would be observed with E𝕐 as the kinetic electric force in its E𝕐/-𝕠d kinetic impulse. If not then energy would not be conserved, over the electron's history it could lose energy. In this model a history is the forces that have occurred, just as forces are conserved then a history composed of forces must also be conserved. These can be from vector addition in impulse or the constructive and destructive interference in work.

The ruler and clock gauge must also be conserved

The electron also has a -𝕆D kinetic temporal history which conserves the work done. The E𝕐/-𝕠d kinetic impulse needs -𝕠d as kinetic time to be conserved otherwise the E𝕐 kinetic electric force would not be conserved along with the constant Pythagorean Triangle area. That means the -𝕆D×e𝕪 kinetic work also needs the E𝕐/-𝕠d kinetic impulse to be conserved as a history of forces. These are inverses, otherwise the history of forces would diverge and the Pythagorean Triangles would no longer have a constant area.

A Newtonian history

This concept of observing and measuring the E𝕐 displacement and -𝕆D temporal history is consistent with the Newtonian universe. Without relativistic changes the measurement of -𝕆D×e𝕪 kinetic work with an electromagnetic field is the inverse of observing the E𝕐/-𝕠d kinetic impulse of the electron particle. If one was not conserved then these would no longer remain inverses, and the Pythagorean Triangle areas would no longer be constant.

A consistent history with relativity

This model retains the constant Pythagorean Triangle area with general and special relativity, as the electron's e𝕪/-𝕠d kinetic velocity approaches c then the angle θ opposite -𝕠d approaches a minimum. When the E𝕐/-𝕠d kinetic impulse of the electron is observed this gives a -𝕠d kinetic time dilation or slowing. That is consistent with the E𝕐 kinetic displacement history, in approaching c the E𝕐 kinetic electric force is contracted as a square.

History as forces creating the present

Because this is consistent with the angle θ, the constant Pythagorean Triangle area is maintained at all kinetic velocities. Also, when the -𝕆D×e𝕪 kinetic work of the electron is measured approaching c it has a larger -𝕆D kinetic probability or kinetic magnetic force. The concept of history is then the forces that create the present with the electron, for example if its e𝕪/-𝕠d kinetic velocity increased then e𝕪 has undergone a larger E𝕐 kinetic electric force to reach that velocity. This E𝕐 kinetic displacement history would be conserved.

The kinetic impulse causes time to slow

This increase in the E𝕐 kinetic displacement history causes a contraction in the -𝕠d Pythagorean Triangle side of kinetic time. This is because to maintain a constant Pythagorean Triangle area, the dilation of e𝕪 causes -𝕠d to contract. This E𝕐/-𝕠d kinetic impulse then causes -𝕠d to get smaller, that is time dilation as clocks run slower. E𝕐 then is not compared with a distance contraction, but with a temporal slowing on a clock gauge.

A position on a ruler versus a displacement

In this model a force from a straight Pythagorean Triangle side is observed as a displacement, like in between two marks on a ruler. A position is where the straight Pythagorean Triangle side has no force, this is like the mark on the ruler. The displacement E𝕐 here is the force required to accelerate it to its e𝕪/-𝕠d kinetic velocity, that is like in between marks on the ruler. The time taken for that kinetic displacement is not on a ruler, it is observed as a series of moments on a clock gauge. The ruler then is a straight scale, the clock is a spin or circular gauge.

A distance contraction from a temporal history

The -𝕆D×e𝕪 kinetic work creates a -𝕆D kinetic temporal history, when an electron approaches c the -𝕆D value increases. This is measured on a ruler as a position, not a displacement. Because -𝕠d has increased with a constant Pythagorean Triangle area, this causes the e𝕪 distance to contract on the ruler. It is the same as a e𝕧 length contraction of a rocket approaching c, the -𝕚d and e𝕧 Pythagorean Triangle as inertia is proportional to the kinetic -𝕠d and e𝕪 Pythagorean Triangle.

Time slowing as a dilation

That is a different terminology to in relativity, the clock gauge on a rocket approaching c appears to turn more slowly as the E𝕐 kinetic displacement history increases. This is referred to as kinetic time dilation, it sounds like something is getting bigger for example a minute stretching into an hour. When the hands on a clock gauge slow down in this model it is like slow motion in a movie, everything around it would be moving more slowly. Because of this time is referred to as slowing rather than dilating, to avoid this impression of it growing larger. The concept of a time dilation and a length contraction implies an inverse relationship, in this model both are contracting as the forces of history grow.

Classical mechanics and distance contraction

This is consistent with classical mechanics, a bucket on a rope might be spun around faster to increase the -𝕆D×e𝕪 kinetic work done on it. When the bucket is released, it has a higher e𝕪/-𝕠d kinetic velocity or -𝕠d×e𝕪 kinetic momentum the greater the -𝕆D kinetic torque that was applied. This kinetic torque is measured by a distance, for example if the rope is shortened then the -𝕆D kinetic torque increases as a square. With classical mechanics then this kinetic torque is associated with a distance not with time, the inverse is a stronger E𝕍 inertial displacement as a square when the period of rotation as -𝕚d decreases linearly.

Classical mechanics and time slowing

If the bucket was instead launched by a spring as a projectile this would be straight-line motion as an impulse, the displacement E𝕐 would be the distance e𝕪 the spring was pushed down squared. When released this gives a larger E𝕐/-𝕠d kinetic impulse the more the spring was compressed. That is consistent with a larger E𝕐 kinetic displacement history creating a faster e𝕪/-𝕠d kinetic velocity, this force is observed on a temporal scale as a clock gauge.

Approaching c makes the contractions noticeable

When this E𝕐 kinetic displacement history increases enough then the contractions of the angles θ in the -𝕠d and e𝕪 Pythagorean Triangles becomes noticeable on this clock gauge as kinetic time slowing. Also when the -𝕆D kinetic temporal history approaches c the e𝕪 distance contraction also becomes noticeable.

Kinetic and inertial distance and time

This would affect a rocket for example in Roy electromagnetism, the e𝕪 kinetic electric charge is contracted proportionally to a e𝕧 length contraction. If this was not so, then compressing the length of the rocket would make it hotter. Also the -𝕠d kinetic magnetic field of the electron slows proportionally to the -𝕚d inertial time. Because an atomic clock for example measures oscillations, if the proportions changed then the kinetic and inertial time would not slow consistently.

An observation or a measurement needs both a distance and a time

An observation cannot be measured on a ruler, that would be measuring a displacement between two positions in terms of a position, the time would not be a factor. Because of this a force must have a straight Pythagorean Triangle side as a distance, and a spin Pythagorean Triangle side as time. When one is squared as a force then the other acts to measure or observe this force.

Leaving behind a reference frame

The reference frame left behind represents the E𝕐 kinetic displacement history and the -𝕆D kinetic temporal history of the bucket. That is not the same as the reference frame of the bucket itself, nor is it the same as another kinetic reference frame where the bucket might be observed or measured from. That kinetic reference frame would have a different E𝕐 kinetic displacement history and -𝕆D kinetic temporal history to where the bucket started from, and so each kinetic reference frame with a different history observes and measures a different amount of e𝕪 kinetic distance contraction and -𝕠d kinetic time slowing.

A spinning reference frame

In this model a reference frame is not just observing a straight-line change, it also measures a rotation with torque. So the bucket being spun had an initial kinetic reference frame and its -𝕆D kinetic temporal history measures the kinetic torque required to attain the e𝕪/-𝕠d kinetic velocity. This torque is measured by the size of the -𝕠d Pythagorean Triangle side, the larger the -𝕆D kinetic torque the larger as a square root the -𝕠d spin Pythagorean Triangle side was.

Spin as a history

Different reference frames can then be spinning in relation to an object approaching c, their torque affects the measurements of the object's velocity. For example if the reference frame is spinning at a rate approaching c on one end then this has a relativistic effect, it is like the reference frame having a different velocity to the object. Gravity can be regarded as a spinning reference frame, instead of a centrifugal force it is directed towards the right angle of the +𝕚d and e𝕙 Pythagorean Triangle. This gives a gravitational frame dragging from +𝕀D×e𝕙 gravitational work, there can also be an inertial frame dragging from -𝕀D×e𝕧 inertial work.

Frame dragging

The object then can have a -𝕆D kinetic temporal history as a torque in relation to this spinning reference frames, for example a rocket might experience frame dragging near a black hole. Its velocity might appear to have a different distance contraction and time slowing depending on whether it was moving with the spin or against it.

Frame dragging and the twin paradox

A rocket then might have two kinds of twin paradoxes in leaving near the event horizon of a black hole. The rotating reference frame would measure a different distance contraction on the rocket depending on whether it moved with the spin or against it. It would observe a different amount of time dilation from the rocket's E𝕐/-𝕠d kinetic impulse again depending on the spin direction. A twin on the rocket might then have a different age on returning to near the event horizon and on greeting the twin that stayed behind, depending on the spin direction.

The twin paradox and distance

The amount of torque in the spin would then affect the time slowing of the twin on the rocket, if the torque was greater the age disparity would be less. The distance contraction on the rocket should also give a change between the two twins when the rocket returned.

A smaller change in distance closer to c

Because the atoms would have appeared to have a smaller distance throughout the journey, the twin would appear to be younger because the chemical reactions of life would have moved less. If they were both growing then the twin from the rocket would be shorter which is proportional to being younger with the slower time.

Slowing time and contracting distance in velocity

This is consistent with the objects on the rocket, and in the twin, being slower in velocity. The distance an object on the rocket travels in a given time is contracted so it appears to be moving slower. The electrons would have a shorter path to travel, because of this it is equivalent to a slower time. For example with a pendulum, if half the swing occurred then only half the time would be used. The twin has all their molecules traveling a shorter path and so they return younger.

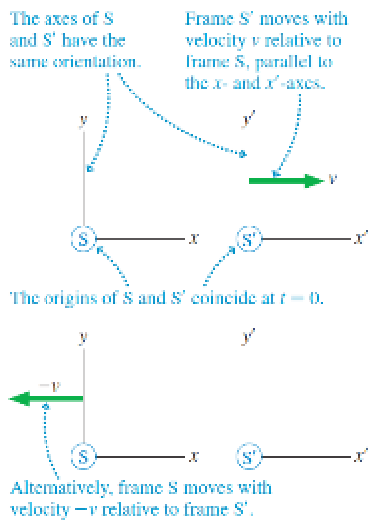
A slower and smaller movie

This would be like playing a movie on a screen half the size, because the distance across the screen is halved a object in the movie seems to be going half the velocity. For example, the movie might be a minute long and shows an object moving from left to right across a meter sized screen. On a half meter screen, it only moves a half meter in a minute instead of a full meter. The time slowing is like playing the movie over 2 minutes, then the velocity of the object is also halved.

Observing and measuring the twin

Because the Pythagorean Triangles have a constant area the E𝕐 kinetic displacement history and the -𝕆D kinetic temporal history are conserved, both give an associated time slowing and distance contraction that is only separated by observing or measuring. The slower chemical reactions in the twin on the rocket occur both from time slowing and the wave functions of the -𝕆D×e𝕪 kinetic work acting over shorter distances. When the twin from the rocket is measured, then her probabilities occurred over shorter distances. When she is observed her displacements happened more slowly.

FIGURE 36.1 The standard reference frames S and S'.



Relativistic action and reaction

In this model the acceleration of a rocket can come from work and impulse. When fuel is burned there a E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work being done, there is also a reaction against the acceleration with an E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work. Because these are equal in this model the spaceship can continue to accelerate past c. The inertia from the -𝕚d and e𝕧 Pythagorean Triangle could not exceed the proportions of the -𝕠d and e𝕪 Pythagorean Triangle producing the active forces.

Relativistic and proper histories

The spaceship when traveling higher than c would still have its own proper time, this would be a +𝕠d proper potential time, a -𝕠d proper kinetic time, a +𝕚d proper gravitational time, and a -𝕚d proper inertial time. For these histories to be conserved they need to allow a faster than c velocity, to avoid a conflict this cannot be observed or measured. Examples of this are beyond the CMB for special relativity, and beyond the event horizon of a black hole for general relativity.

Observing and measuring relativistic iotas

When an iota approaches c it can be observed with its impulse or measured with its work, for example it might collide with another iota so its E𝕍/-𝕚d inertial impulse is observed or its -𝕀D×e𝕧 inertial work is measured. These cannot be done together, in the same time or position because then the spin Pythagorean Triangle or straight Pythagorean Triangle sides respectively would be have forces. That would mean the E𝕍×-𝕚d inertial impulse could have no -𝕚d inertial time on a clock gauge, this would be at the same time a -𝕀D inertial probability. Also the -𝕀D×e𝕧 inertial work could have no e𝕧 length to be measured on, that would instead be an E𝕍 inertial displacement force.

The present as time and distance without forces

It also means there would be no present, both Pythagorean Triangle sides would be a E𝕍 inertial displacement history and a -𝕀D inertial temporal history respectively. For there to be a present observation or measurement there must be Pythagorean Triangle sides that are not forces, instead e𝕧 would be a length like a ruler mark and -𝕚d would be a moment on a clock gauge.

Exceeding c as a jump

This also implies that c cannot be exceeded as an observation or measurement, not that it cannot be exceeded in this model. If it was then the spaceship would no longer be observable or measurable, it would disappear similar to the concept of a jump in science fiction. The Pythagorean Triangles in this model would not operate backwards, and so the spaceship would not go backwards in time, the Pythagorean Triangles in the spaceship would look normal in the reference frame of people on it.

Jumping to past light speed

To the sides light might be emitted and received because reference frames there would not have a greater than c relative motion. To the front and back the spaceship would not be visible. This would be the equivalent of an event horizon, when c would be exceeded on a black hole then time would slow to a minimum, not stop in this model. The spaceship would appear frozen or in slow motion as it reached the event horizon of exceeding c, then this image would disappear.

Self-propulsion and exceeding c

In this model exceeding c is possible because the spaceship has its own propulsion, an iota such as a particle in an accelerator is not self-propelling. Because of this it can only be accelerated by sub light forces from separate reference frames. A rocket propels itself with a reaction drive, the E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work of the fuel burning creates an E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work. This causes the spaceship to continue to accelerate, similar to it accelerating downwards towards a black hole event horizon.

Observing and measuring other spaceships

If several ships exceeded c together then the light between them should be emitted and received normally. This allows for energy as impulse and mass as work to be conserved. If the spaceships are colliding with dust then this may produce a shock wave similar to Cerenkov radiation.

Entering a black hole

Because this addition velocity is conserved, the spaceship could also penetrate the event horizon of the black hole with a velocity. When this is maintained the light from behind it falling into the black hole could not be observed or measured. As it moved towards the other side of the black hole the light from in front also could not be observed or measured. Light from the sides could be observed or measured in this model at right angles to the spaceship's motion.

Exiting a black hole

However the rocket would be its own eV-Iv reference frame and would not experience time dilation on board, its -𝕚d inertial mass is the same throughout the ship. This is like being under acceleration, for a given force every part of the shape feels the same increase in weight. The rocket would also not experience e𝕧 length contraction inside it because the -𝕚d and e𝕧 Pythagorean Triangle has a constant area under the hyperbola. So if there is no increase in -𝕚d inertial mass locally then there is no length contraction either. With this additional velocity it should be possible to exist the other side of the black hole.

Disappearing from an event horizon

It may then be in this model that a rocket could exceed c by continuing to accelerate, its eY-Oy chemical reaction in burning fuel are not contracted either. This might mean it suddenly disappears going into an event horizon after a long time, when the appearance of the rocket was slowing and close to stationary. When an iota falls into a black hole with no extra velocity, then it might remain on the event horizon. This would be related to α, proportional to the +𝕚d and e𝕙 Pythagorean Triangle.

The event horizon as a ground state

Dropping below this ground state as the event horizon, the iotas would be equivalent to a nucleus. Because there would be no strong force, in this model that is gravity being stronger than the repulsive potential between protons, then the iotas would come back up to the event horizon.

Hyperspace

This mass would also disappear as the light from it could not be absorbed. It would be in a featureless void called perhaps hyperspace from the hyperbola, on the sides however the relative velocity should allow objects to be seen as the relative speed would be below c.

The Doppler effect and not observing or measuring

Light from the rocket would be subject to the doppler effect, when coming towards an observer it would have an excess of -𝕚d inertial mass and its frequency would be too high to measure, its e𝕧 wavelength too short to be absorbed by an atom. So it should not be detectable, also when going away its photon frequencies would be too redshifted like from beyond the CMB and again this light could not be absorbed to be observed.

Conserving energy with Cerenkov radiation

The ship might slow as the light from ahead acts as a brake on it because of its high -𝕚d inertial mass, but this would not be much different just above c as just below. This would be similar to Cerenkov radiation, this is where particles traveling close to c find themselves at over c in a material with a reduced light speed. That occurs when the -𝔾D×e𝕪 light work creates interference patterns from the atoms, because the waves are going in different directions to straight ahead this is slower overall.

Inertia of photons at faster than c

They are then braked by some force, perhaps the inertial mass from the photons that hit these particles. This might then slow the particles to lower than c. However the rocket has the ability to propel itself, something that particles cannot do, it may be able to maintain this higher than c velocity against the -𝕚d inertial mass of the photons striking the ship.

An electron has no height

In Figure 36.2 x=x’+vt, in this model x would be e𝕧 as a position. That would be a particle, as an electron it has no radius or e𝕙 height, it only has a length e𝕧 and so is observed as a point particle. This is done with the E𝕍/-𝕚d inertial impulse, by using the inertial displacement history this gives an approximate position of where the particle was in relation to the -𝕚d inertial time on a clock gauge.

Curved space as a field of probability

If this was moving in curved space, as a geodesic in general relativity, then that space acts as -𝕀D×e𝕧 inertial work and +𝕀D×e𝕙 gravitational work. In this model +𝕀D gravitational probability causes an attraction of iotas towards planets for example. The iotas are more likely to be found near these planets, this is measured as an acceleration towards them.

The kinetic wavefunction and quantum mechanics

The figure below is referring to special relativity which comes from the -𝕚d and e𝕧 Pythagorean Triangle and inertia. An acceleration with -𝕀D×e𝕧 inertial work happens with the -𝕀D inertial probability. An iota or object is more likely to not change its e𝕧/-𝕚d inertial velocity, the -𝕆D kinetic probability causing the firecracker to accelerate is the kinetic wavefunction in quantum mechanics.

A probable change in position from kinetic energy

The energy that moves the firecracker makes it more likely it will change its position, this kinetic field is the same as the -𝕠d kinetic magnetic field in this model. For example in an electric circuit electrons are moved by the difference between +𝕆D×e𝕒 potential work from the positive terminal of a battery to -𝕆D×e𝕪 kinetic work from the negative terminal. As an example the firecracker might be accelerated by a magnetic field, this connects the Roy electromagnetism and Biv space-time.

Ignoring relativistic velocity and gravity

When the e𝕧/-𝕚d velocity is slow compared to c, the -𝕚d and e𝕧 Pythagorean Triangles here have only a small e𝕧 length contraction and -𝕚d inertial time slowing. Because of this the equation e𝕧=e𝕧'+e𝕧"/-𝕆D as x=x'+vt can be used as an approximation. The initial position e𝕧 would be observed with the E𝕍/-𝕚d inertial impulse, then the final position estimated with another E𝕍/-𝕚d inertial impulse. The change between these is measured with vt which here is e𝕧/-𝕚d ×1/-𝕚d which is an acceleration.

A difference between the Pythagorean Triangle side sizes

This model is also relativistic because as the angle θ, opposite the spin Pythagorean Triangle side, contracts the velocity e𝕧/-𝕚d would approach c. Then there is a large difference between the sizes of the straight and spin Pythagorean Triangle sides. That means when one side is squared, in an observation of impulse or measurement of work, there is a much larger difference between the two sides when relativity is taken into account.

The units of acceleration

This means the firecracker had to accelerate between x and x', in this model however e𝕧/-Od is a classical approximation. Here it can be rewritten as -𝕠d/E𝕍 which goes from meters/second^2 to seconds/meter^2. Now the difference between the observation of e𝕧 to e𝕧' is done with the E𝕍/-𝕚d inertial impulse, it is the same as perturbing the initial position with a force to observe where it moves to.

The uncertainty principle and history

In that case it connects to the uncertainty principle, estimating the position e𝕧 more closely requires an increasing E𝕍/-𝕚d inertial impulse. When one position is compared to another then this can be regarded as coming from -𝕆D×e𝕪 kinetic work, the inertia from this change comes from -𝕀D×e𝕧 inertial work. As e𝕧 changes to e𝕧' the -𝕆D kinetic probability make it more probable the firecracker would be in a different position. When this change in position is very small then the change in its history of forces is also very small.

A constant Pythagorean Triangle area and history

Because the atoms of the firecracker are composed of Pythagorean Triangles with constant areas, the smaller the straight Pythagorean Triangle side e𝕧 becomes the larger -𝕚d becomes. This becomes a fundamental limit imposed by the E𝕍 inertial displacement history, the observation of the firecracker's position is determined by the history of its previous positions and how they were displaced inertially by forces. This is observed on a scale of the -𝕚d inertial time with a clock gauge. So if the particle moves quickly then this can be used to estimate its new position.

Observing a displacement on a ruler

The other fundamental limit comes from the -𝕀D inertial temporal history where the difference in positions is measured. In this model a particle is observed with an E𝕍/-𝕚d inertial impulse, but this is done on a scale of -𝕚d inertial time on a clock gauge not on a ruler of e𝕧 lengths. This is because a force E𝕍 as a displacement cannot be just measured on a ruler, then there is no knowledge of the time taken.

The dual nature of an iota

There is a duality with an iota, it can be a particle or a wave, this is why the term iota is used to refer to either one. The idea of observing a particle as it changes position then mixes an observation of its E𝕍/-𝕚d inertial impulse as a particle, with its change in position as a wave with -𝕀D×e𝕧 inertial work. To know what force is being applied there must be time, otherwise the same force could be applied for different amounts of time.

Initial and final positions

Because of this a particle is moved a e𝕧 length with -𝕀D×e𝕧 inertial work. But then to observe the particle in its initial and final position it must be an object and not a wave, that requires an observation with the E𝕍/-𝕚d inertial impulse. In quantum mechanics this is called a collapse of the wave function, the -𝕆D kinetic probability moves the iota with an inertial resistance as the -𝕀D inertial probability.

The collapse of a wave function into a moment

But then the iota is a wave of probability, to establish a position then it must become a particle. That requires collapsing this -𝕆D×e𝕪 kinetic work probability into a E𝕐/-𝕠d kinetic impulse. Now there is no more -𝕆D kinetic probability because it is now being used to observe a displacement on a clock gauge. The wave function of probability has collapsed into a moment of time.

Impulse following work

When a measurement of work is followed by an observation of impulse, this is a collapse of the wave function in this model. The term "followed by" itself means time has elapsed, and that impulse is being observed on a clock gauge. When an observation of impulse occurs, then a measurement of work does not "follow it", because that would be on a clock gauge as another moment.

Work at a distance from impulse

Instead the work occurs near the previous impulse on a ruler. So there is an initial position of the firecracker with impulse at a time, then there is a further observation near to it not later than it in time. This second observation happens at a time with impulse, but the two are separate by a distance or e𝕧 length not by time.

Separating time slowing and distances contracting

The distinction is important in relativity because there is time slowing and distances contracting. When there is an observation of impulse there can be an associated time slowing, when there is a measurement of work there can be an associated distance contracting. Because each is defined in relativity the separation of observations and measurements is important in this model.

The collapse of the inertial and gravitational wave functions

When the firecracker moves, and then is observed, it no longer has a -𝕀D kinetic probability with how likely it is to be at a position e𝕧. It has collapsed into an E𝕍 displacement force that is observed at a time -𝕚d. Observing the firecracker happens with its E𝕍/-𝕚d inertial impulse in Biv space-time, when approaching c this can have the -𝕚d inertial time slowed. When in a strong gravitational field, it is still being observed as a Eℍ/+𝕚d gravitational impulse with general relativity.

Roy and Biv wave functions

There are then two fields of probability in Biv space-time, the -𝕀D inertial probability and the +𝕀D gravitational probability. These are analogous to and proportional to the -𝕆D kinetic probability of quantum mechanics and the +𝕆D potential probability usually referred to as potential energy.

Tensors and width

These two are combined in the Einstein equation, tensors are used in each to model the distance contractions and time slowing. In the basic model tensors are not used except as an approximation, this is because the +𝕚d and eℍ Pythagorean Triangle with gravity only has a eℍ height contraction and a +𝕚d gravitational time slowing. The -𝕚d and e𝕧 Pythagorean Triangle with inertia only has a e𝕧 length contraction and a -𝕚d inertial time slowing. Together these can model a 3-dimensional space, in this model there is no actual width along with height and length.

Distance dilation and faster time

When the e𝕧 lengths between the firecracker become very small, or a single iota can be used as a model, then this is associated with the uncertainty principle. When the E𝕍 inertial displacement history and -𝕀D inertial temporal history are very large, such as with an iota approaching c, there is a e𝕧 length contraction and a slowing of -𝕚d inertial time. This happens from the E𝕍/-𝕚d inertial impulse where E𝕍 is very large and so the -𝕚d inertial time becomes smaller and slower. The -𝕀D×e𝕧 inertial work has -𝕀D as very large and so e𝕧 contracts as length.

The angle θ as a maximum

Conversely when the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work are very small then the unsquared Pythagorean Triangles sides increase in size by comparison. This is because the angle θ is now approaching a maximum, in relativity it approaches a minimum.

A length dilation and uncertainty of position

When e𝕧 increases this is measured as a length dilation, so it becomes more difficult to measure where an iota is. The ruler appears to be expanding in size whereas in special relativity it was contracting. The position becomes more uncertain, there is different -𝕆D kinetic probabilities of where the electron is within this uncertainty.

Observing particles

Also then the electron is observed then the -𝕚d inertial time quickens, this causes particle and antiparticle pairs to appear and decay more quickly. In trying to reduce this uncertainty there are more particle and antiparticle pairs lasting for shorter times with the impulse observations. These are modeled in quantum electrodynamics and Feynman diagrams.

Particle and antiparticle probabilities

These particle antiparticle pairs have a probability which is measured by the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, that changes according to the e𝕧 length from the electron. These probabilities are measured from switching back to -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, they appeared as particles and antiparticles from the observation of impulse on a clock gauge not a ruler of distance.

Feynman diagrams

In this model Feynman diagrams combine the observation of impulse, with more particles, and the measurement of their probabilities. These occur with trying to reduce uncertainty, the smaller histories are associated with longer distances as uncertain positions and faster decay times.

Particle accelerators using impulse

This is seen with observing particles in an accelerator as well, with an increased E𝕍/-𝕚d inertial impulse some particles such as electrons might be aimed at a proton to break it apart. A faster velocity can make an iota act more like a particle, because the e𝕧 length is much larger than the -𝕚d inertial time closer to c.

Faster versus slower time

The increased impulse forces create particles that have a faster -𝕚d inertial time on a clock gauge, because of this they quickly decay. That is the opposite of a muon for example entering the atmosphere, its -𝕚d inertial time is slowed and so it survives longer before decaying.

Larger particles and faster decay

In breaking apart a proton for example there are many iotas with short decay times. These are also larger in size the faster they decay. In this model this is because of their small Eℍ gravitational displacement history and +𝕀D gravitational temporal history, that gives them a larger e𝕙 height as a radius and a faster +𝕚d gravitational time to decay.

The strong force

The strong force in this model is a balance between the Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work in between protons and neutrons, and the E𝔸/+𝕠d potential impulse and +𝕆D×e𝕒 potential work reacting against this. Because both are squared forces when opposing each other, this gives a constant force as color charges are separated.

Dividing squares

In conventional physics this is referred to as a flux tube in between the color charges, in this model a squared attractive force divided by a squared repulsive force is a constant. This is because closer together the gravity increases as a square, as it weakens as a square with a greater e𝕙 height then the repulsive force is also weakening as a square. The difference in this model is gravity creates this attraction.

The weak force

In this model the weak force occurs when the neutron is separated from the nucleus, this is where the electron moves up into the ground state as α. The balance of the +𝕚d and e𝕙 Pythagorean Triangle as gravity against the +𝕠d and e𝕒 Pythagorean Triangle as the potential changes, the reactive force is stronger so that the -𝕠d and e𝕪 Pythagorean Triangle as the electron with the -𝕚d and e𝕧 Pythagorean Triangle as inertia become stronger.

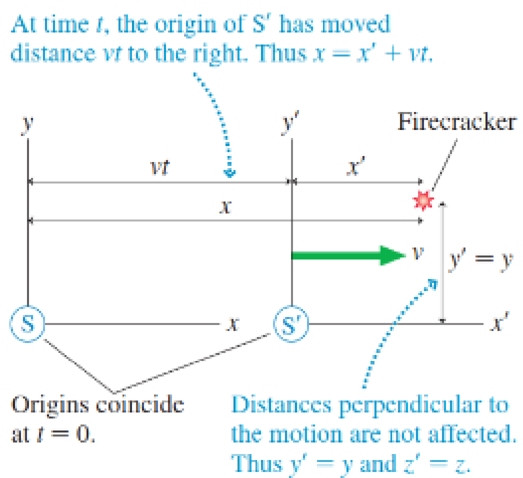
Neutron decay

There is a e𝕙 height dilation so that the electron tends to move upwards from the proton, also the faster +𝕚d gravitational time increases the decay period of the neutron.

The CMB

Towards the CMB the +𝕚d and e𝕙 Pythagorean Triangle approaches its maximum, then the E𝕀 gravitational displacement history and the +𝕀D gravitational temporal history both approach their maximum values. This causes the e𝕙 height to contract and the +𝕚d gravitational time to slow towards their minimums, it gives the CMB the appearance of a surface with a minimum e𝕙 height moving slowly or frozen in +𝕚d gravitational time.

FIGURE 36.2 The position of an exploding firecracker is measured in reference frames S and S′.



Vectors as derivatives

In this model the two reference frames shown are for example the -𝕚d and e𝕧 Pythagorean Triangles, the vector is a derivative slope of a Pythagorean Triangle with respect to the straight Pythagorean Triangle side. This is because it acts like a hypotenuse, the velocity is the straight Pythagorean Triangle side such as e𝕧 divided by the spin Pythagorean Triangle side such as -𝕚d to give e𝕧/-𝕚d. A vector is associated with impulse not work, the E𝕍/-𝕚d inertial impulse here is where there is an observable force on a velocity.

Reference frames as integral areas

To compare two reference frames with work this model uses areas of Pythagorean Triangles, the -𝕚d and e𝕧 Pythagorean Triangle then would have a field of -𝕚d×e𝕧. Velocity acted as a first derivative with respect to e𝕧, this is a first integral with respect to -𝕚d. Comparing the reference frames then changes the values of d and e in the field, a force is represented by the -𝕀D×e𝕧 inertial work where the spin Pythagorean Triangle side is squared.

An inertial field

That would change the angle θ in the first reference frame area, this could represent a change in the inertial field around a rocket accelerating for example. This is the field that reacts against a change in its angle θ, when observed this would be a change in its derivative slope as the e𝕧/-𝕚d velocity.

Integrals as momentum

Because the Pythagorean Triangles have a constant area the integrals can be measured as they change as the inertial momentum -𝕚d×e𝕧, this is like observing a change in velocity as e𝕧/-𝕚d. The -𝕚d×e𝕧 inertial field is part of space-time where e𝕧 refers to space and -𝕚d to inertial time.

Inertia observed and measured indirectly

In this model the -𝕚d and e𝕧 Pythagorean Triangle is not observed with an E𝕍/-𝕚d inertial impulse or measured with -𝕀D×e𝕧 inertial work, as active forces, instead this is subtracted from the Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work. It also is a reactive force against the E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work, there it is not observed or measured either except in relation to the active kinetic forces.

Square roots of +1

This is because in this model -𝕚d is the negative square root of +1 which is not directly used, the active +𝕚d is the positive square root of +1. Before being squared +𝕚d-𝕚d is calculated and then the result is squared. It gives the same answers but allows for inertia to not act but only react.

Collapse of the inertial wave function

When the integral area changes from one reference frame to another, so does the ratio d:e in -𝕚d as the inertial time and e𝕧 as the length. This happens with a measurement of the -𝕀D×e𝕧 inertial work, then the E𝕍/-𝕚d inertial impulse can be observed after this on a scale of -𝕚d inertial time. It is like the collapse of the inertial wave function, first the change in the -𝕀D inertial probability happens and then the E𝕍/-𝕚d inertial impulse is observed according to the -𝕀D probability distribution. From this observation there can be -𝕀D×e𝕧 inertial work near it on a e𝕧 scale like a ruler, that is where the derivative slope with respect to e𝕧 changes with an integral with respect to -𝕚d.

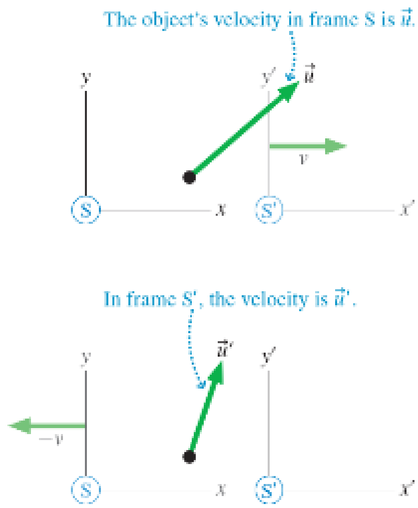
Gravitational reference frames

In general relativity the same process happens with active forces, there can be a derivative slope of the +𝕚d and e𝕙 Pythagorean Triangles with respect to e𝕙. There is also the gravitational field from the integral area of the +𝕚d and e𝕙 Pythagorean Triangle with respect to +𝕚d. An acceleration of a rock under gravity would be a motion from one +𝕚d and e𝕙 Pythagorean Triangle reference frame to another.

Gravitational uncertainty

This happens with the angle θ changing from a force, the change in the +𝕚d×e𝕙 integral gravitational field gives a different ratio of d:e as with inertia. The uncertainty in the motion of the rocket through the +𝕀D gravitational probability leads to an observation of the Eℍ/+𝕚d gravitational impulse.

FIGURE 36.3 The velocity of a moving object is measured in reference frames S and S′.



Einstein field equations

In this model the Einstein field equations can be replaced by Pythagorean Triangles with a constant area. With general relativity there is a single dimension of e𝕙 height, where there are multiple planets and moons their +𝕚d gravitational mass is still a function of their e𝕙 heights from their centers.

Schwarzschild equation

For each planet and moon a perfectly spherical body would have the +𝕚d gravitational time slowing and e𝕙 height contraction modeled by the Schwarzschild equation. With classical gravity the +𝕚d and e𝕙 Pythagorean Triangles can extend from the center of the planet, for a given e𝕙 height there is a +𝕚d gravitational mass. Each would then use the +𝕚d and e𝕙 Pythagorean Triangle to model gravity, with +𝕀D×e𝕙 gravitational work this is a field that interferes constructively for all interactions between them.

Cartesian metric

In a metric a cube of Cartesian coordinates is modeled around a planet, these cubes can be made small to approximate calculus infinitesimals and fluxions. In this model the +𝕚d and e𝕙 Pythagorean Triangle as gravity is in circular geometry as a two-dimensional construct, this can be turned to approximate spherical geometry.

Tensors using squared forces

A three-dimensional tensor is also made up of Pythagorean Triangles and squares, in this model the concept of width to make a cube is not used. Instead there can be a series of straight lines in any kind of lattice, these can for example be regarded as how particles bounce off each other to form the lattice shape.

An irregular lattice of collisions

With gravity these collisions would tend to fall more downwards towards a planet, the velocity of these collisions can model the energy and momentum of the particles using a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse. Assuming they are colliding in three dimensions they can still be described by two, the e𝕙 height above a planet and the e𝕧 length between collisions.

A denser lattice with gravity

The downward motion is modeled by the +𝕚d gravitational mass, this tends to cause a collision to spin downwards more. An inertial motion is modeled by the -𝕚d inertial mass, when this is stronger the particles tend to move outwards towards and escape velocity and hyperbolic geometry.

Modeling cubes with collisions

These collisions can then form a metric with the +𝕚d and e𝕙 Pythagorean Triangles and -𝕚d and e𝕧 Pythagorean Triangles, they do not need a width except as an approximation. A cubic metric can be deformed with tensors to approximate the motion of these particles, that would use squared forces. The particles can then be modeled as being in curved space, the curvature is the amount of the +𝕚d gravitational spin and -𝕚d inertial spin.

The density of the lattice

If the metric needs to be more detailed, then there can be more particles. This would reach the limit of the constant areas of the +𝕚d and e𝕙 Pythagorean Triangles and -𝕚d and e𝕧 Pythagorean Triangles, the sides act as infinitesimals of distances and fluxions of time. These do not change with forces unless observed by impulse or measured with work, there is no curvature or straightness in these.

Energy momentum tensor

In this model the energy momentum tensor would be modeled by the +𝕠d and e𝕒 Pythagorean Triangle as protons with the potential, also with the -𝕠d and e𝕪 Pythagorean Triangles as electrons. Where there is more ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy the -𝕠d and e𝕪 Pythagorean Triangles are stronger and proportionally there is a higher inertia in the particles from the -𝕚d and e𝕧 Pythagorean Triangles.

Potential and kinetic energy

In conventional physics the motion of the particles can be modeled with kinetic energy from the -𝕠d and e𝕪 Pythagorean Triangle, and potential energy from the +𝕠d and e𝕒 Pythagorean Triangle. Gravity is sometimes referred to as having a gravitational potential energy, this is proportional to the proton's potential energy. In this model that energy ends at the ionization level so inside that there is a proportionality between the two.

Energy as impulse and momentum as work

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is referring to the E𝕐/-𝕠d kinetic impulse in this model, the momentum comes from -𝕆D×e𝕪 kinetic work. The energy momentum tensor then would be a combination of impulse as energy for observing particles and work for measuring momentum as fields.

Changing energy and momentum

The particles might be modeled by changing the energy and momentum in their collisions, for example from the sun's energy. This increases the particles' E𝕐/-𝕠d kinetic impulse and so the lattice would become less dense. This would be proportional to an increase in their E𝕍/-𝕚d inertial impulse so that the collisions caused them to move to a greater e𝕙 height from the gravitational attraction.

Density of a metric

Conversely closer to the planet the particles would collide more densely, this is where the E𝕙/+𝕚d gravitational impulse is stronger and the E𝕍/-𝕚d inertial impulse has less energy. In a conventional metric the edges of the cubes are assumed to be infinitesimals, there is then no increase in density.

Fields of probability

The collisions can also be modeled by work and fields of probability, the +𝕚d and e𝕙 Pythagorean Triangles as gravity and the -𝕚d and e𝕧 Pythagorean Triangles as inertia have integral areas. These would change with the collisions, the ratio of the e𝕙 straight Pythagorean Triangles side to the +𝕚d spin Pythagorean Triangle side gives the same area integral but with a different +𝕚d×e𝕙 gravitational momentum.

Curved space as changing integrals

The area in between the lines drawn by the collisions can then be referred to as separate integrals, when the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work is measured then these give the gravitational and inertial probabilities of where the particles will go. This gives an approximation of curved space as fields, the differences between parts of the Pythagorean Triangle integrals gives changes in their gravitational and inertial momenta.

Gravitational path integrals

These can also be referred to as path integrals, the paths of the particles have probabilities according to the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work being done. Measuring these probabilities has some uncertainty relating to the areas of the +𝕚d and e𝕙 Pythagorean Triangles and -𝕚d and e𝕧 Pythagorean Triangles.

General and special relativity

The motion of the particles is consistent with relativity, for example they might be around an event horizon of a black hole. The lower particles have a smaller e𝕙 height, this means they have a larger +𝕀D +𝕀D gravitational temporal history in how far they have fallen into the gravitational well. This can be referred to also as their bottom e𝕓 starting with b, in the sense that it is the bottommost point they have reached.

Height contraction

As the +𝕀D gravitational temporal history reaches its maximum this is the same as the +𝕀D×e𝕙 gravitational work, the e𝕙 value contracts while +𝕀D increases as a square. This makes e𝕙 appear contracted when measured. The particles have also fallen with close to a maximum E𝕙 gravitational displacement history, the +𝕚d gravitational time is observed as being slower.

Two kinds of downward acceleration

Both these can happen together because the particles are observable with their E𝕙/+𝕚d gravitational impulse increasing their acceleration downwards in meters^2 as E𝕙 over +𝕚d seconds in gravitational time. They are also measurable because the +𝕀D×e𝕙 gravitational work moved them to a lower e𝕓 bottom or smaller e𝕙 height, this is also approximately an acceleration as +𝕀D seconds^2 per e𝕙 meter. When the particles fall towards an event horizon, while still colliding with each other then these two kinds of downward accelerations have their forces from the histories of how far and how long they fell.

Two kinds of upward acceleration

The particles would also experience special relativity, to stay out of the event horizon they would be colliding at approaching c. Their E𝕍 inertial displacement history from the E𝕍/-𝕚d inertial impulse means they have a history of strong impulse to reach this higher velocity. Their -𝕀D inertial temporal history means they have a history of strong work also, these do not conflict because the first is an observation and the second is a measurement.

Gravitational histories are conserved

For particles that move upwards with collisions away from the black hole, these Eℍ gravitational displacement history and +𝕀D gravitational temporal history decrease, they no longer have a history of overall strong downwards acceleration. These may have happened in their recent history, but this was countered to some degree by their upward motion. This allows for the gravitational histories to be conserved if they moved a long way from the black hole, and perhaps to around a planet or a different black hole.

Inertial histories are conserved

The E𝕍 inertial displacement history and the -𝕀D inertial temporal history are also conserved, the particles moving upwards have increased their inertial forces by comparison with their previous lower e𝕙 height. But they also have attained similar inertial forces to before they fell towards the event horizon.

Inverse histories

These gravitational and inertial histories are inverses, the Eℍ gravitational displacement history grows as the E𝕍 inertial displacement history weakens. Some particles more lose their velocity and inertia with some collisions and increase their gravitational downward forces. The +𝕀D gravitational temporal history and -𝕀D inertial temporal history are also inverses, as the +𝕀D×e𝕙 gravitational work weakens by the particles moving upwards this increases the -𝕀D×e𝕧 inertial work the particles are doing.

Length and height contraction

The contraction of the e𝕧 lengths happens for the particles at a lower e𝕙 height, also their -𝕚d inertial times are slowed by the E𝕍 inertial displacement history and the -𝕀D inertial temporal history respectively. This makes them also appear to have a slower velocity as a combination of an observation and a measurement classically.

Photons as rolling wheels

Light also experiences this around a gravitational body, the rolling wheel model has the e𝕪×-𝕘d photons undergo a change in their E𝕐 light displacement history from their e𝕐/-𝕘d light impulse. They also change with their -𝔾D light temporal history from their -𝔾D×e𝕪 light work. This appears as the rolling wheel both contracting with its e𝕪 phasor and decreasing its -𝕘d rotational frequency. The photons then move slower around the gravitational body in accordance with the histories of these forces. They also increase their -𝕘d rotational frequency with a blueshift but this is with an inverse contraction of the e𝕪 phasor.

Canceling out histories

This slowing on one side causes the photons to curve towards the gravitational body, for example an event horizon. In climbing out of the gravitational well photons experience an overall history that can cancel out the original contraction of the e𝕪 phasor or spoke of the rolling wheel. They also increase their -𝕘d rotational frequency until it is the same as before they passed the gravitational body. The E𝕍 inertial displacement history and -𝕀D inertial temporal history cancel out as the photons do down into the gravitational well and climb out again.

Adding displacement histories as vectors

This is the same as equal and opposite forces canceling each other. The E𝕍 inertial displacement history acts as a force, it is like the E𝕍/-𝕚d inertial impulse as particles collide with each other around the black hole. When a particle goes to a lower e𝕙 height and then higher, these E𝕍 inertial displacement histories can be added together as vectors to give a total history with some uncertainty.

Constructive and destructive interference with temporal histories

When the particles do opposing -𝕀D×e𝕧 inertial work on each other, they can also go to a lower e𝕙 height and up again. In this model these are not addable as vectors, the straight Pythagorean Triangle sides can be vectors but not the spin Pythagorean Triangle sides. Instead these are added as constructive interference from the -𝕀D×e𝕧 inertial work or subtracted as destructive interference.

Inertial probabilities

They become like inertial probabilities of where the particles probably are. With destructive interference the -𝕀D inertial temporal history can also be canceled out, the photons then can regain their rolling wheel size and frequency with both a e𝕐/-𝕘d light impulse and -𝔾D×e𝕪 light work.

Slower and smaller rolling wheels

When photons climb out of the gravitational well, this is with their original E𝕐 light displacement history and -𝔾D light temporal history coming from around the event horizon. The rolling wheel photons are slower at a lower e𝕙 height because their e𝕪 phasor spokes are contracted and their -𝕘d rotational frequency is lower.

Conserving histories in redshifts

The photons then appear redshifted, the E𝕐 light displacement history and -𝔾D light temporal history when they move away from the event horizon allows them to speed up to c again. Because the lost forces as histories need to be conserved, this gives a slower or redder rotational frequency as -𝕘d.

Redshifts from work

The photons are more redshifted in moving away from the black hole because this needs more -𝔾D×e𝕪 light work to be done. It is like electrons moving to higher orbital with -𝕆D×e𝕪 kinetic work, to move upwards there needs to be more -𝕆D kinetic torque. If they move up with a e𝕐/-𝕘d light this causes them to move in an elliptical orbit not a higher orbital.

Fractions of h in elliptical orbitals

In the atom the elliptical orbitals are a fraction of h as -𝕠d ×e𝕐/-𝕠d for this reason. The derivative slope changes to move an electron from a circular orbital to an elliptical one. To move to another circular orbital this is quantized in whole numbers as work.

Roy uncertainty and a continuous spectrum

The uncertainty principle for Roy electromagnetism relates to the area of the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron. The changes in the angle θ is emitted and absorbed by the area of the e𝕪×-𝕘d photon. When the e𝕐/-𝕘d light impulse is observed this can give a continuous spectrum because E𝕐 is not quantized.

Continuous fractions from the derivative slope

This is because the e𝕐/-𝕘d light impulse can give many different fractions of h, as the angle θ changes continuously. It also cannot be quantized because the fractions as the Pythagorean Triangle slope cannot form integers.

Discrete spectrums and quantization

When the -𝔾D×e𝕪 light work is measured this gives a discrete spectrum because -𝔾D is quantized. That is because it cannot form a fraction, when two numbers are divided this is like a slope in a Pythagorean Triangle as a derivative. An integral only multiplies two numbers and so it cannot be a fraction. That makes it impossible for it to form a continuous spectrum with e𝕐/-𝕘d light impulse.

Quantized orbits

In this model the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work would have to be quantized in some way. This is seen for example in how satellites can maintain a constant orbit around a planet without going up or down. The forces here come from the +𝕀D×e𝕙 gravitational work and the -𝕀D×e𝕧 inertial work, the Eℍ/+𝕚d gravitational impulse can cause a satellite to hit the ground or E𝕍/-𝕚d inertial impulse to cause it to leave orbit.

Impulse forms ellipses

This is also why electrons would not spiral down to lower circular orbits with their E𝕐/-𝕠d kinetic impulse. In this model the spiraling would require a continuous spectrum to be emitted with the e𝕐/-𝕘d light impulse. Changing the E𝕐/-𝕠d kinetic impulse would mean an E𝕍 kinetic displacement force was applied at one point on the circular orbit, that would change it into an ellipse.

An exponential spiral from work

The exponential spiral would occur with changes in -𝕆D×e𝕪 kinetic work, the -𝕆D kinetic torque can form an approximate exponential spiral such as in a galaxy. But -𝕆D×e𝕪 kinetic work can only jump in quantized integer amounts, that prevents the spiral from occurring in the atom.

The cosmological constant in the Einstein field equations

The cosmological constant in this model comes from the +𝕚d and e𝕙 Pythagorean Triangles, as the e𝕙 height increases towards the CMB there is a motion backwards in +𝕚d gravitational time towards the past. Here the +𝕚d gravitational time and +𝕠d potential time flow towards the past, the -𝕚d inertial time and -𝕠d kinetic time flow towards the future. Because the cosmological constant indicates an expansion or repulsion in space, with +𝕚d gravitational time this is a small gravitational attraction back into the past.

Accelerating back to the CMB

That appears as an acceleration backwards in time towards the CMB as the big bang, looking at -𝕠d kinetic time and -𝕚d inertial time going forward there is an explosion that slows but does not stop completely at the cosmological constant. It does not go to zero because then the +𝕚d and e𝕙 Pythagorean Triangles would have no forces at some angle θ. Instead in this model there are limits, the CMB is where the Eℍ/+𝕚d gravitational impulse reaches its maximum going backwards in +𝕚d gravitational time.

A minimum gravitational impulse

In nearby space the Eℍ/+𝕚d gravitational impulse approaches its minimum, because the +𝕚d and e𝕙 Pythagorean Triangles cannot disappear with no e𝕙 height then there is a small acceleration into the past remaining as this Eℍ/+𝕚d gravitational impulse. This minimum gives the cosmological constant.

The ground state and the CMB

The cosmological constant and CMB constant are in Biv space-time, the equivalents in Roy electromagnetism are the ground state like the CMB and the ionization boundary as the cosmological constant. This can also be regarded as an event horizon of a black hole as the ground state, the cosmological constant would be like the last amount of attraction back in time towards the big bang. Conversely it would be the last amount of repulsion from the big bang going forward in -𝕠d kinetic time.

The ground state as an event horizon

The ground state of an atom is where the electron can disappear inside to form a neutron with a proton there. This is like matter being drawn into the event horizon of a black hole. Usually that does not happen, the electron instead stops at the ground state such as in a hydrogen atom. This is a quantized orbital, to move lower the electron needs a E𝕐/-𝕠d kinetic impulse. When the atom has more protons and electrons, then the electron might not get to the ground state because of other electrons with a lower energy than it.

A minimum attraction

As the electron approaches the ionization boundary there is a potential attracting it, that +𝕆D×e𝕒 potential work is a reaction force in this model. The limit of this force is the minimum attraction holding the electron, it can also be regarded as the minimum acceleration pulling the electron downwards. The potential forces from the +𝕠d and e𝕒 Pythagorean Triangles are added to the -𝕆D×e𝕪 kinetic work, these reduce its -𝕆D kinetic torque and hold the electron in the atom. There is then a minimum attractive force going backwards in time like the cosmological constant.

A minimum repulsion

Looking forwards with -𝕠d kinetic time there is a minimum repulsive force, this is a tendency for the electron to leave the atom. Often it remains in an orbital as the potential reaction forces are stronger than this repulsion, also stars can remain in galaxies despite the small repulsive -𝕚d inertial forces on their edges from this cosmological constant.

A quantized jump

This minimum constant acts as a quantized value, when the electron reaches the edge of this ionization boundary then there is a quantized jump of repulsion as it leaves the atom. In Biv space-time there is a minimum quantized constant of repulsion as the cosmological constant. It must be quantized because in this model a continuous change comes from impulse. To move inwards or outwards in circular geometry, there are quantized changes.

The cosmological constant increases into the past

The Biv cosmological constant, when seen going into the past with +𝕚d gravitational time, increases until the attraction reaches an event horizon seen as the big bang. The +𝕠d potential time going into the past becomes stronger, electrons are increasingly captured such as into neutrons and in neutron stars. Looking forward with -𝕠d kinetic time, the electrons are increasingly liberated as the universe spread out.

No singularity or big bang

In this model there was no actual singularity with the big bang. Instead there is a limit of observation of impulse, and measurement of work, at the CMB. This would occur anywhere in Biv space-time, someone near where we observe and measure the CMB would find their own CMB where we are now.

Atoms appearing to have exploded from the nucleus

That limit appears as an explosion because of the limits of the +𝕚d and eℍ Pythagorean Triangles. The same kind of limit happen to electron in an atom, beyond their CMB as the ionization boundary nothing can be observed or measured. Electrons in different orbitals could be imagined as have exploded outwards from the nucleus, like a neutron star closer to the big bang that decayed into normal matter.

Light comes from the past

The universe appears to have exploded outwards from the big bang, in this model the +𝕚d gravitational time goes into the past to connect larger redshifts to increasing eℍ heights back into +𝕠d gravitational time. In this model that is why Biv space-time appears everywhere as being in the past, in cosmology we can only observe and measure gravitational events that have happened not that can or will happen. E𝕪×-𝕘d photons move forward in time, so they can only come from events in the past.

Potential time

The atom's nucleus has +𝕠d potential time which moves into the past with reactive forces. It appears to repel electrons from going into the nucleus like the weak force breaks up neutrons by the proton, electron, and electron neutrino seeming to be repelled by each other in an explosion. Radioactivity also looks like an explosion.

The CMB as the limit of gravity

This is a reactive E𝔸/+𝕠d potential impulse, it becomes zero past the ionization energy where the electrons can leave the atom. In this model the CMB is like the ionization energy, beyond this the Eℍ/+𝕚d gravitational impulse has no more ability to attract objects.

The Roy event horizon

An electron then inside this ionization energy is bound to the protons in the nucleus to make neutrons. In this model a neutron is like a collapsed hydrogen atom, the electron has gone into the Roy event horizon as the ground state and is bound with the proton by gravity.

Kinetic energy and inertia outside the atom

In this model moving forward in time comes from -𝕠d kinetic time and -𝕚d inertial time, these appear to move outwards away from the big bang dominated by their ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia. This is like where electrons leave the atom, they move with this kinetic energy and inertia free of the potential of the protons. They are still subject to forces from the +𝕚d and e𝕙 Pythagorean Triangles and gravity, this would happen up to the CMB as a kind of ionization boundary for Biv space-time.

Exploding with kinetic energy and inertia

So the big bang appears to have exploded outwards with kinetic energy and inertia, this is the same as the kinetic energy and inertia of electrons coming out of the nucleus. While the matter in the universe is not just electrons, the kinetic motion comes from them. The electrons in this model reach an intermediate stage outside Roy and inside Biv, they can leave the atom and Roy electromagnetism and still be inside Biv space-time.

Between Roy and Biv

The nucleus also has this intermediate stage, electrons can be captured by protons into the nucleus, that brings them below the ground state as the event horizon of Roy. They are outside underneath the ground state or event horizon of Roy but inside the influence of gravity with Biv space-time. Under this is the event horizon of Biv space-time, that attracts the protons and electrons to become neutrons and is the strong force in this model. Conversely the electron can escape a neutron when the Roy event horizon can be reached, that gives it enough energy to overcome the strong force from the Biv event horizon under the Roy event horizon.

Converting Cartesian into circular geometry

In this model Cartesian geometry is composed of straight lines, this is from the Newtonian universe where only impulse and straight Pythagorean Triangle sides are used. In generally relativity this is in circular geometry, that requires curves so these straight lines are bent with tensors. A similar process would be done to use hyperbolic geometry or in between an elliptical or parabolic geometry.

Approximating curves with straight lines

This can also be done by only using impulse and straight lines, then curves are approximated using infinitesimal distances of e𝕙 height and e𝕧 length. In this model that is done by only using derivatives as the slopes of the Pythagorean Triangles, the integrals are the +𝕚d and e𝕙 Pythagorean Triangle geodesics as curved space from gravity. There would also be a curved space in special relativity where e𝕧 length can be contracted and -𝕚d inertial time slowed closer to c.

A Roy metric

The same process can be done inside the atom with Roy electromagnetism, the +𝕠d and e𝕒 Pythagorean Triangle as the potential is in circular geometry like the +𝕚d and e𝕙 Pythagorean Triangle as gravity. The motions of electrons can then be approximated as infinitesimal impulse forces, this would give the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia in Schrodinger’s equation.

Infinitesimals as straight line square roots

In this model calculus comes from using infinitesimals as straight-line square roots. Because they are not squared they are not observable, there is no paradox in making them a minimum size but not infinitely small. Instead they can be regarded as infinitesimals because they are where the forces no longer exist in derivatives.

A velocity at an infinitesimal point of length

For example a projectile can be accelerating when fired, it decelerates up to an apex then accelerates downwards. At any point a derivative can assume there are no squared forces by taking the e𝕧/-𝕚d velocity at a e𝕙 height. In this model that also happens, the -𝕚d and e𝕧 Pythagorean Triangle of inertia is not observable where this velocity occurs. In calculus this point of no forces is reached by making e𝕧 and -𝕚d infinitely small, in this model that begin inertial temporal history no forces and a constant Pythagorean Triangle area. Then this can be observed as a square.

A metric has no forces

A metric then assumes there are no forces around a gravitational body by using infinitesimals. In this model the +𝕚d and e𝕙 Pythagorean Triangles of gravity have no forces to begin with. While the Pythagorean Triangles have a minimum size these infinitesimals are never observed, so there is no conflict. In conventional physics this metric has first and second derivatives which are used to give velocities and acceleration.

Minimum distance between points

The metric begins as a lattice of cubes, ideally with infinitesimal sides. This model has +𝕚d and e𝕙 Pythagorean Triangles which can be used with infinitesimals when not observed with impulse forces. Any point in this lattice can then be modeled with the +𝕚d and e𝕙 Pythagorean Triangle, but two points close enough together might be less than the minimum e𝕙 height of the Pythagorean Triangle. This also occurs in conventional physics where they might be less than a Planck length.

Covariant and contravariant tensors

The infinitesimals are then bent in conventional physics using covariant and contravariant tensors. Using this they can approximate any trajectory on a geodesic in curved space using these infinitesimal straight lines.

The Ricci tensor

The Ricci tensor can also be used as the volume of these infinitesimal cubes, the change in the shape of the cube is modeled by the tensor. In this model volumes are not used, instead there are areas which would be approximately modeled by the facets of these cubes. When they are distorted in shape by gravity, this is how-𝕚d and e𝕧 Pythagorean Triangles would have their shape changed by their angle θ changing.

Christoffel symbols

The distortion of these volumes is also described by Christoffel symbols, these would also describe the changes in the facets of the cubes. In this model the Pythagorean Triangles retain their right angles, this happens because the +𝕚d and e𝕙 Pythagorean Triangle has a e𝕙 height directly out of a gravitational mass and a +𝕚d gravitational field value at right angles to that.

Increments of height

These larger +𝕚d and e𝕙 Pythagorean Triangles can be broken up into smaller Pythagorean Triangles as an approximation, the e𝕙 heights of each might be the sides of a cube. Any distortion modeled by the Ricci tensor would change the e𝕙 height and inversely the +𝕚d gravitational field value. If a cube is at an angle to this height then a distortion of its shape would be modeled by the Ricci tensor. That happens because the metric starts out as cubes, some of this are not parallel to the e𝕙 height coming from the center of the gravitational body.

Basis vectors

The distortion of a cube then is modeled by the Ricci tensor, that requires the use of basis vectors that do not have a right angle between them. In this model there cannot be two e𝕙 heights in a coordinate system at an angle to each other, except as an approximation. This is because they are in separate Pythagorean Triangles, each can be observed with a Eℍ/+𝕚d gravitational impulse or measured with +𝕀D×e𝕙 gravitational work.

The Ricci tensor and basis vectors

Taking the two together can use e𝕙 height as each basis vector, then as the Ricci tensor changes the cube shape is deformed. With two sides of the cube as basis vectors this distortion can then be also modeled by the change in the angle between the basis vectors.

Special relativity and basis vectors

This is also used in special relativity where right angles are changed closer to c. In this model the two e𝕧 lengths can only be used as basis vectors there as an approximation. Instead they are separate -𝕚d and e𝕧 Pythagorean Triangles that are observed or measured with some uncertainty between them.

Basis vectors as impulse

When two e𝕧 lengths are used as basis vectors in special relativity they are approximating using impulse only, in general relativity two e𝕙 heights as basis vectors also use impulse only. In the example of particles colliding, surrounding a gravitational body, each collision can be represented by an -𝕚d and e𝕧 Pythagorean Triangle with the particle's inertia. When two are taken together the e𝕧 lengths can be regarded as basis vectors without using a right angle. Then the collision is modeled on those vectors as coordinates. In this model vectors are only used with the straight Pythagorean Triangle sides, the spin Pythagorean Triangle sides are not vectors.

Breaking apart basis vectors

In this model each of the basis vector can be regarded as being from a separate +𝕚d and e𝕙 Pythagorean Triangle as gravity. The associated +𝕚d gravitational field value gives the strength of this as the amount of spin gravity would be exerting on the vector. This gives an angle θ in the +𝕚d and e𝕙 Pythagorean Triangles which changes according to the forces according to this approximation. It can give the same changes as basis vectors from this, the areas of the +𝕚d and e𝕙 Pythagorean Triangles can give the same changes in volumes as Ricci tensors.

Smaller Pythagorean Triangles as approximations

This is not intended to say +𝕚d and e𝕙 Pythagorean Triangles can be made smaller, or point away from gravitational bodies at different angles. It is to show first how the Ricci tensor and basis vectors can be converted first into these +𝕚d and e𝕙 Pythagorean Triangles as approximations.

Then these Pythagorean Triangles can be transformed into those where the e𝕙 height points straight out of the gravitational mass. When there are two or more gravitational bodies, like a planet and a moon, these can be added together as e𝕙 heights with vector addition.

Curl and gravity

This is similar to the representation of curl as vectors pointing in different directions with Roy electromagnetism. They can converge and diverge, any two could be taken as basis vectors not having right angles and the others compared to them. This is not using a metric or a Ricci tensor but can describe similar forces. The changes in these vectors with curl can then be used in this model with +𝕠d and e𝕒 Pythagorean Triangles as protons and -𝕠d and e𝕪 Pythagorean Triangles as electrons.

Ricci tensors and relativity

The use of tensors and basis vectors in relativity allows for the e𝕙 height and e𝕧 length contractions to be described. These are an additional aspect to the example with curl. In this model there is a proportional change in Roy electromagnetism with relativity, this is how energy is conserved at relativistic speeds and closer to large gravitational bodies.

Smaller Pythagorean Triangles under general relativity

Closer to a planet there would be a e𝕙 height contraction and +𝕚d would also decrease, the +𝕚d and e𝕙 Pythagorean Triangles would then have smaller areas at lower heights as explained earlier. This would model the changes in the Ricci tensor and basis vectors in general relativity. As explained earlier this happens with the changes in the displacement and temporal histories around the gravitational body.

Reference frames as Pythagorean Triangles

In the diagram below there are two reference frames, these would be -𝕚d and e𝕧 Pythagorean Triangles for example in special relativity. Each is a space time coordinate system where e𝕧 is space where distances are in lengths. The second coordinate, by convention pointing upwards, is like an imaginary axis of -i but as the negative square root of +1.

Observing and measuring a reference frame

The two inertial reference frames would be compared by drawing a hypotenuse to connect the two sides, this completes the -𝕚d and e𝕧 Pythagorean Triangles. They would also have a constant Pythagorean Triangle area. If they have the same angle θ then they are approximately at rest compared to each other. There is always some uncertainty because an observation of the E𝕍/-𝕚d inertial impulse or -𝕀D×e𝕧 inertial work in one reference frames needs a force which moves it compared to the other.

Eight kinds of reference frames

In this model there are 8 different kinds of reference frames, these correspond to the different Pythagorean Triangles. There can be for example two -𝕠d and e𝕪 Pythagorean Triangles as electron reference frames, the area in a Pythagorean Triangle represents the -𝕠d kinetic magnetic field of the electron. Two electrons might be compared with their kinetic reference frames, if they are repelled then this might be drawn as two -𝕠d and e𝕪 Pythagorean Triangles with their right angles touching.

Kinetic reference frames

This would appear like two lines intersecting at right angles, the vertical line above and below the origin would be -𝕠d as the kinetic magnetic field of the -𝕠d and e𝕪 Pythagorean Triangle. The horizontal line would be e𝕪 as the kinetic electric charge of each electron.

Hyperbolas give the derivatives

As they repelled each other they would describe a hyperbola in each Pythagorean Triangle, a point on each hyperbola would have a tangent to an -𝕠d and e𝕪 Pythagorean Triangle with a constant area. As the angle θ changed in the -𝕠d and e𝕪 Pythagorean Triangle this tangent would give a slope or derivative as the velocity of the electron at that point.

Special relativity and the hyperbola

The two kinetic reference frames can then be compared, it can also describe special relativity by proportional -𝕚d and e𝕧 Pythagorean Triangles for each electron. These would give the velocity e𝕧/-𝕚d of each electron as a slope or derivative of the respective -𝕚d and e𝕧 Pythagorean Triangle.

Kinetic energy and the Hamiltonian

This allows for the kinetic energy of an electron to be connected to its Hamiltonian, the kinetic energy comes from the -𝕠d and e𝕪 Pythagorean Triangle and the Hamiltonian describes inertia with the -𝕚d and e𝕧 Pythagorean Triangle. That also connects the two sides of Schrodinger's equation, so that the kinetic energy is proportional to the change in position of an electron with the kinetic and inertial reference frames.

Potential and kinetic energy

In this model a single electron in an orbital can be described by the kinetic and inertial reference frames. There is also a potential reference frame from the +𝕠d and e𝕒 Pythagorean Triangle as the proton, this gives the potential energy as a positive value from which the kinetic energy is subtracted. The signs are the opposite of those used in Schrodinger' s equation but the answers are the same in absolute terms.

The gravitational reference frame

There is also a gravitational reference frame from the +𝕚d and e𝕙 Pythagorean Triangle as gravity, this would pull down the electron in an orbital with Schrodinger's equation. Close to an event horizon this would give different answers in the equation, the electrons have a contracted e𝕙 height and move with a slower +𝕚d gravitational time.

Central reference frames

The other 4 reference frames are divided into 2 in Roy electromagnetism and 2 in Biv space-time. This are referred to as the central reference frames, they come from the four Pythagorean Triangles in the middle of the overall Pythagorean Equation.

Light reference frames

The e𝕪×-𝕘d photon is represented as a light reference frame, the change in its angle θ gives changes in its redshift and frequency. There is also a virtual photon reference frame e𝕣×+𝕘d, this is the inverse of the e𝕪×-𝕘d light reference frame. It represents the energy lost when a photon is emitted for example.

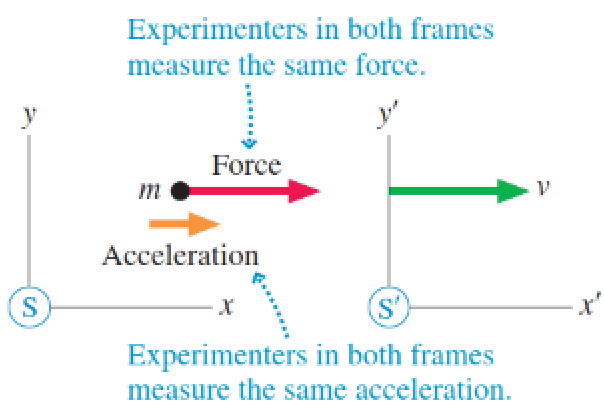
Gravis and iners reference frames

In Biv space-time there is a +𝕘d×e𝕓 gravitas reference frame measured as gravitational waves, there is also a -𝕘d×e𝕧 iners reference frame which changes in inertia being subtracted from the gravitas reference frame.

Changing the right angle in Pythagorean Triangles

In each case then the different reference frames can describe the interaction between iotas. These reference frames can be modeled as the right angle becoming more acute, acting as basis vectors in relativity. In this model that is two Pythagorean Triangles at an angle to each other, the two Pythagorean Triangle sides being observed or measured are an approximation with some uncertainty.

FIGURE 36.5 Experimenters in both reference frames test Newton's second law by measuring the force on a particle and its acceleration.



Moving between reference frames

In this model a change in reference frames means a force is used. This can be a E𝕐/-𝕠d kinetic impulse for example so that the balls here are observed as particles with a change in their kinetic velocity e𝕪/-𝕠d. If -𝕆D×e𝕪 kinetic work is used to move between them, then the balls can change their kinetic momentum -𝕠d×e𝕪/-𝕠d.

In the macro world impulse dominates

In classical physics the difference is not observed or measured, the balls are large enough so that their E𝕐/-𝕠d kinetic impulse dominates their -𝕆D×e𝕪 kinetic work. This is because a larger e𝕪 kinetic distance when squared gives a larger force. Because the -𝕠d and e𝕪 Pythagorean Triangles have a constant area, this means their -𝕠d kinetic magnetic field sides contract and so the -𝕆D×e𝕪 kinetic work is less measurable. Work can still be measured but in this model that is impulse being converted into work. This can be done because the time of the impulse is the inverse of the distance with a constant Pythagorean Triangle area.

Work dominates in the micro world

The balls are not measured like waves of probability as much, this changes when smaller electrons are measured in orbitals. Then the -𝕆D×e𝕪 kinetic work dominates, with occasional E𝕐/-𝕠d kinetic impulse such as from the Compton effect. This is where an increase in wavelength as e𝕪, and proportionally e𝕧, scatters electrons because the E𝕐/-𝕠d kinetic impulse is stronger.

Electrons more like particles in higher orbitals

It also happens more often where electrons are in the outer orbitals, they are closer to free flight. This is because the +𝕆D×e𝕒 potential work from the proton is weaker at a higher e𝕒 altitude, the electron acts more like a particle with a E𝕐/-𝕠d kinetic impulse.

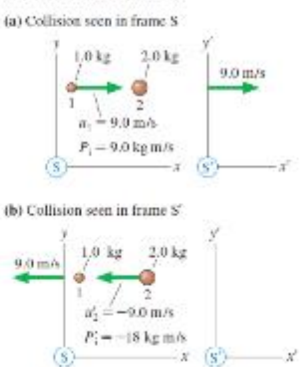
Knocking an electron or satellite out of orbit

The electron's -𝕆D×e𝕪 kinetic work is closer to overcoming the reactionary +𝕆D×e𝕒 potential work of the protons as it approaches the ionization boundary. The Compton effect can have two reference frames, from the electron inside the atom there is -𝕆D×e𝕪 kinetic work giving it a wave and probabilistic measurement. The e𝕪/-𝕘d photon acts more like a particle, this is like a meteor hitting a satellite high up in a gravitational field. The weaker +𝕀D×e𝕙 gravitational work at this e𝕙 height allows for the E𝕐/-𝕠d kinetic impulse of the meteor to push the satellite out of orbit.

Moving from observing to measuring a reference frame

The other reference frame is outside the atom where the y-𝕘d photon will knock out the electron to. Here there is a E𝕐/-𝕠d kinetic impulse, the electron is observed as a particle whereas in the first reference frame it was more like a wave. The two reference frames are then harder to compare, in moving in between them it changes from observing impulse to measuring work, or vice versa.

FIGURE 36.6 Total momentum measured in two reference frames.



Galilean principle of relativity The laws of mechanics are the same in all inertial reference frames.

The Galilean principle of relativity is easy to state, but to understand it we must understand what is and is not "the same." To take a specific example, consider the law of conservation of momentum. FIGURE 36.6a shows two particles about to collide. Their total momentum in frame S, where particle 2 is at rest, is $P_i = 9.0$ kg m/s. This is an isolated system, hence the law of conservation of momentum tells us that the momentum after the collision will be $P_f = 9.0$ kg m/s.

FIGURE 36.6b has used the velocity transformation to look at the same particles in frame S′ in which particle 1 is at rest. The initial momentum in S′ is $P'_i = -18$ kg m/s. Thus it is not the *value* of the momentum that is the same in all inertial reference frames. Instead, the Galilean principle of relativity tells us that the *law* of momentum conservation is the same in all inertial reference frames. If $P_f = P_i$ in frame S, then it must be true that $P'_f = P'_i$ in frame S′. Consequently, we can conclude that P'_f will be −18 kg m/s after the collision in S′.

The photon as a rolling wheel

In this model e𝕪×-𝕘d photons move like a rolling wheel. The -𝕘d spin Pythagorean Triangle side acts like an axle and the e𝕪 kinetic electric charge turns like the spoke of a wheel. If this is measured as -𝔾D×e𝕪 light work it appears as a wave, the end of the e𝕪 phasor traces out a sine wave shape.

The photon as a standing wave

Also because -𝔾D×e𝕪 light work is squaring the rotational frequency this gives a -𝔾D light torque. That is also light probability, the photons is then measured according to a Gaussian curve. Moving at c near a photon would have it appear as a standing wave, but the photon cannot actually be measured without being absorbed completely.

Quantization from integers

This is because, according to this model, the photon is the difference between amount of -𝕠d×e𝕪/-𝕠d kinetic momentum of the electron in an orbital. The -𝕆D×e𝕪 kinetic work being done is integers only, that is because a fraction would be a derivative slope of the -𝕠d and e𝕪 Pythagorean Triangle, and be observed as a E𝕐/-𝕠d kinetic impulse. An elliptical orbit has an integral area of π×-𝕠d$_a$×-𝕠d$_b$, this oscillates between two integers rather than acting as a fraction a/b.

Work from momentum

Because the electron is a wave the -𝕆D×e𝕪 kinetic work can appear at different e𝕪 values, proportional to a -𝕚d×e𝕧 inertial momentum. This means there are kinetic probabilities of the electron being measured like a cloud. Being a kinetic probability the electron cannot remain deterministically in one orbital, it is a resonance around this integer value of -𝕆D.

Collapsing the wave to observe it

This means the electron can be observed with a E𝕐/-𝕠d kinetic impulse at different times, the bounds of these observations are -𝕆D kinetic probabilities but where this -𝕆D×e𝕪 kinetic work collapses into a E𝕐/-𝕠d kinetic impulse. That would not usually happen in the atom except for the forces used for this observation to occur by the apparatus employed.

Velocity from a particle

If the e𝕪/-𝕘d photon could be observed it would have a e𝕧/-𝕚d inertial velocity of c, the rolling wheel would have its e𝕪 phasor divided by the rotational frequency of the axle to give this velocity. In this model speed refers to the e𝕒/+𝕠d potential speed and the e𝕙/+𝕚d gravitational speed, this don't move in straight lines and so there is usually not E𝔸/+𝕠d potential impulse and Eℍ/+𝕚d gravitational impulse to observe as a velocity.

Colliding with photons from behind

In this case the photon could collide as a particle with an observer at c, then it would be like bouncing off an electron. A spaceship moving faster than c could then collide with e𝕪/-𝕘d photon from behind them slowing it down.

> It was in this muddled state of affairs that a young Albert Einstein made his mark on the world. Even as a teenager, Einstein had wondered how a light wave would look to someone "surfing" the wave, traveling alongside the wave at the wave speed. You can do that with a water wave or a sound wave, but light waves seemed to present a logical difficulty. An electromagnetic wave sustains itself by virtue of the fact that a changing magnetic field induces an electric field and a changing electric field induces a magnetic field. But to someone moving with the wave, *the fields would not change*. How could there be an electromagnetic wave under these circumstances?

A sine wave from the rotational frequency

In this model a photon can trace out a sine wave, this is a conventional view of a photon. The e𝕪 kinetic electric charge of the photon acts as a phasor or spoke of the photon rolling wheel. The -𝕘d rotational frequency acts like the axle, as the wheel rolls the end of the e𝕪 phasor traces out a sine wave. There is no cosine wave used here, that is because the straight-line Pythagorean Triangle does not spin. It would represent the straight-line motion of the photon.

The photon probability distribution

When the e𝕪×-𝕘d photons are measured this can give a Gaussian distribution rather than the sine wave, this comes from the -𝔾D×e𝕪 light work where -𝔾D is the light probability. This decreases further away from the photon, as e𝕪 gets longer then the -𝔾D light probability decreases as a square. The photon is not represented as two sine waves orthogonal to each other as in conventional physics. The rolling wheel does not have its Pythagorean Triangle sides changing as it moves, just as a rolling wheel does not need to change the sizes of its axle and spokes when it moves.

The rolling wheel has no forces

This is because the rolling wheel is not being observed with its e𝕐/-𝕘d light impulse or measured with its -𝔾D×e𝕪 light work, it can move without a Pythagorean Triangle side being squared. It is not actually rolling in the sense that there is a surface, the motion along a straight-line acts like this surface with the e𝕐/-𝕘d light impulse. Instead the photon wheel would be rotating a given number of revolutions from being emitted to absorbed, this conserves the -𝕘d light time and e𝕪 light distance in between atoms.

A constant Pythagorean Triangle area gives a constant velocity

Because the e𝕪 and -𝕘d Pythagorean Triangle has a constant area, if the e𝕪 phasor or spoke doubles in size for example the -𝕘d rotational frequency halves. This maintains the same inertial velocity of c.

The photoelectric effect and light torque

This leads to the photoelectric effect, e𝕪𝕘d photons with a -𝕘d fast rotation rate or high frequency make electrons jump out of a material whereas -𝕘d low rotation rate photons with larger e𝕪 electric fields as spokes do not. This happens from the -𝔾D×e𝕪 light work of the e𝕪×-𝕘d photon as an integral, the increase in the -𝕘d rotational frequency as a square is the -𝔾D light torque as well as the light probability.

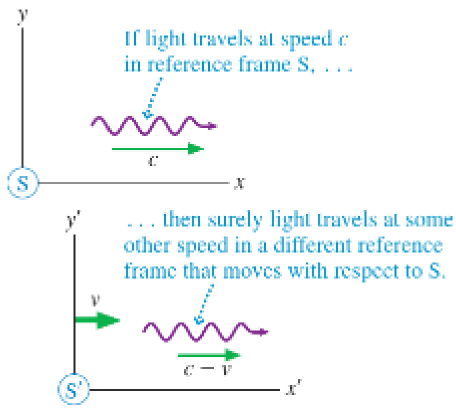
Work functions and the photoelectric effect

This increases the -𝕆D kinetic torque of an electron, spinning it around an orbital faster until it moves to a higher orbit or out of the atoms with the photoelectric effect. If the -𝔾D×e𝕪 light work is lower then the e𝕐/-𝕘d light impulse is higher, this does not move the electrons as much because they are acting as waves not particles.

Fermi energy and impulse

That also connects to the Fermi energy of fermions, the increase in e𝕪 temperature of matter does not increase this -𝔾D light torque just the E𝕐 light displacement force. Unless the electrons can be knocked out of the material, such as with the Compton effect, this increased e𝕐/-𝕘d light impulse results in fewer electrons being emitted with the photoelectric effect.

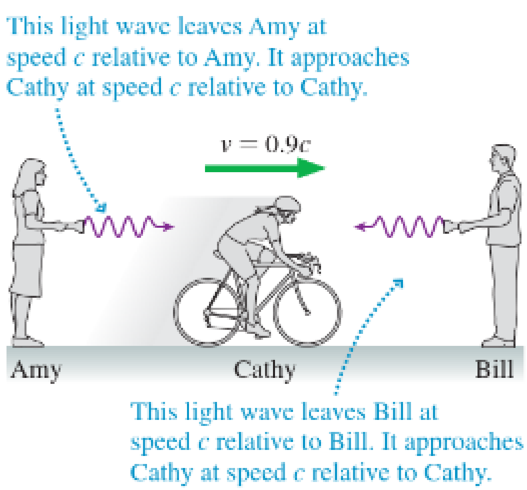
FIGURE 36.7 It seems as if the speed of light should differ from *c* in a reference frame moving through the ether.



The rolling wheel has a constant velocity

In this model c acts like a rolling wheel, when the e𝕪×-𝕘d photons move to the right they are blueshifted with a higher -𝕘d rotational frequency. This is like a wheel on a bicycle that spins faster, because the spokes are the e𝕪 kinetic electric charge these decrease in size inversely to the increase in rotational frequency. That means the wheels move at the same velocity of c, the light going to the left is redshifted with a slower -𝕘d rotational frequency and longer e𝕪 spokes. This makes the photon rolling wheels move to the left at the same velocity as to the right.

FIGURE 36.8 Light travels at speed *c* in all inertial reference frames, regardless of how the reference frames are moving with respect to the light source.



Muon inertial velocity

The photons from the muon have a higher -𝕘d rotational frequency and an inverted e𝕪 kinetic electric charge, coming towards the observer or measurer. This makes the rolling wheels spin faster as they are smaller, the photons move at the same inertial velocity e𝕧/-𝕚d of c.

Muon inertial time is slower

The muon also has its -𝕚d inertial time slowed, that allows it to survive longer before decaying. That is because of the inertial acceleration in reaching this inertial velocity close to c. The -𝕀D inertial temporal history is larger with this acceleration and so the e𝕧 length of the muon is contracted. The E𝕍 inertial displacement history is also large and so the -𝕚d inertial time is slowed.

Direction of the inertial velocity

The inertial velocity of the muon has a direction, towards an observer or away from them. Because these are opposites the -𝕀D×e𝕧 inertial work of the muon has its force also in opposing directions. When the muon is moving towards the observer then the -𝕀D inertial probability is in that direction, the muon is more likely to be found going that way.

Contracting the wavelength

That makes the e𝕪 kinetic electric charge and proportionally the e𝕧 wavelength contracted in the same amount. This causes the -𝕘d rotational frequency to be faster as e𝕪 is contracted, the spokes of the rolling wheel are smaller so it must spin faster. This blueshifts the photons towards the observer.

The opposite direction of the inertial velocity

When the muon is moving away from the observer then the -𝕀D×e𝕧 inertial work has its force in the opposite direction. That increases the e𝕧 wavelength of the photons by the same amount, they are now redshifted and the -𝕘d rotational frequency decreases.

The photoelectric effect and special relativity

A blueshifted photon can do more -𝔾D×e𝕪 light work on electrons in an atom, this is the photoelectric effect. The photons from a muon, or for example a rocket approaching c, would have their e𝕧 wavelength contracted by the same proportion. This causes those e𝕪×-𝕘d photons to do more -𝔾D×e𝕪 light work on the electrons in an atom.

Light torque and blueshift

The increased -𝔾D light torque acts on the -𝕆D kinetic torque of the electrons, that causes them to move outwards leaving the atom. The redshifted photons, from the muon or rocket going away from the observer or measurer, can do less -𝔾D×e𝕪 light work and so they cannot liberate electrons as much.

The Compton effect and redshift

They can knock electrons on the outer orbits out of the atom more with the Compton effect. This is where a longer wavelength e𝕧, proportional to a higher e𝕪 temperature, causes the photons to have more e𝕐/-𝕘d light impulse. The electrons in the outer orbitals act more like particles, the e𝕐/-𝕘d light impulse results in a collision with the photons as particles.

Climbing out of a gravitational well

The direction of the -𝕀D×e𝕧 inertial work of the muon or rocket is determined by the e𝕧 length of the -𝕚d and e𝕧 Pythagorean Triangle, Biv space-time has e𝕙 heights and e𝕧 lengths. When photons are climbing out of a gravitational well their e𝕙 height is increasing, this has the +𝕀D×e𝕙 gravitational work acting downwards on them. That is like photons from the muon moving away from the observer, the e𝕪 kinetic electric charge increases and so does the e𝕧 wavelength. This causes the photons to be redshifted moving out of the gravitational well.

Light torque and the gravitational well

This causes the e𝕪/-𝕘d photons to have a slower -𝕘d rotational frequency, the spokes of the rolling wheels are longer and so the wheels rotate more slowly. Because of this the photons do less -𝔾D×e𝕪 light work on electrons in atoms, the photoelectric effect is lower because the photons have a smaller -𝔾D light torque.

Going down a gravitational well

If the photons are going down into the gravitational well, this would contract the e𝕧 wavelength of the photons like the photons from the muon coming towards the observer. That would increase the -𝕘d rotational frequency of the photons, as the e𝕪 kinetic electric charge is inversely contracted. The photoelectric effect would then be larger when the e𝕪×-𝕘d photons travelled downwards into the gravitational well.

Length contraction in both directions

When a rocket is approaching c it has a e𝕧 length contraction, this is whether it is moving towards or away from the measurer. That is because the length contraction comes from the -𝕀D inertial temporal history, the rocket has the same temporal history in both directions. Even though the force direction is reversed, a e𝕧 length is the same from either end.

Length as points on a ruler

This e𝕧 length refers to different points on a ruler, not the distance between points which is a displacement. When the rocket approaches c the -𝕀D×e𝕧 inertial work causes the e𝕧 Pythagorean Triangle side to contract. This appears as the contracted e𝕧 length of the rocket but as separate points like on the ruler. The displacement from the front of the rocket to the back is not being measured, this would be a force with an E𝕍/-𝕚d inertial impulse.

Instants on a clock gauge

With the E𝕍/-𝕚d inertial impulse the clocks on the rocket are slower with their -𝕚d inertial time. But there is no duration between one clock and another being observed, this might happen if one part of the rocket was moving faster than the other. The instants on the clock gauges are the scale for the E𝕍/-𝕚d inertial impulse.

Durations and displacements on the rocket

In the same way the points of e𝕧 length on the rocket are positions, an inertial displacement might be from observing an acceleration from the front of the rocket to the back. For example someone might run between those two positions with an E𝕍/-𝕚d inertial impulse. While they did this a duration could be measured on the clocks as the runner did work over the e𝕧 length of the rocket.

Work is conserved with direction

For work to be conserved it is different according to the direction, however different path integrals can give a probability of a muon for example moving a given length e𝕧. This is because the -𝕀D inertial probabilities are on a Gaussian curve, the muon has a smaller probability of the wave being measured further away from the e𝕧 straight-line between two points. Some of these probabilities can destructively interfere to leave the one that is measured.

Here to there and the direction of time

In this model Biv space-time has two straight-line Pythagorean Triangle dimensions, a eh height and a ev length. That means a ev length or a eh height can have points or positions in Biv space-time. Moving in between these positions is done with impulse, then the clock gauge with its instants of time is used. This clock gauge can rotate forward towards the future or back towards the past with a duration as a torque. Work is then measured with this torque on a clock gauge as a force, a distance is used on a scale such as a ruler.

Biv space-time as positions and instants

Biv space-time has these positions of ev length like on a straight scale such as a ruler, also used with eh height. It has instants of time going towards the future or the past on a clock gauge, time in this model comes from the spin Pythagorean Triangle sides. To move from an initial to a final position needs a displacement force of impulse, this is observed with instants of time on a clock gauge.

Motion in between position and instants

A direction from one position to the next need not be a force, but if there is a motion in between these positions that is an EV/-id inertial impulse or EH/+id gravitational impulse. That can go in two directions, from closer to further away or vice versa. Time can also have a direction from one instant to another, this can close to now and then further away in time or vice versa. Both of this are like the concepts near and far. They allow the universe to be observed and measured so that iotas can be closer or further away in distance or time.

Moving forward in time

A ev length can then have near and far as concepts with two directions, a eh height also has these. A negative time such as -od kinetic time and -id inertial time moves forwards towards the future, this can be from the near future to a more distance future. This can also be from the more distant past to a more recent past, for example a supernova from a more distant past might have left some different elements on a planet in the more recent past.

Moving backwards in time

There is also a positive +od potential time and +id gravitational time, this can be from the near past to the more distant past or from a distant future to a closer future. For example a collision between two meteors in the distant future might have been caused by a first meteor’s orbit being perturbed by a planet. This can be regarded as moving backwards in time, the +id gravitational time goes from the collision to the perturbed orbit though both are still in the future. Their motion can also be regarded as moving forwards with a -od kinetic time and a -id inertial time.

Straddling the present

The instants of time can also straddle the present, the asteroid collision might be going to occur because of the perturbed orbit in the recent past. With +id gravitational time flowing backwards, in the future the gravitational attraction will move the asteroid back to where it was originally perturbed.

Towards the future or past as a direction

In this model the spinning of a clock gauge can then be towards the future or the past. Towards the future has a negative exponent as -𝕠d with the electron as kinetic time, and -𝕚d with inertial time. Towards the past has a positive exponent with +𝕠d as the proton and potential time, or +𝕚d as gravitational mass with gravitational time.

Newtonian distance and time

In the Newtonian model there is mainly impulse, the timeline acts like a clock gauge. With collisions between particles these can be modeled into the future with a E𝕐/-𝕠d kinetic impulse and an E𝕍/-𝕚d inertial impulse. They can be modeled back into the past with a E𝔸/+𝕠d potential impulse and a Eℍ/+𝕚d gravitational impulse. That allows for the model of particle collisions to be wound backwards and forwards deterministically like a movie. In principle it was thought the future could be known from the present, such as with a device called Maxwell's Demon.

Limits of the past and future

In this model the minimum angles θ in the Pythagorean Triangles give a limit to the past and future, the past limit comes from the +𝕠d and e𝕒 Pythagorean Triangles as protons and the +𝕚d and e𝕙 Pythagorean Triangles as gravity. The past appears to begin with the big bang and the CMB, in this model that is at the maximum e𝕙 height of the +𝕚d and e𝕙 Pythagorean Triangle where the angle θ reaches its minimum. The future appears as a limit where the universe continues to expand until entropy reaches its maximum. That is the limit of inertia from the -𝕚d and e𝕧 Pythagorean Triangle.

Future expansion of Biv space-time

Kinetic energy from the -𝕠d and e𝕪 Pythagorean Triangles and inertia from the -𝕚d and e𝕧 Pythagorean Triangles cause space to expand, this becomes stronger than the gravitational attraction of matter and the potential of protons to capture electrons. This is observed and measured in conventional physics, the universe continues to accelerate with its expansion of space and time rather than reaching a balance between expansion and collapse. It is the opposite of observing how the universe seems to contract backwards in the past towards the big bang.

Circular and hyperbolic space

This expansion occurs in hyperbolic space, so the attractions of +𝕠d and e𝕒 Pythagorean Triangles as protons are overcome as well as the gravity from the +𝕚d and e𝕙 Pythagorean Triangles. Going backwards in time is in circular space, then matter appears to be contracting into a smaller circular area as a field. In this model only squares are used as forces, there are no spheres except as approximations from many fields at different angles. For example a satellite can orbit a planet in any orientation but the +𝕀D×e𝕙 gravitational work has an inverse square law not a cube.

Newtonian special and general relativity

In this model special and general relativity are accounted for by the angles θ in the Pythagorean Triangles becoming smaller. This gives a larger temporal and displacement history with a corresponding contraction of distances and slowing of time.

The big bang in the past

The model starts out with gravity and the potential being strongest at the big bang, protons and electrons were compressed together such as in neutrons, and as a quark gluon plasma like in the nucleus. This is the limit of the +𝕚d and e𝕙 Pythagorean Triangle, gravity is at its maximum and so inertia from the -𝕚d and e𝕧 Pythagorean Triangle is at its minimum. The +𝕠d and e𝕒 Pythagorean Triangle protons are also stronger because they have a smaller e𝕒 altitude, electrons are below the ground state.

Moving forward in time from the big bang

Moving forward in -𝕠d kinetic time and -𝕚d inertial time, this appears as an explosion because the electrons can separate from the quark gluon plasma. Atoms form and as this ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia increases the density of matter drops. This is referred to as an expansion of Biv space-time itself, the distances between the e𝕧 and e𝕙 positions increase as -𝕠d and -𝕚d time moves forward.

Reaching the limits of the expansion of Biv space-time

The +𝕠d potential time and +𝕚d gravitational time still exist going backwards, but as the angle θ of the +𝕚d and e𝕙 Pythagorean Triangle increases, and e𝕙 to the observers and measurers decreases, this increases the ½×e𝕍/-𝕀d ×-𝕚d linear inertia because its angle θ is also growing. Eventually this matter forms stars and galaxies, with the continued expansion of Biv space-time in the future this would appear as the universe cooling and disorder reaching a maximum.

Newtonian fields and gravity

The Newtonian universe has a problem with fields, gravity was described but there was no way for matter to interact except through collisions. Newton was able to describe the inverse square law of +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, but not what was in the space between planets and moons. This is done here by adding work to the model, The torque of the squared spin Pythagorean Triangle side gives a wave like motion instead of a straight-line as with impulse.

Some of the time and all of the time

The -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work do not move deterministically into the future, instead they represent -𝕆D kinetic probabilities and -𝕀D inertial probabilities of what might happen sometimes. The timeline in impulse is deterministic on a clock gauge, in work time becomes probabilistic. Instead of the timeline being instants on a clock gauge as "all of the time", it becomes "some of the time" as a force or duration between these instants.

Duration between instants or torque

From the initial instant to the final instant, the clock gauge has a hand which must accelerate in its spin. A starting and final time, like one and three o'clock, can have time passing without a force at a constant rate. This would be used to observe impulse. If the clock hand was speeding up then this becomes a torque, that can do work when measured as a distance on a ruler. Cogs in a mechanical clock use torque to unwind the main spring, such as with a pendulum, this is approximated to be a linear motion of the clock hands.

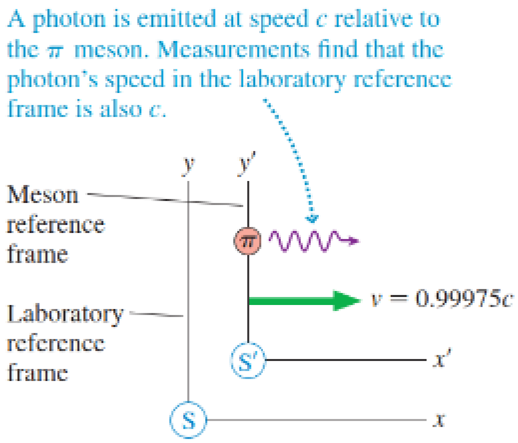
Distance and displacement

With impulse there can be a distance on a ruler, this can be a e𝕧 length or e𝕙 height. But moving from the initial point to the final point can take different amounts of time on a clock gauge. This makes the torque of that spin have different amounts of force. This cannot be measured in relation to time because the torque is on the clock gauge, it then uses a straight scale of distance to compare different amounts of force. Impulse has a different amount of force with a displacement from one position on a straight scale to another. This also cannot be measured in reference to itself, because of this linear time on a clock gauge observes this impulse.

Probability and torque

With gravity objects can move in a geodesic or +𝕀D gravitational probability, this fills in the space between planets and moons in the Newtonian model. It can be described as a +𝕀D gravitational torque causing the planets and moons to orbit each other, then the +𝕚d gravitational time is an acceleration or torque and is no longer deterministic like with impulse.

FIGURE 36.9 Experiments find that the photons travel through the laboratory with speed c, not the speed $1.99975c$ that you might expect.



Changing the reference frame

In this model changing the reference frame needs a force, this is so the change can be observed or measured. In the diagrams there is an E𝕍/-𝕚d inertial impulse to accelerate to a new velocity relative to the cyclist. That changes the observed inertial velocity e𝕧/-𝕚d, and the angle θ of the cyclist's -𝕚d and e𝕧 Pythagorean Triangle. With impulse the clock gauge is used for time, to observe the cyclist they need to be accelerating or decelerating with an E𝕍/-𝕚d inertial impulse and E𝕐/-𝕠d kinetic impulse.

No forces, nothing to observe

This is because with a constant e𝕧/-𝕚d inertial velocity nothing is changing so there is nothing to observe. The atoms of the cyclist are also moving so their E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work can be observed or measured. This makes it appear as if the cyclist can be observed and measured even when moving at a constant velocity, photons are being emitted and absorbed from this and not from the velocity.

Changing the reference frame with work

The reference frame can also be changed with work, the -𝕀D×e𝕧 inertial work accelerates it to a different inertial momentum -𝕚d×e𝕧. If the cyclist collided with this reference frame, such as a car with a camera measuring them, then this inertial momentum would be measured. With a larger difference in inertial momentum it could result in an injury.

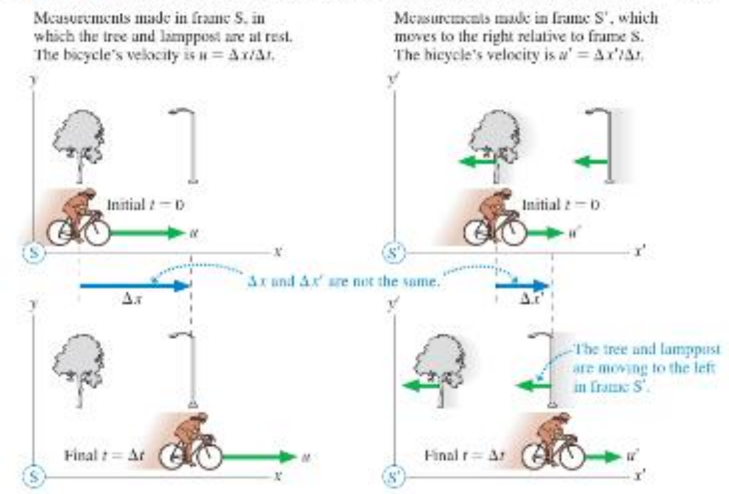


FIGURE 36.10 Measuring the velocity of an object by appealing to the basic definition $u = \Delta x/\Delta t$.

Observing and measuring events

In this model an event is a combination of impulse being observed and work being measured. The E𝕍/-𝕚d inertial impulse for example can be observed at an instant of -𝕚d inertial time, the -𝕀D×e𝕧 inertial work can be measured at a definite point in space. A collision between two particles is observed with impulse, a light wave hitting a detector is work being measured.

Width is not used

The coordinate system in relativity uses 3 orthogonal dimensions of e𝕙 height. e𝕧 length, and width which is not used in this model. That is because the width can be approximated from the other two dimensions. The e𝕙 height is in circular geometry, it points out of a gravitational field. Proportionally there is also the e𝕒 altitude of potential electric charge of the proton which also points outwards in circular geometry.

Height and length describe a satellite's motion

The e𝕧 length is in hyperbolic geometry, it is orthogonal to the e𝕙 height. A satellite for example can describe a hyperbolic trajectory past the e𝕙 height of a gravitational field if its e𝕧/-𝕚d inertial velocity is fast enough. If not then it is dominated by circular geometry, it can move into a circular orbit.

No width in Roy electromagnetism

The e𝕪 kinetic electric charge is proportional to the e𝕧 length in Biv space-time, this is orthogonal to the e𝕒 altitude of the potential electric charge from the proton. This is in Roy electromagnetism, it also does not have a y axis for width as in Biv space-time.

Two spin Pythagorean Triangle sides as width

The fourth dimension of time is the spin Pythagorean Triangle side, in Biv space-time there is the +𝕚d gravitational time orthogonal to the e𝕙 height. This points in the same direction as width. With the e𝕧 length of a satellite, in a circular orbit, the -𝕚d inertial time is also orthogonal like width. Together these two can be modeled as a width like in a graph of complex numbers, the +𝕚d like +i and -𝕚d like -i. The vertical axis would be the e𝕙 height, a third axis is added as the e𝕧 length giving a kind of three-dimensional modeling of Biv space-time.

Moving in width with torque

This width from the spin Pythagorean Triangle sides can determine the satellite's height above a planet with its e𝕙/+𝕚d gravitational speed, as well as its e𝕧/-𝕚d inertial velocity. The satellite can move in this third dimension of width by applying a torque or spin to its orbit doing -𝕀D×e𝕧 inertial work. This is not an actual width, the e𝕧 length uses its -𝕀D inertial torque to change its direction from its original e𝕧/-𝕚d inertial velocity.

Roy electromagnetism's dimensions

In Roy electromagnetism the same is modeled with a vertical e𝕒 altitude, an orthogonal e𝕪 kinetic electric charge like a length, the third dimension is +𝕠d like +i and -𝕚d like -i. The electron's motion can be modeled in these three dimensions, the spin from the +𝕠d potential magnetic field and -𝕠d kinetic magnetic field can turn the electron to provide a width.

No fourth dimension

This model does not use time as the fourth dimension, instead there is a +𝕚d gravitational time associated with a e𝕙 height and a -𝕚d inertial time with the e𝕧 length. These cannot be changed, for example the e𝕙 height cannot use the -𝕚d inertial time except with antimatter.

Superposing gravitational fields

The equations of general and special relativity work the same way, with general relativity there is only the +𝕚d gravitational time associated with a e𝕙 height. Gravity always points towards the center of mass and so there is no need to add two other dimensions. If there are multiple sources of gravity then the +𝕚d gravitational time acts as a wave, superposing the different +𝕚d and e𝕙 Pythagorean Triangles.

Impulse and the three body problem

The motions of these gravitational masses can be modeled with +𝕀D×e𝕙 gravitational work where the +𝕀D gravitational probabilities have constructive and destructive interference giving the correct solutions. In some cases there is chaotic motion such as in the 3 body problem. In this model that comes from +𝕀D gravitational destructive interference, then the Eℍ/+𝕚d gravitational impulse can move chaotically.

Inertia only uses length

With special relativity the -𝕚d inertial time only is used with a e𝕧 length. There is no need for e𝕙 height or +𝕚d gravitational time, the inertial velocity of a rocket for example can change with the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work only.

Gravitational and inertial reference frames

The two straight-line dimensions of e𝕙 and e𝕧, as well as the two spin dimensions of +𝕚d and -𝕚d can be regarded as a gravitational reference frame and an inertial reference frame. A second pair of reference frames can also be used, then there is a Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work to move to the new gravitational reference frame. E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work is needed to move to the new inertial reference frame.

Potential and kinetic reference frames

The firecracker can be observed and measured from the old and new reference frames. There is also the Roy electromagnetic reference frame pair, this is the potential reference frame of e𝕒 and

+𝕠d combined with the kinetic reference frame of e𝕪 and -𝕠d. There can be two Roy reference frame pairs, the firecracker can then be observed and measured from both.

Einstein field equations

This is connected to the energy momentum tensor in the Einstein field equations. Because the Biv space-time reference frames are proportional to the Roy electromagnetic reference frames, they give both sides of the field equations.

Cosmological constant

The cosmological constant gives the expansion of Biv space-time forward in time with hyperbolic geometry. It also gives the contraction backwards in time with circular geometry. This constant cannot be zero because then the +𝕚d and e𝕙 Pythagorean Triangle with gravity would have a zero side. Also the expansion of Biv space-time with inertia would have a zero side.

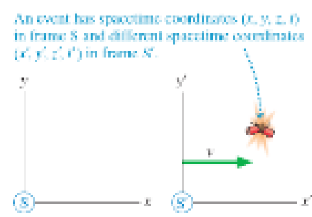
Events

The fundamental element of relativity is called an **event.** An event is a physical activity that takes place at a definite point in space and at a definite instant of time. An exploding firecracker is an event. A collision between two particles is an event. A light wave hitting a detector is an event.

Events can be observed and measured by experimenters in different reference frames. An exploding firecracker is as clear to you as you drive by in your car as it is to me standing on the street corner. We can quantify where and when an event occurs with four numbers: the coordinates (x, y, z) and the instant of time t. These four numbers, illustrated in FIGURE 36.11, are called the **spacetime coordinates** of the event.

The spatial coordinates of an event measured in reference frames S and S′ may differ. It now appears that the instant of time recorded in S and S′ may also differ. Thus the spacetime coordinates of an event measured by experimenters in frame S are (x, y, z, t) and the spacetime coordinates of the *same event* measured by experimenters in frame S′ are (x', y', z', t').

FIGURE 36.11 The location and time of an event are described by its spacetime coordinates.



A grid of Pythagorean Triangles

The grid in the diagrams can be regarded as -𝕚d and e𝕧 Pythagorean Triangles. The inertial velocity e𝕧/-𝕚d come from the angle θ of these Pythagorean Triangles. A diagonal is drawn from the lower right to the upper left of each cell, e𝕧 would be horizontal and -𝕚d vertical. The derivative slope of these Pythagorean Triangles would give the inertial velocity.

Clock gauges in the grid

The clocks in the grid refer to the clock gauges from the -𝕚d inertial time, this rotates like the hands of a clock gauge. The e𝕧 length moves to the left. In moving to the second inertial reference frame a force is needed, this can be the E𝕍/-𝕚d inertial impulse or -𝕀D×e𝕧 inertial work. The firecracker can be observed with e𝕐/-𝕘d light impulse or measured with -𝔾D×e𝕪 light work from its photons.

Relativistic grid changes

In this model the -𝕚d and e𝕧 Pythagorean Triangle changes in accordance with special relativity. A different reference frame has a different angle θ opposite the spin Pythagorean Triangle side, this gives the E𝕍 inertial displacement history and the -𝕀D inertial temporal history from the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work done. This can be in accelerating the firecracker like a rocket, accelerating the reference frame, or accelerating from one reference frame to another.

A hyperbolic grid

This grid is in hyperbolic geometry according to this model. If each grid cell has the -𝕚d and e𝕧 Pythagorean Triangle, then a hyperbola can be drawn to make a tangent to the hypotenuse of each.

As the angle θ changes the tangent remains on the hyperbola, this comes from the constant area of the Pythagorean Triangle. If this grid is used for a satellite in a hyperbolic trajectory, then each grid cell might have a different angle θ. This is because the inertial velocity e𝕧/-𝕚d would be different according to the varying e𝕙 heights above a gravitational mass. More accurately each -𝕚d and e𝕧 Pythagorean Triangle would be at a different angle so they were a series of hyperbolas.

A grid in parabolic geometry

The Cartesian coordinates in the diagram are an approximation, they also apply to parabolic geometry in this model. This is where the circular and hyperbolic geometry are balanced enough to approximate this grid.

A grid in circular geometry

Another grid can be composed of the +𝕚d and e𝕙 Pythagorean Triangles in circular geometry. Then the e𝕙 height acts like the radius, these point outwards in different directions from the center of mass. This center occurs because of destructive interference from the +𝕀D×e𝕙 gravitational work done. The opposite sides of a planet cancel each other out with destructive interference, that leaves the center.

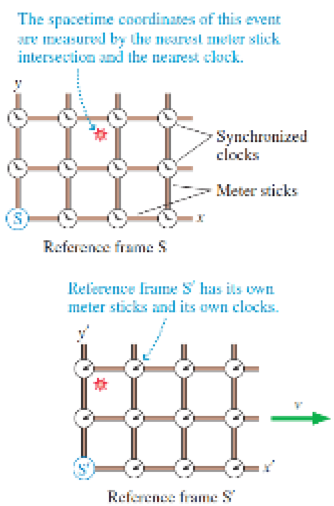


FIGURE 36.12 The spacetime coordinates of an event are measured by a lattice of meter sticks and clocks.

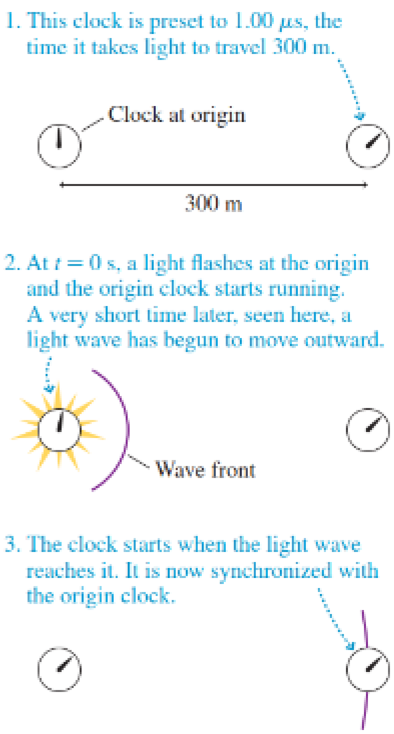
Observing the time photons take or the distance

In the diagram a e𝕧 length is observed with e𝕐/-𝕘d light impulse, how long the photons take. This would be observed by the photons bouncing off particles such as with the Compton effect. If the photons were absorbed, for example then reemitting photons which are observed or measured, then this would be from -𝔾D×e𝕪 light work.

Synchronizing time with impulse

By synchronizing clock gauges this would be a e𝕐/-𝕘d light impulse, the E𝕐 light displacement history and the -𝔾D light temporal history are conserved so that Biv space-time can be accurately observed and measured.

FIGURE 36.13 Synchronizing clocks.



Gravitational reference frames

When the firecracker explodes this can be observed and measured in different Biv space-time reference frames. The gravitational reference frame would have the e𝕙 height contracted and the +𝕚d gravitational time slowed, this is assumed here to be even through the experiment.

Circular wavefront

The e𝕪×-𝕘d photons spread out as a wave, the circular wavefront can be measured as -𝔾D×e𝕪 light work. When a photon is absorbed by an atom this can be measured, the -𝔾D×e𝕪 light work has a light probability of where the photon is on a e𝕧 length scale proportional to e𝕪. Because this is a probability not the -𝕘d rotational frequency, this can collapse from the other probable positions of the photon into one atom.

Collapse to a position

An electron can have a -𝕆D kinetic probability density that is very large, but without it being measured the -𝕠d and e𝕪 Pythagorean Triangle has no forces. When it is measured this integral field collapses in no time, this is because the -𝕠d kinetic mass of the electron is not acting as time. Instead it is a -𝕠d kinetic magnetic field, this can collapse into a -𝕆D kinetic probability where the e𝕪 position constrains the electron with its constant Pythagorean Triangle area.

No time component in a measurement

For example if the e𝕪 value is proportional to a e𝕧 length, this gives a position of a -𝕆D kinetic probability density. This is not time either, but the probability of what position the electron will be measured in. This -𝕆D kinetic probability cannot be too large or small, that could only happen if the Pythagorean Triangle area was not constant. This would be in the case of an electron being absorbed as a wave into an atom. The electron can then exist as an integral field or a derivative slope, the field collapses into a measurement where there is no time component.

An observation in time

If instead the electron was observed as a particle with an E𝕍/-𝕚d inertial impulse, this would be deterministic. Then its motion would be observable with respect to time on a -𝕠d kinetic clock gauge. There is no wave function to collapse, the electron is generally observed as a particle outside the atom. One exception to this is with a double slit experiment, the -𝕆D×e𝕪 kinetic work of the electron is measured on the target screen.

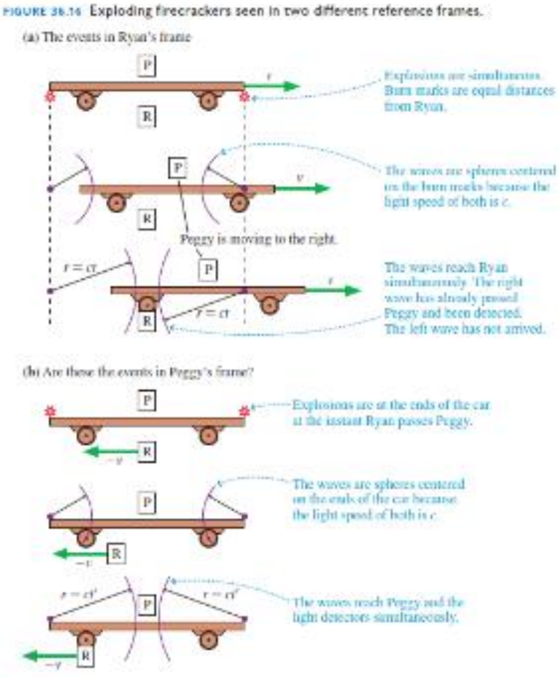
Relativity as a particle or wave

If the e𝕪/-𝕘d photon is observed with a e𝕐/-𝕘d light impulse then this acts as a particle not a wave, it appears at a -𝕘d light time deterministically. The experiment below can then be viewed as either a measurement of -𝔾D×e𝕪 light work or an observation of e𝕐/-𝕘d light impulse with the Biv space-time pair of reference frames.

A photon particle takes longer to travel

With the e𝕐/-𝕘d light impulse the e𝕪/-𝕘d photon acts as a particle, it takes longer to travel in -𝕘d light time to some reference frames than others. When the -𝔾D×e𝕪 light work is measured there is a light momentum -𝕘d×e𝕪 with the same proportion as in e𝕪/-𝕘d the light velocity of c. This can also be used to derive the permittivity of free space as e𝕪 and the permeability of free space as -𝕘d, the proportions give c from Maxwell’s equations.

FIGURE 36.16 Exploding firecrackers seen in two different reference frames.



No simultaneous events

In this model there are no simultaneous events, this is because a Pythagorean Triangle would have to have a spin side of zero. For the same reason two events cannot occur at the same position, then the straight Pythagorean Triangle side would be zero.

> One of the most disconcerting conclusions of relativity is that **two events occurring simultaneously in reference frame S are *not* simultaneous in any reference frame S′ moving relative to S.** This is called the **relativity of simultaneity**.

No simultaneous impulse

The two events could not be observed simultaneously, first the observer would detect the e𝕐/-𝕘d light impulse from a first photon from the first firecracker. Then the second photon from the second firecracker would be observed. The time between each event has some uncertainty, this is from the Heisenberg uncertainty principle. When one Pythagorean Triangle side is squared, this is a force. The other side is not squared and acts as a scale or clock gauge for work or impulse respectively.

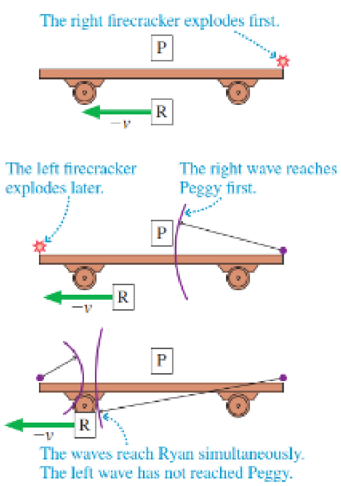
No work in the same positions

The distances between the two firecrackers also cannot be measured as the same, the first photon with its -𝔾D×e𝕪 light work would be absorbed by a first electron. This would give the e𝕧 length from the first firecracker. Then the second photon from the second firecracker would be measured giving a second length. In between these two forces would be a e𝕧 length which is a different position.

Uncertainty as probability and predictability

In this model measuring too precise a e𝕧 length in -𝕀D×e𝕧 inertial work causes the -𝕀D inertial probability to increase as a square. This is a probability and so measuring equal distances becomes uncertain, a range of e𝕧 lengths have different inertial probabilities. Observing too precise an -𝕚d inertial time causes E𝕍 as the inertial displacement force to also increase as a square. This becomes chaotic and unpredictable, another aspect of uncertainty.

FIGURE 36.17 The real sequence of events in Peggy's reference frame.



Inertial velocity

When the mirror moves this can add inertial velocity, for example if balls are being thrown from the emitter to the detector instead of photons. In this model e𝕪×-𝕘d photons transmit the differences between inertial velocities, for example in an atom the -𝕠d and e𝕪 Pythagorean Triangles as electrons have different inertial velocities in the orbitals. They have a faster inertial velocity in lower orbitals, changing an orbital then emits or absorbs a photon to change the e𝕧/-𝕚d Pythagorean Triangle side ratio.

Rolling wheels and the mirror

Photons act like a rolling wheel in this model, when the moving mirror has photons bounce off it then this changes the radius of the rolling wheel so the photons become blueshifted. The e𝕪 spoke or phasor contracts and the -𝕘d rotational frequency speeds up so c remains the same.

Sound waves and photons

The effect is similar to sound waves instead of photons emitted in the diagram, the source would then be a speaker for example. When the sound waves bounce off the mirror they cannot move faster through the air, their velocity is determined by the density and Young's modulus of the medium they are in.

Sound waves as rolling wheels

Sound waves move as -𝕚d and e𝕧 Pythagorean Triangles with a kinetic energy from electrons as -𝕠d and e𝕪 Pythagorean Triangles. They also move with a constant Pythagorean Triangle area, so if the frequency of the sound doubles the wavelength halves. Their motion is similar to the rolling wheel model, their back and forth motion can be imagined as coming from a rolling wheel such with a crankshaft driving a piston.

Sound waves and a blueshift

The moving mirror, in the diagram below, would change the frequency of the sound waves, similar to a blueshift. The equation for this would be like that in special relativity, γ being the square root of the difference of two squares and 1 being the inertial velocity of sound waves in a given medium. The positive square does not come from the hypotenuse in this model, as is often used in special relativity. Instead the two squares act like the equation of a hyperbola, the -𝕚d and e𝕧 Pythagorean Triangle of the sound waves would be at a tangent to the hyperbola as its angle θ changed.

Maxwell's equations

The speed c is defined in Maxwell's equations as being from the permittivity and permeability of free space being multiplied together, and the square root taken. This can be rearranged to give a fraction of permittivity/permeability equal to c. This makes them proportional to a e𝕧 length as permittivity, and the -𝕚d inertial time proportional to the permeability.

Permittivity and permeability

This permittivity is related to electric charge and how it can penetrate a medium, so it is also proportional to e𝕪 as the kinetic electric charge. The permeability is related to magnetism in free space and how a magnetic field can permeate a medium, so this is proportional to -𝕠d as the kinetic magnetic field. The ratio between these two is fixed, according to this model, by α in the ground state as the e𝕧/-𝕚d inertial velocity and e𝕪/-𝕠d as the kinetic velocity.

α and permittivity/permeability

This is ≈ 1/137 of c, that fixes the values of c as well as the ratio of the permittivity and permeability. Because the inertial velocity increases in lower orbitals so does this permittivity/permeability when below c. In this model that means there is a changing ratio of the e𝕪 kinetic electric charge and -𝕠d as the kinetic magnetic field in different orbitals.

Fractions of c

Cos1/α is ≈ e^{-1} so in this model that becomes $e^{-𝕆D}$ as the first quantized orbital. This is proportional to the -𝕆D×e𝕪 kinetic work in that orbital, each has a different D value as an integer. They are numerators with ≈ 137 as the denominator, in transferring a change in orbital to another atom this is done as 137 or c.

Permittivity/permeability and inertial velocity

In free space an electron can move with a permittivity/permeability ratio as its inertial velocity, then e𝕪/-𝕘d photons as particles can collide with the electron changing this ratio. The photons as the e𝕪 and -𝕘d Pythagorean Triangle have a constant area as -𝕘d×e𝕪, this makes the permittivity×permeability area a constant Pythagorean Triangle area. as the permittivity/permeability fraction changes with a e𝕪/-𝕠d kinetic velocity, or e𝕧/-𝕚d inertial velocity, both the numberator and denominator change to keep the permittivity×permeability area a constant. This allows their -𝕘d rotational frequency × e𝕪 kinetic electric charge to be a constant integral field while the inertial velocity c remains a constant.

Permittivity/permeability, α and c

An increase in the E𝕐/-𝕠d kinetic impulse increases the inertial velocity of the electron and its permittivity/permeability ratio of e𝕪/-𝕠d as the kinetic velocity. The -𝕠d and e𝕪 Pythagorean Triangle is relativistic so this has a limit at c where the angle θ goes to its minimum.

Displacement and temporal history

This e𝕪 and -𝕘d Pythagorean Triangle area can decrease near a gravitational mass, that is because the E𝕐 light displacement history and the -𝔾D light temporal history increase. This makes the e𝕐/-𝕘d light impulse have E𝕐 dilated so -𝕘d slows down just like clocks slow on a rocket approaching c. Also the -𝔾D×e𝕪 light work has e𝕪 contracted like the e𝕧 length of the rocket, that contracts the e𝕧 lengths in between the e𝕪×-𝕘d photons.

Blueshifted sound waves

This is like when sound waves are blueshifted on reflecting from the moving mirror below, their rotational frequency or pitch increases and the e𝕧 length between the sound waves contracts. That allows for both a slower time and a length contraction to occur even though the Pythagorean Triangles have a constant area. In this model the -𝕀D×e𝕧 inertial work of the sound waves is measured, when the sound acts like a phonon there is an E𝕍/-𝕚d inertial impulse which allows for the phonon to be observed like a particle.

Permittivity/permeability ratio of sound in air

The sound waves move through air as a fixed permittivity/permeability ratio, this determines their inertial velocity. This assumes a particular air density corresponding to a vacuum for c, then a higher air density has sound slow down like e𝕪×-𝕘d photons do near matter. In this model sound can move faster in less dense air, as Biv space-time expands the speed of c also increases. Galaxies can then appear to be receding faster than the standard value of c as this permittivity/permeability ratio expands.

Sound waves as a rolling wheel

The permittivity of the air is a straight-line direction from the straight Pythagorean Triangle sides, the permeability is spin from the spin Pythagorean Triangle sides. The ratio of these determines the inertial velocity of the sound waves. The permeability comes from the compression and expansion of the air molecules. This is represented in conventional physics by a rolling wheel, the compression and expansion in a forwards direction is like a piston connected to a wheel. That is observing the E𝕍/-𝕚d inertial impulse of the sound wave as a series of straight-line forces from the spin Pythagorean Triangle side.

Converting straight-line motion into torque

Conversely a straight-line direction of sound waves is converted into a -𝕀D inertial torque, pushing the piston from the example above causes a rotary motion and a torque. This allows the rolling wheel to be observed as a particle with an E𝕍/-𝕚d inertial impulse, it can push on an observer with this piston like compression. It can also be measured as a wave where the sound can rotate a measuring apparatus. Another example is how an ocean can cause a rotation in buoys used to extract electrical power from the wave action.

Constant Pythagorean Triangle area with sound

This sound rolling wheel moves with a constant Pythagorean Triangle area like with photons, when the frequency of sound doubles then the wavelength halves for example. This gives the sound a constant inertial velocity like with photons, to conserve energy the sound pitch is changed with the equivalent of redshifts and blueshifts.

Air density and gravity

When the air is denser the inertial velocity slows, this is like e𝕪×-𝕘d photons as waves slowing near a gravitational body. Density of air is also proportional to gravity from the +𝕚d and e𝕙 Pythagorean Triangle, the air has weight and so becomes denser when pulled downwards by gravity. The slowing of the sound waves with this air density is then proportional to the slowing of e𝕪×-𝕘d photons from General Relativity. In this model that happens because the same Pythagorean Triangles are controlling them.

Air temperature and sound

Conversely an increase in temperature of the air comes from e𝕪 as the kinetic electric charge and temperature, this acts as an inverse of the air density. That is because hotter air will become less dense and so counteracts gravity from the +𝕚d and e𝕙 Pythagorean Triangles. This temperature comes from the -𝕠d and e𝕪 Pythagorean Triangles as kinetic energy, also proportional to the -𝕚d and e𝕧 Pythagorean Triangles with inertia. That means a gas with a higher inertia and inertial velocity from this temperature will be less dense.

Permittivity/permeability and temperature

The sound waves can then move faster as the air becomes less dense at higher e𝕙 heights, also when the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia increase opposing gravity. A higher temperature decreases air density and increases the sound wave velocity. When the air is less dense molecules can move more in straight lines with a E𝕐/-𝕠d kinetic impulse, there is less rotation or -𝕀D inertial torque in bouncing off other molecules with -𝕆D×e𝕪 kinetic work. This increases the permittivity/permeability ratio and the sound's inertial velocity.

Phonons and impulse

The sound waves can also act as particles called phonons, then they move with more of an E𝕍/-𝕚d inertial impulse. The changes in the inertial velocities of phonons and sound waves are proportional to a permittivity/permeability ratio as with e𝕪×-𝕘d photons.

The permittivity/permeability ratio as 1

In this model photons move with this permittivity/permeability ratio in space as c, that can change so that Biv space-time has been expanding since the appearance of a big bang. This permittivity/permeability ratio is set by α, because this is ≈ 1/137 then there is 1 as 137/137. Higher orbitals are slower than α, they all have the same denominator of ≈ 137 which is the medium of transmission of changes in the numerator between atoms.

Fractions are transmitted with a common denominator

When an electron drops an orbital, this emits a photon as this common denominator of ≈ 137 to a second atom. Then this fractional change of the orbital in the first atom is transmitted to a fraction in the second atom.

Permittivity/permeability is not an ether

The ratio changes because the permittivity/permeability is not an actual ether, it is the ratios between different atoms mediated by e𝕪×-𝕘d photons. Each atom has an inertial velocity as a permittivity/permeability ratio, it also has Roy electromagnetic ratios of which orbitals the electrons are in.

A road conserves the permittivity/permeability of a bike

The permittivity is proportional to a e𝕧 length and a e𝕙 height, this is also proportional to the e𝕪 kinetic electric charge and the e𝕒 potential electric charge. That acts like a ruler or scale, the distances in Biv space-time are proportional to the kinetic and potential energies this way. A road for example conserves the energy of rolling wheels on a bike as long as the tires don't slip. The distances the bike travels as its permittivity correspond to a number of rotations of its tires as the permeability.

Variations in the permittivity/permeability ratio are also conserved

For this ratio to be not conserved there must be forces, such as the tire expanding in heat or slipping on the road. For e𝕪×-𝕘d photons to not have a conserved permittivity/permeability ratio there must also be forces. These can be going closer to a gravitational body or coming from further away in terms of the Biv expansion of space-time. But these forces are also conserved by the constant areas of Pythagorean Triangles.

Biv space-time expanding

In conventional physics Biv space-time is expanding towards the future, this comes from the -𝕠d and e𝕪 Pythagorean Triangles and -𝕚d and e𝕧 Pythagorean Triangles. This inertial velocity continues below the angle θ corresponding to c, Distant galaxies can appear to move faster than c up to where θ is closer to zero. In this model it cannot get to zero because then the Pythagorean Triangles would no longer have a constant area.

Biv space-time contracting

With the +𝕚d and e𝕙 Pythagorean Triangles as gravity, and the +𝕠d and e𝕒 Pythagorean Triangles as protons, they go backwards in +𝕚d gravitational time and +𝕠d potential time. This is like the reverse of Biv space-time expanding, it also acts like an increasing gravitational field around a black hole. Roy electromagnetism is also contracting, this gives an increasing e𝕪×-𝕘d redshift the further back in +𝕠d potential time. Because c can be exceeded going forwards in time, it can be exceeded going backwards in time. The big bang then appears to have has Biv space-time expanding up to the point of c, then e𝕪×-𝕘d photons appear.

The photosphere

This is similar to the photosphere above a black hole, in this model the infalling matter can exceed c going downwards. Because e𝕪×-𝕘d photons have a fixed inertial velocity then they cannot escape the event horizon. In this model the same happens with the CMB as a kind of photosphere.

The angle θ

An angle θ from the -𝕚d and e𝕧 Pythagorean Triangle represents c, a smaller angle denotes an inertial velocity of galaxies moving away faster than c. The ground state has an inertial velocity as e𝕧/-𝕚d of α, in this model that gives $e^{-𝕠d}$ with d=1 as the first quantum number of this ground state. From ≈ 1/137 comes 137/137 as c, but this is still a finite angle θ on the +𝕚d and e𝕙 Pythagorean Triangles.

The hypotenuse as c

Using the angle θ is different from the special relativity equation where c is set as 1 appearing as the hypotenuse of the -𝕚d and e𝕧 Pythagorean Triangle. Instead γ in this model is the e𝕧 length contraction and -𝕚d inertial time slowing from comparing two different inertial velocities, two different angles θ. The equation works the same, but setting c as the hypotenuse makes it impossible to go past c without the -𝕚d and e𝕧 Pythagorean Triangle going to a zero area or flipping over.

Gravis and photons move at c

This same angle as c also gives the gravitational speed of the +𝕘d×e𝕓 gravis, they move in the opposite direction to e𝕪×-𝕘d photons so the balance between them must be conserved. That gives them the same speed, e𝕪×-𝕘d photons move at c as e𝕧/-𝕚d inertial velocity. The +𝕘d×e𝕓 gravis move mainly as waves with +𝔾D×e𝕓 gravis work.

Photons and gravis oppose each other inversely

When an electron moves upwards in an orbital this is from the absorption of e𝕪×-𝕘d photons with -𝔾D×e𝕪 light work. This is opposing the +𝕘d×e𝕓 gravis and their +𝔾D×e𝕓 gravis work, the electron moves upwards and so the +𝕚d gravitational field weakens inversely. These changes produce gravitational waves as +𝔾D×e𝕓 gravis work, they are only currently measurable with larger phenomena such as neutron stars and black holes merging.

The electron changes actively, the proton reactively

In Biv space-time the -𝕠d and e𝕪 Pythagorean Triangle changes actively with the emission and absorption of e𝕪×-𝕘d photons in an atom. This occurs with -𝕆D×e𝕪 kinetic work as waves of probability, the e𝕪×-𝕘d photons give the difference between orbitals as -𝔾D×e𝕪 light work. Because the -𝕠d kinetic magnetic field of the electron has a smaller d value than the +𝕠d potential magnetic field, the proton adds to the negative -𝕠d value keeping the electron in the atom.

The proton's work is stronger than the electron's work

The +𝕆D potential torque of the proton is stronger than the -𝕆D kinetic torque of the electron, the electron is trapped in an orbital and its -𝕆D×e𝕪 kinetic work is subtracted from the proton's +𝕆D×e𝕒 potential work. The electrons changes actively with the emission and absorption of e𝕪×-𝕘d photons with -𝔾D×e𝕪 light work, however it remains trapped with the stronger +𝕆D potential probability of it remaining in an orbital.

Proportional to this, and as an inverse, the +𝕘d×e𝕓 gravis moves backwards in time as the e𝕪×-𝕘d photons moves forward in time. The +𝕀D×e𝕙 gravitational work done is reaced against by the +𝕆D×e𝕒 potential work of the proton, it still pulls the electron down to the lowest possible orbital. That causes the electron to emit e𝕪×-𝕘d photons, these are balanced by the absorption of +𝕘d×e𝕓 gravis.

Action and reaction pairs

The photons and gravis cancel each other out, the electron moves with active changes of -𝕆D×e𝕪 kinetic work while the protons reacts inversely with its +𝕆D×e𝕒 potential work. The electron proportionally does -𝕀D×e𝕧 inertial work as a reaction to its active -𝕆D×e𝕪 kinetic work. This -𝕀D×e𝕧 inertial work is reactive, and inversely proportional to the active +𝕀D×e𝕙 gravitational work done by the proton.

Gravitational work more than gravitational impulse

The +𝕘d×e𝕓 gravis then are emitted and absorbed inversely to the emissions and absorptions of the e𝕪×-𝕘d photons. In Biv space-time there is mainly +𝕀D×e𝕙 gravitational work, that is because the +𝕚d and e𝕙 Pythagorean Triangle has a much greater e𝕙 height than the e𝕒 altitude of the +𝕠d and e𝕒 Pythagorean Triangle as the proton up to the ionization boundary. This limit of the e𝕙 height would be the origin of the big bang in conventional cosmology.

Gravitons and impulse

The universe as measured appears to have its +𝕚d and e𝕙 Pythagorean Triangles mainly do +𝕀D×e𝕙 gravitational work while a graviton would be a particle with a Eℍ/+𝕚d gravitational impulse. This causes general relativity to be in curved space, the curves come from the wave like nature of spin from the +𝕚d spin Pythagorean Triangle side. Inside atoms there is then a balance of the active -𝕆D×e𝕪 kinetic work producing -𝔾D×e𝕪 light work, and the +𝕀D×e𝕙 gravitational work producing +𝕘d×e𝕓 gravis work.

Virtual photons and iners

Opposing these in the atom are the +𝕆D×e𝕒 potential work from the proton producing +𝕘d×e𝕒 virtual photons and the -𝕀D×e𝕧 inertial work of the electron producing -𝕘d×e𝕧 iners. These two are mot measurable directly, the +𝕘d×e𝕒 virtual photons are added to the changes of the electrons as a reaction to the e𝕪×-𝕘d photon changes going backwards in time. The -𝕘d×e𝕧 iners are subtracted from the changes to the proton as a reaction to the +𝕘d×e𝕓 gravis changes, these go forwards in time.

The permittivity/permeability ratio

The permittivity/permeability ratio is approximately a constant locally, but decreases looking backwards in time towards the appearance of the big bang. This means Biv space-time was expanding when looking forwards in time with this changing ratio. The appearance is like looking at e𝕪×-𝕘d photons or sound waves being emitted at different e𝕙 heights from a gravitational body.

Density and inertial velocity

These would be redshifted as photons or a lower pitch as sound waves, the denser air slows the inertial velocity of the sound waves like the changing permittivity/permeability ratio slows the e𝕪×-𝕘d photons. The sound waves would speed up as they move to a greater e𝕙 height, this is like the height contraction in general relativity reducing.

Air density and gravitational field density

As the air decreases in density the sound waves increase their e𝕧/-𝕚d inertial velocity. This change in density is proportional to the change in the +𝕚d gravitational field, as the e𝕙 height increases the +𝕚d gravitational field decreases inversely. That also causes the e𝕪×-𝕘d photons to increase their inertial velocity like the sound waves. Because the sound waves are accelerating they must lose something to conserve energy, this is from a reduction in their frequency. The same happens with e𝕪×-𝕘d photons moving up in a gravitational well.

The permittivity/permeability ratio and the big bang

The permittivity/permeability ratio decreases with greater e𝕙 heights towards the big bang. Because of this the e𝕪×-𝕘d photons at these greater e𝕙 heights are speeding up towards the observer and measurer like moving upwards in a gravitational well. This is referred to as the expansion of Biv space-time in conventional cosmology. With the -𝕚d and e𝕧 Pythagorean Triangles and inertia these photons are initially moving faster than c, as this expansion in the permittivity/permeability ratio decreases it reaches c where photons can appear.

A contracting length between photons

The slowing of the -𝕘d rotational frequency of the photons causes them to redshift more with a greater e𝕙 height ending at the CMB. The e𝕧 length between these photons is also contracting further backwards in +𝕚d gravitational time, this means the photons would be closer together from the e𝕧 length contraction. This acts like a contraction of Biv space-time, the photons would be closer together which would appear as a greater density of matter.

The big bang as a singularity

This matter appears to have a e𝕙 height contraction like it does in general relativity, that happens as the +𝕚d and e𝕙 Pythagorean Triangle approaches its minimum angle θ. As this continues Biv space-time appears to be more concentrated with this height contraction, also it is increasingly redshifted. That appears to approach a singularity as the beginning of the big bang. In this model there is no actual singularity, the +𝕚d and e𝕙 Pythagorean Triangle would reach its minimum angle θ.

Traveling to the big bang

There would be no actual big bang if an observer and measurer went to this singularity, the +𝕚d gravitational time taken to get there would mean it had already aged to appear like local Biv space-time.

An ether flow

These changes in the permittivity/permeability ratios can also be modeled as velocities, it would then appear as if there was an ether flow back in +𝕚d gravitational time towards the big bang. This can be regarded as like Biv space-time contracting as a flow. Then e𝕪×-𝕘d photons would be redshifted as they climb up against this backwards flow, the same would happen if sound waves were being emitted with a wind blowing away from the observer and measurer. This would keep reducing the pitch of the sound waves, and the e𝕧 lengths between them. At some point the sound would lose all its energy which would appear as a CMB like level.

Electrical and magnetic flux

In Roy electromagnetism a magnetic flux is represented as a flow, it has a curl to represent the spin Pythagorean Triangle sides. The electric flux is also modeled as a flow, it comes out of the protons and into the electrons. In this model the direction of the potential ether flow would be into the protons, this gives the same answers. When put together with the +𝕠d and e𝕒 Pythagorean Triangles as the protons, and the -𝕠d and e𝕪 Pythagorean Triangles as the electrons, the permittivity/permeability ratio changes can be modeled as a flow of e𝕒/+𝕠d potential speed and e𝕪/-𝕠d kinetic velocity.

Gravity as an ether flow

If a gravitational body is modeled like an ether flow towards it, then e𝕪×-𝕘d photons would appear to be redshifted like sound waves in an air flow. Conversely the expansion of Biv space-time would appear as an ether flow accelerating, that would allow galaxies to exceed c at great e𝕙 heights.

The permittivity/permeability ratio and an ether flow

The difference between an ether flow and a changing permittivity/permeability ratio is that it represents a force, the change in ratio means the Pythagorean Triangles have their angles θ changing. That implies a changing impulse and work with these forces.

Electromagnetic flux and ether

In Roy electromagnetism this can also be modeled as an electromagnetic flux, like this ether flow. Then the permittivity/permeability ratio changes with different orbitals reaching a limit at the ground state with α. A gaussian flux appears to have the same amount of flow into an out of a volume, this is also referred to as an electrical field flux in conventional physics.

No electrical flux

In this model there can be a magnetic flux from the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, but the potential electric charge and kinetic electric charge are not waves. They would be observed as particles, but the density would be proportional to the permittivity/permeability density and ether flow.

Biv space-time as a gravitational and inertial flux

In this model Biv space-time is the combination of the +𝕚d and e𝕙 Pythagorean Triangle as gravity and the -𝕚d and e𝕧 Pythagorean Triangle as inertia. This gravitational ether flow would go backwards in time towards the CMB, the inertial ether flow would go forwards in time towards the galaxies exceeding c.

The Higgs field as an inertial flux

The Higgs field also appears as a kind of inertial flux or ether, electrons have a -𝕚d inertial mass by this field reacting against their motion. The +𝕚d gravitational field then appears as a gravitational flux or ether, the two are inversely proportional to each other. The electron acts in a similar way to sound waves in air, the permittivity/permeability ratio impedes the permittivity and slows the electron. This gives it a -𝕚d inertial mass, that comes from the permeability.

The permittivity/permeability ratio and c

This also allows for e𝕪×-𝕘d photons to move at c because of the permittivity/permeability ratio, if they are emitted from a rocket moving towards and observer and measurer, the photons would increase in rotational frequency or blueshift. They would also be closer together as the rocket's inertial velocity reduced the e𝕧 length between them proportional to the length contraction on the rocket.

Sound waves and photons

When the photons left the rocket they would be constrained by this permittivity/permeability ratio to only travel at c, this is like the sound waves being confined to a single velocity in air with a constant temperature and density. To conserve energy their pitch or rotational frequency changes in pitch like with photons when the velocity is a constant. That acts the same as the rolling wheel with sound waves, the increased pitch of a sound wave is like a wheel with a shorter spoke rotating faster.

The Michelson Morley experiment

With the Michelson Morley experiment no ether was detected, but in this model the permittivity/permeability ratio would be approximately the same in all directions around a planet. There would be some smaller differences, but these are in general relativity where +𝕚d gravitational time is slower at a lower e𝕙 height. There was a slowing of c closer to a gravitational body but the experiment could not detect this.

A stationary ether

Instead it was assuming this ether was stationary and the solar system was moving though it like a river. In this model there are four permittivity/permeability ratios which act like ethers, gravitational, inertial potential, and kinetic. These ratios change so light can move slower in some areas, such as when it curves around a star.

Velocity as a permittivity/permeability ratio

When a satellite moves, its e𝕧/-𝕚d inertial velocity is a different permittivity/permeability ratio with this model. That as e𝕧/-𝕚d has a higher e:d ratio, in an orbit this ratio can be -𝕀D×e𝕧 inertial work where the d value as spin causes the trajectory to curl around in a circle. When the e value is larger then the inertial velocity increases, this can make the satellite move in an ellipse, a parabola, or a hyperbola.

Rolling wheels as particles or waves

Sound waves and photons can be represented as rolling wheels, depending on the rotational frequency this can act more like a particle or a wave. When the wheel has a constant Pythagorean Triangle area, the spoke as the straight Pythagorean Triangle side changes inversely to the spin Pythagorean Triangle side as the axle.

Impulse and work from the rolling wheel

If the rolling wheel is spinning faster then its pitch is higher, conversely its spoke length is smaller. This wheel imparts more torque when it interacts with other wheels or atoms. Bluer e𝕪×-𝕘d photons have a higher -𝕘d rotational frequency, they have more light torque and so they get refracted more. This is why, according to this model, blue light refracts more in a prism or in the sky.

Red light as a derivative

When the light is redder there is a longer spoke length, this increases the E𝕍/-𝕚d inertial impulse of the e𝕪/-𝕘d photons. They act more like a derivative, the light displacement force is more in a straight-line so the redder photons pass through a prism with less refraction. This is also why a sunset is redder, the red light travels more towards the observer while the bluer light is more refracted.

Comparing frisbees as spinning wheels

This also occurs with an actual rolling wheel, there can be two wheels both with the same inverse relationship between their rotational frequency from the axle and the spoke length as their radius. When the smaller wheel turns faster, this imparts more spin onto objects it hits. With many wheels moving in different orientations, like for example frisbees flying through the air, the different spins interfere constructively and destructively.

Gaussian curve from interference

This can average out if objects are hit with clockwise and counterclockwise spins, it tends to average out on a Gaussian curve similar to the Boltzmann constant. When the frisbees are larger but spin inversely slower, this tends to push other objects in a deterministic way. Then there is less of a Gaussian probability, the frisbees tend to collide more like particles.

Ocean waves as a curl or wall of water

This effect is also experienced with ocean waves at the beach, when the waves is curling then there is an increased rotational frequency. The swimmer measures this torque by being spun by the wave. At other times the wave approaches them without curling, then they can be thrust backwards like the water is a solid with its E𝕍/-𝕚d inertial impulse. A tsunami moves with a faster e𝕧/-𝕚d inertial velocity, it has a stronger E𝕍/-𝕚d inertial impulse striking like a wall of particles.

Snooker balls as particles or waves

Another example would be snooker balls, when the white ball has a spin it can move at the same inertial velocity as one with no spin. This is because the ball is spinning on the felt rather than gripping the surface. With a higher spin the ball does more -𝕀D×e𝕧 inertial work, when striking a red ball for example it can spin this ball to either side. With a top or bottom spin it can also affect at what angle the red ball moves, this is similar to with the frisbees. When the white ball has no spin it moves with more of an E𝕍/-𝕚d inertial impulse, the angles are deterministic more like a particle.

FIGURE 36.18 The ticking of a light clock can be measured by experimenters in two different reference frames.

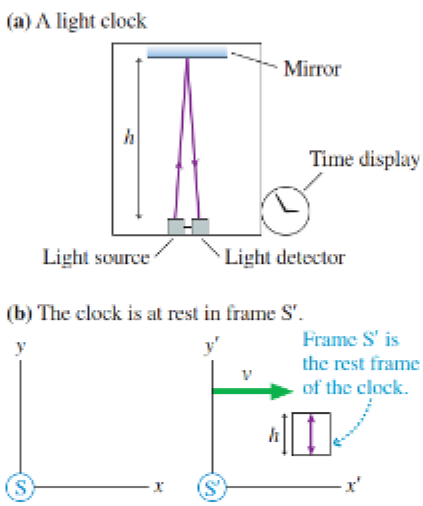
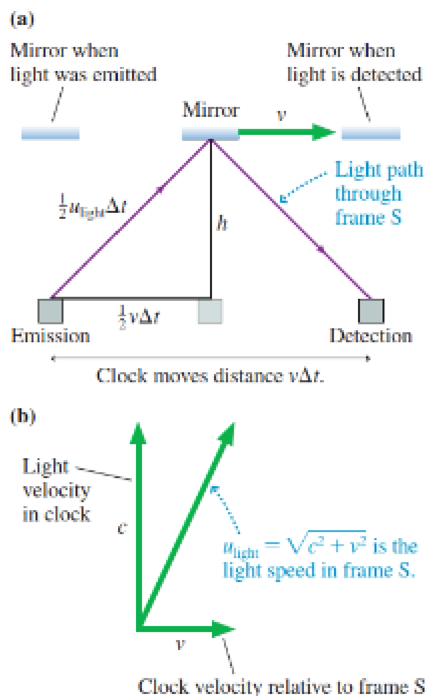


FIGURE 36.19 A classical analysis of the light clock.



The hypotenuse as velocity

In the diagram below the inertial velocity of light is the hypotenuse, this could also be the inertial velocity of sound waves. The -𝕚d and e𝕧 Pythagorean Triangle here takes c as 1, then the Pythagorean Triangle angle θ opposite the spin Pythagorean Triangle side can change its angle so the hypotenuse is a constant.

A constant Pythagorean Triangle area

In this model the hypotenuse is not constant, instead this Pythagorean Triangle has a constant area. The geometry is otherwise the same, c corresponds to e𝕧/-𝕚d where e𝕧 is a length and -𝕚d is the inertial time. This gives an inertial velocity, the angle θ becomes fixed at c or the inertial velocity of the sound wave.

A constant inertial velocity as a reaction

When the mirror moves the -𝕚d and e𝕧 Pythagorean Triangle still has a fixed angle θ as c, to conserve energy the e𝕪×-𝕘d photons must change their -𝕘d rotational frequency and e𝕪 kinetic electric charge or e𝕧 wavelength. This is because the -𝕚d and e𝕧 Pythagorean Triangle is reactionary only, the e𝕪 and -𝕘d Pythagorean Triangle as the photon is active so it changes its angle θ.

Blueshifting the photons

If the mirror is a different e𝕧 length away from the emitter, not as the hypotenuse but as the length from the right angle to the mirror, then the -𝕚d and e𝕧 Pythagorean Triangle changes its area keeping the same angle θ. This angle change blueshifts the sound waves or light for the measurer. That is because the mirror is also moving towards the measurer.

Proportional to c and the mirror's inertial velocity

The difference between the two can be modeled as the e𝕪 and -𝕘d Pythagorean Triangle photon changing its angle θ from the mirror's inertial velocity, that changes the ratio between the -𝕘d rotational frequency and the e𝕪 kinetic electric charge. This change in its angle θ is proportional to the -𝕚d and e𝕧 Pythagorean Triangle of the moving mirror with its e𝕧/-𝕚d inertial velocity, and the -𝕚d and e𝕧 Pythagorean Triangle of the e𝕧/-𝕚d inertial velocity of the photons.

Ratios of the angle θ

This can be represented on the same -𝕚d and e𝕧 Pythagorean Triangle, there is the angle θ for c and a second -𝕚d and e𝕧 Pythagorean Triangle superposed with the same area. This has the inertial velocity of the mirror. This gives a ratio $\sqrt{}(E\mathbb{V}_m/E\mathbb{V}_c)$ which with a slower mirror is a small fraction as γ. That gives the blueshift the e𝕪×-𝕘d photons at the detector.

Changing the absorption of photons

Because the -𝕠d and e𝕪 Pythagorean Triangles as electrons are proportional to the -𝕚d and e𝕧 Pythagorean Triangles, this changes the proportions of how e𝕪×-𝕘d photons can be emitted and absorbed. When the photons are blueshifted this changes their angle θ, the photons would then have a higher -𝕘d rotational frequency when absorbed into another atom.

Photons bouncing off an atom

The excess -𝕘d rotational frequency can be reemitted as another photon, the e𝕪/-𝕘d photon can also bounce off an atom where its -𝕘d rotational frequency does not match that of an orbital. That is called Raman scattering. This would be a e𝕐/-𝕘d light impulse, the electron and photon would be observed as particles.

The mirror has a length contraction and time slowed

The moving mirror experiences a e𝕧 length contraction and -𝕚d inertial time slowing, this is from its -𝕀D inertial temporal history and -𝕀D×e𝕧 inertial work causing the e𝕧 length contraction. The E𝕍 inertial displacement history and E𝕍/-𝕚d inertial impulse create the -𝕚d inertial time slowing.

Proportional to the blueshift and length between photons

These are also proportional to the blueshift of the e𝕪×-𝕘d photons, the slowing of the -𝕚d inertial time of the mirror is the same as the increase in the blueshift of the photons. Also the e𝕧 length contraction of the mirror is proportional to the e𝕪×-𝕘d photons being further apart with a e𝕧 length.

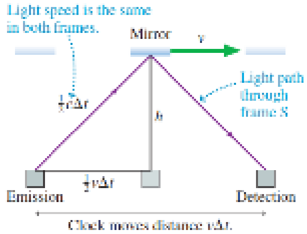


FIGURE 36.20 A light clock analysis in which the speed of light is the same in all reference frames.

FIGURE 36.20 shows the light clock as seen in frame S. The difference from Figure 36.19a is that the light now travels along the hypotenuse at speed c. We can again use the Pythagorean theorem to write

$$h^2 + \left(\tfrac{1}{2}v\,\Delta t\right)^2 = \left(\tfrac{1}{2}c\,\Delta t\right)^2 \qquad (36.6)$$

Solving for Δt gives

$$\Delta t = \frac{2h/c}{\sqrt{1-v^2/c^2}} = \frac{\Delta t'}{\sqrt{1-v^2/c^2}} \qquad (36.7)$$

The time interval between two ticks in frame S is *not* the same as in frame S′.

It's useful to define $\beta = v/c$, the velocity as a fraction of the speed of light. For example, a reference frame moving with $v = 2.4 \times 10^8$ m/s has $\beta = 0.80$. In terms of β, Equation 36.7 is

$$\Delta t = \frac{\Delta t'}{\sqrt{1-\beta^2}} \qquad (36.8)$$

Proper time and distance

In this model proper -ⅈd inertial time is where there are no forces, when the clock gauge moves with the train then there is no E𝕍/-ⅈd inertial impulse. There is also a e𝕧 proper length, on the train the e𝕧 length is not measured to contract because there is no relative -𝕀D×e𝕧 inertial work.

Proper time and spin

The proper time refers to the spin Pythagorean Triangle sides, when there is no force this can also be referred to as proper spin. Where the impulse is observed there is a second derivative with respect to the spin Pythagorean Triangle side. This appears as time because it is a constant rotation.

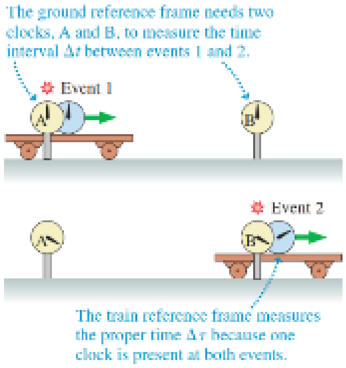
No proper distance with impulse and observation

With an observation of impulse there is no proper distance, this is because the straight Pythagorean Triangle side is squared. As a force it cannot be also measured with a distance. This is because there must be time as well, otherwise there would be no way to know the strength of the force without knowing how long the impulse was applied for. When this force is applied for a shorter time its magnitude changes.

No proper time with work and measurement

The proper distance refers to the straight Pythagorean Triangle sides, when work is measured there is a second integral with respect to the straight Pythagorean Triangle side as a scale or ruler. Because work uses the spin Pythagorean Triangle side squared as torque, this cannot also be measured with a clock gauge. Instead it uses a scale or ruler to determine the strength of the torque. For example a torque might be applied for a second, then doubling the torque for a second would be measured as the same force. This is because torque needs to move a distance to be different, otherwise it is spinning in one position.

FIGURE 36.21 The time interval between two events is measured in two different reference frames.



The muon and inertial velocity

The -𝕚d and e𝕧 Pythagorean Triangle of a muon has a large angle θ opposite the -𝕚d inertial mass side, so it appears to have a large inertial mass and time dilation. It would also appear to have a e𝕧 length contraction when its -𝕀D×e𝕧 inertial work is measured. Because of its higher e𝕧/-𝕚d inertial velocity it acts more like a particle, it is then observed with its E𝕍/-𝕚d inertial impulse and a slower -𝕚d inertial time.

The muon and the moving mirror

The reference frame of a planet has the muon coming towards it, this is like the moving mirror in the last example. The muon is a second generation of the electron, this also comes from the -𝕠d and e𝕪 Pythagorean Triangle. In this model it could be where two -𝕠d and e𝕪 Pythagorean Triangles are connected at right angles, then their hypotenuse ζ would become longer. A third generation, the τ electron, would be a third -𝕠d and e𝕪 Pythagorean Triangle so the hypotenuse would connect all three.

Kinetic mass

The -𝕠d kinetic magnetic field is a kind of kinetic mass in this model, it is proportional to the -𝕚d inertial mass. The ratios of the three lepton masses are proportional to three different angles θ.

Three generations of leptons and neutrinos

The τ electron can then emit a e𝕪×-𝕘d photon to decay an -𝕠d and e𝕪 Pythagorean Triangle to become the muon. Then a second e𝕪×-𝕘d photon to become the electron. This would also explain where there are only three generations of leptons. The neutrino would also have three generations with the same three Pythagorean Triangles orthogonal to each other. These neutrinos are also emitted when the τ electron decays to the muon then the electron.

Third direction of spin

In this model the neutrino has a third direction of spin, this is orthogonal to the proton as the +𝕠d and e𝕒 Pythagorean Triangle and the electron as the -𝕠d and e𝕪 Pythagorean Triangle. The neutrino moves with its spin in the direction of motion like a corkscrew. Adding these three spins together cancels them out to form a neutron.

The proton spin

The proton has a spin like a planet, the +𝕕d axis can be regarded as being vertical in the hydrogen atom. The e𝕒 altitude of the proton is proportional to the e𝕙 height, this extends outward from the proton center. Alternatively the +𝕕d spin can be modeled as being on the end of the e𝕒 straight Pythagorean Triangle side, the values are the same.

The electron spin

The electron would have a horizontal axis as -𝕕d, in this model it is like a rolling wheel that goes around the proton. This has a -𝕕d axis of the rolling wheel, the e𝕪 kinetic electric charge acts as the spoke. When the orbital is elliptical this is at an angle to the +𝕕d proton axis, that reduces the orthogonal relationship of the +𝕕d potential torque and the -𝕕d kinetic torque.

The photon spin

The e𝕪×-𝕘d photon also moves as a rolling wheel, the -𝕘d rotational axis turns orthogonally to the direction of motion. The e𝕪 kinetic electric charge acts as a spoke, the photon can be polarized so that the axis points in different orientations. This affects how the photon is reflected or absorbed.

The neutrino spin

The neutrino has the third orthogonal direction, this is represented a 𝕕d with neither a positive or negative sign. Because of this it does not interact directly with the +𝕕d and e𝕒 Pythagorean Triangle as the proton and the -𝕕d and e𝕪 Pythagorean Triangle as the electron. Its straight Pythagorean Triangle side is referred to here as 𝕨 for width, together this makes the 𝕕d and 𝕨 Pythagorean Triangle.

Three generations of leptons and neutrinos

The -𝕕d and e𝕪 Pythagorean Triangle as the electron has an angle θ, the -𝕕d kinetic magnetic field value is proportional to its -𝕚d inertial mass. The τ electron has the τ neutrino with an orthogonal spin, it is composed of three -𝕕d and e𝕪 Pythagorean Triangles with a single hypotenuse. When this decays the τ neutrino is emitted, this is a 𝕕d and 𝕨 Pythagorean Triangle. There are three 𝕕d and 𝕨 Pythagorean Triangles in the τ electron with a common hypotenuse like the -𝕕d and e𝕪 Pythagorean Triangles.

Decaying to the muon

After this decay there are two -𝕕d and e𝕪 Pythagorean Triangles as the muon, when this decays the 𝕕d and 𝕨 Pythagorean Triangle as the muon neutrino is emitted to leave the -𝕕d and e𝕪 Pythagorean Triangle as the electron.

The neutrino changes into the electron

In conventional physics the neutrino can change into the electron, in this model that can occur by a -𝕕d kinetic torque which adds a -𝕚d inertial mass. That is by changing the spin orientation by 90° with a -𝔻D kinetic torque, the 𝕕d neutrino mass then has a negative sign as the -𝕕d kinetic mass. Because this is -𝔻D×e𝕪 kinetic work there is a torque, that allows for the spin orientation of the neutrino to change into the electron.

Neutrinos become leptons

When the electron moves to the next generation as a muon, the muon neutrino interacts with it. The additional -𝔻D×e𝕪 kinetic work causes the 𝕕d muon neutrino to turn by 90° to become the muon.

Conversely when the muon decays the -𝕆D×e𝕪 kinetic work has a probability of turning the muon Pythagorean Triangle back to a muon neutrino Pythagorean Triangle, then this moves away.

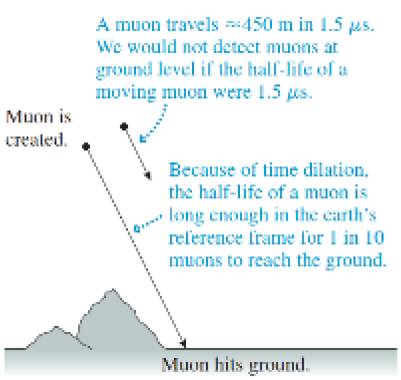
Rotating a neutrino into a lepton

With additional -𝕆D×e𝕪 kinetic work the muon has a higher probability of turning into a τ neutrino, this is where a τ neutrino is turned 90° to become a third -𝕠d and e𝕪 Pythagorean Triangle. Because each is orthogonal they have a common hypotenuse. Conversely there is a -𝕆D kinetic probability of this decaying, then this turns the τ neutrino 90° as the τ electron becomes a neutrino. The additional energy is emitted as -𝔾D×e𝕪 light work with a e𝕪×-𝕘d photon like in an atom.

The Koide formula

This would be consistent with the Koide formula where $(-\mathbb{I}D_e-\mathbb{I}D_m-\mathbb{I}D\tau)/(-\mathbb{i}d_e-\mathbb{i}d_m-\mathbb{i}d_\tau)^2\approx4/9$. In this model a square is a force, the numerator would be the measured -𝕀D inertial masses of the electron, muon, and τ electron. It is squared because otherwise it cannot be measured. In the denominator this is the three unsquared -𝕚d inertial masses added then squared. This is the -𝕀D inertial probability of the three generations on three orthogonal Pythagorean Triangles, it acts like one -𝕠d and e𝕪 Pythagorean Triangle as do Pythagorean triples.

FIGURE 36.23 We wouldn't detect muons at the ground if not for time dilation.



The twin paradox and inertial work

In this model Helen goes on the rocket, that does -𝕆D×e𝕪 kinetic work and has a E𝕐/-𝕠d kinetic impulse moving to a different star. When -𝕀D×e𝕧 inertial work is done, proportional to the -𝕆D×e𝕪 kinetic work from the rocket, this gives her a -𝕀D inertial weight as the rocket accelerates.

Gravitational work

This is equivalent to the +𝕀D×e𝕙 gravitational work done by the planet she left behind. The +𝕚d and e𝕙 Pythagorean Triangle as gravity gives people weight, this is where a spring scale is compressed by the +𝕀D×e𝕙 gravitational work. The +𝕚d and e𝕙 Pythagorean Triangle as gravity, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia, work inversely to each other. This means when in orbit a rocket experiences weightlessness. The +𝕚d gravitational weight is balanced by the -𝕚d inertial weight for each atom in the rocket.

The equivalence principle

This leads to the equivalence of inertial acceleration and gravity in relativity. In this model gravity is an active force, it is measured as +𝕀D×e𝕙 gravitational work when the elevator is stationary. Inertial acceleration is a reactive force, the -𝕀D×e𝕧 inertial work is measured by the change in inertial velocity as the elevator moves.

Free fall and weightlessness

There is also a Eℍ/+𝕚d gravitational impulse and an E𝕍/-𝕚d inertial impulse, when these are balanced this is defined as free fall here. The difference is weightlessness relates to mass and work, freefall with a displacement force from impulse.

Comparing gravitational and inertial time

The -Id inertial weight is equal and opposite the +𝕀D gravitational weight at the e𝕙 height of an orbiting rocket. When George is left behind, his +𝕚d gravitational time is slower on the surface compared to in orbit. When Helen accelerates towards the star her -𝕚d inertial time is much slower than George's +𝕚d gravitational time. Compared to the +𝕚d gravitational time and the -𝕚d inertial time in free space away from gravitational masses, both Helen and George are observed to have slower time.

Inertial displacement history and time

In this model the increased E𝕍/-𝕚d inertial impulse of the rocket would increase Helen's e𝕧/-𝕚d inertial velocity to approaching c, this changes her E𝕍 inertial displacement history. Because of this her -𝕚d inertial time is slowed, E𝕍 as the inertial displacement force has increased. This happens in both directions because the E𝕍/-𝕚d inertial impulse is the same, -𝕚d inertial time is spin which is not directional. The E𝕍 inertial displacement force is not a direction either, it is the interval between e𝕧 positions with an acceleration.

Time slowing and the relativity equation

The slowing of Helen's -𝕚d inertial time follows the same relativity equation, this is equivalent to a change of the angle θ as before. Because this angle change is for a longer E𝕍 displacement the time slowing continues as the rocket accelerates. In this model the time slowing cannot be directly compared with the time she is away, instead it is a function of her E𝕍 inertial acceleration. When she reaches a constant inertial velocity then it is a function of her E𝕍 inertial displacement history, her -𝕚d inertial time remains slower until E𝕍 is reduced when she returns home.

Time slowing and chemical reactions

This slowing of -𝕚d inertial time has a chemical effect as well, the atoms on the rocket will have decomposed less such as with rust. Helen is younger because her atoms have metabolized food more slowly. She would not observe this herself because the E𝕍 inertial displacement history on the rocket is the same everywhere on it.

Length contraction and chemical reactions

The rocket also undergoes a e𝕧 length contraction from its -𝕀D×e𝕧 inertial work. The -𝕀D inertial temporal history increases as the rocket approaches c, when this is measured by George the e𝕧 gravitational temporal history has its e𝕧 length contracted. In this model the e𝕧 length would be contracted in all atoms, this would appear to slow the velocity of vibrations as well as make electrons move more slowly inside atoms.

A contracted path

Not only does the rocket's e𝕧 length contract, also its path contracts. This is seen with a muon for example. When it approaches a planet it can have its -𝕀D×e𝕧 inertial work measured in a cloud chamber. It can also have its E𝕍/-𝕚d inertial impulse observed as a particle. With its -𝕀D×e𝕧 inertial work the e𝕧 length of its path is contracted, because this is shorter the muon can travel further without decaying. When its E𝕍/-𝕚d inertial impulse is observed, its -𝕚d inertial time is slowed. This allows it to survive longer before it decays. A single muon cannot be both measured with its -𝕀D×e𝕧 inertial work and observed with its E𝕍/-𝕚d inertial impulse. Multiple muons can then have some measured with work, others with impulse.

Slowing inertial velocity and momentum

The contraction of the e𝕧 path has the same effect as slowing -𝕚d inertial time, with the e𝕧/-𝕚d inertial velocity of atoms if the -𝕚d inertial time is slowed then the e𝕧/-𝕚d inertial velocity is also slowed. A given e𝕧/-𝕚d inertial velocity is a derivative fraction, it refers to impulse. A given -𝕚d×e𝕧 inertial momentum has a contracted e𝕧 length or path as an integral.

Slower electrons

The slower -𝕚d inertial time is observed with the E𝕍/-𝕚d inertial impulse, the e𝕧 length contraction is measured with -𝕀D×e𝕧 inertial work. Because inside atoms the electrons are mainly doing -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, there would be a e𝕪 kinetic electric charge contraction and a e𝕧 length contraction. This would slow the orbital inertial velocity of electrons.

Proper inertial time

When on the rocket the e𝕧/-𝕚d inertial velocity is much lower than c, because of this Helen sees the -𝕚d inertial time passing normally. The rocket has a contracted e𝕧 length in the direction of motion, because this is one direction the rocket becomes flattened in shape perpendicular to its motion. At right angles to its trajectory the rocket is not moving with a e𝕧/-𝕚d inertial velocity, because of this the e𝕧 length is not contracted all around the rocket to make it smaller.

The direction of motion

Also the -𝕚d inertial time slowing only occurs in the direction of motion. If George could observe a clock on the rocket with its face orthogonal to the direction of motion, then its -𝕚d inertial time would not be slowed. This slowing of time only occurs in the direction the rocket is moving. If the clock was at a 45° angle to this trajectory, then the clock would appear as an ellipse with its shorter minor axis pointing towards George. The clock hands would be observed as moving slower in this part of the ellipse, then at a normal velocity along the major axis orthogonal to the direction of motion.

Asymmetrical change

Because of this, the rocket's atoms have an asymmetrical change, they become more flattened in one direction. While an individual iota such as a muon has its decay slowed, the actual time dilation on a rocket has not been observed or measured to date. So it is not known whether this asymmetrical e𝕧 contraction and -𝕚d slowing would have health effects on someone traveling near c. While this asymmetry would not be observable or measurable on the rocket, Helen is still expected to return younger. So in this model the health effects are unknown.

Gravitational height contraction and neutron stars

The process is like that in strong gravity, the E𝕃/+𝕚d gravitational impulse causes a slowing of +𝕚d gravitational time and so George is aging less quickly than others in orbit. There is also a e𝕙 height contraction, this causes atoms to become smaller. With a strong enough gravity these atoms can be crushed down into neutrons, such as in a neutron star. This would have adverse health effects on George, in this model inertia is a reactive force so it may not have the same effect on Helen.

Near c travel and human safety

It may be that prolonged journeys near c would damage the rocket and its passengers. With gravity the slowing of +𝕚d gravitational time and a e𝕙 height contraction can hurt people, for example in traveling to the surface of Jupiter. This would happen even when everyone would observe the same E𝕃 gravitational displacement history and measure the same +𝕀D gravitational temporal history.

Health effects of a height contraction

Approaching c there would be a similar asymmetry, near a black hole there is a e𝕙 height contraction that is fatal. However there is no e𝕧 length contraction, so one and not the other may also be dangerous when traveling up to and past c. A rocket traveling near c near an event horizon would be contracted in its e𝕙 height and e𝕧 length, it is not known whether this would also have a health effect on the passengers.

Stronger gravity and normal inertia

In this model the changes would come, not from the actual inertial velocity, but from the acceleration. This is like people on a normal sized planet compared to Jupiter, it is the stronger E𝕃/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work that can hurt people. This only happens however when it is reacted against by the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work of the planet's surface. For example the stronger gravity on Jupiter would cause a person's atoms to be crushed, but there is no equivalent stronger inertia canceling out the gravity.

Weightlessness and freefall in strong gravity

If someone is falling down towards Jupiter, or an event horizon, they are weightless from the +𝕀D×e𝕙 gravitational work. They are in freefall from the E𝕃/+𝕚d gravitational impulse, this is not likely to hurt them except from tidal effects from a smaller event horizon. However trying to accelerate away from it may expose them to this danger.

The Twin Paradox

The most well-known relativity paradox is the twin paradox. George and Helen are twins. On their 25th birthday, Helen departs on a starship voyage to a distant star. Let's imagine, to be specific, that her starship accelerates almost instantly to a speed of $0.95c$ and that she travels to a star that is 9.5 light years (9.5 ly) from earth. Upon arriving, she discovers that the planets circling the star are inhabited by fierce aliens, so she immediately turns around and heads home at $0.95c$.

A **light year,** abbreviated ly, is the distance that light travels in one year. A light year is vastly larger than the diameter of the solar system. The distance between two neighboring stars is typically a few light years. For our purpose, we can write the speed of light as $c = 1$ ly/year. That is, light travels 1 light year per year.

This value for c allows us to determine how long, according to George and his fellow earthlings, it takes Helen to travel out and back. Her total distance is 19 ly and, due to her rapid acceleration and rapid turnaround, she travels essentially the entire distance at speed $v = 0.95c = 0.95$ ly/year. Thus the time she's away, as measured by George, is

$$\Delta t_G = \frac{19\ \text{ly}}{0.95\ \text{ly/year}} = 20\ \text{years} \qquad (36.10)$$

George will be 45 years old when his sister Helen returns with tales of adventure.

While she's away, George takes a physics class and studies Einstein's theory of relativity. He realizes that time dilation will make Helen's clocks run more slowly than his clocks, which are at rest relative to him. Her heart—a clock—will beat fewer times and the minute hand on her watch will go around fewer times. In other words, she's aging more slowly than he is. Although she is his twin, she will be younger than he is when she returns.

Calculating Helen's age is not hard. We simply have to identify Helen's clock, because it's always with Helen as she travels, as the clock that measures proper time $\Delta\tau$. From Equation 36.9,

$$\Delta t_H = \Delta\tau = \sqrt{1-\beta^2}\,\Delta t_G = \sqrt{1-0.95^2}\,(20 \text{ years}) = 6.25 \text{ years} \qquad (36.11)$$

George will have just celebrated his 45th birthday as he welcomes home his 31-year-and-3-month-old twin sister.

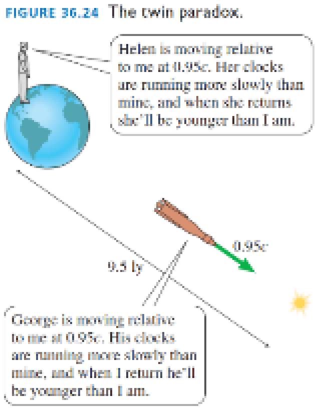
Time slows from impulse

In this model the -𝕚d inertial time slowing comes from the E𝕍/-𝕚d inertial impulse of the rocket. This makes Helen younger, the planet does not experience a force and so there is no slowing of -𝕚d inertial time or a e𝕧 length contraction. The time can appear to slow as Helen looks back at the planet, this is because she is accelerating from the Doppler effect. The e𝕧 length between the photons is increasing as they have further to travel.

The Doppler effect and the rocket

For example if a light flashes on the planet each second, then as Helen accelerates the flashes will be further apart, the effect is the same as the pitch of sound lowering when a car accelerates away from a sound source. When she is accelerating back towards George they will becomes closer than one second apart until she arrives back. This is like the sound pitch becoming higher as someone accelerates towards a sound source.

FIGURE 36.24 The twin paradox.



Vector addition and subtraction

In this model e𝕧 as a length can be regarded as from there to there. As a vector with the E𝕍/-𝕚d inertial impulse it uses vector addition and subtraction, these vectors represent forces in the sense that the speed or velocity is not the same at each end of the vector. So as the interval would change along the vector this would be an increasing force. With work the e𝕧 length can also be regarded as a vector, it is like a ruler or scale and so the different e𝕧 lengths can be connected to each other.

An interval versus positions

The difference is the E𝕍 displacement force can be observed as a vector, the e𝕧 length is a scale the -𝕀D inertial torque or probability is measured on. This is the difference between an interval between positions and the positions themselves. When an object is accelerating this is observed in between positions as an interval, according to this model. But when the positions are used as a scale then this scale is not directly being observed, instead it is being used to measure another force.

Spin as scalars

Scalars do not use scalar addition and subtraction, these are used in spin Pythagorean Triangle sides because spin cannot point in a straight-line. Instead it spins around a e𝕧 point as a scalar. The addition of +𝕚d as gravitational time or -𝕚d inertial time can be done, together they can be scalar subtraction, this is because one is positive and one is negative. The addition of -𝕠d and -𝕚d can be done as an approximation, this is because they are proportional to each other. +𝕠d and +𝕚d can also be approximately added, then there can be an approximate subtraction of +𝕠d -𝕚d and +𝕚d -𝕠d.

Scalars as forces or moments

With spin there is also a clockwise or counterclockwise spin associated with these scalars, that is analogous to from left to right or right to left. With these scalars they can also be a force or a moment. When they are forces they are like a torque, the initial amount of force is different from the initial position to the final position. They can still be added by sign, so negative torques can be added to give a larger negative value as can adding positive torques. When these are subtracted this would be like +𝕆D as the potential torque minus the -𝕆D kinetic torque. The spin can also be without a force, then it is like the moments or fluxions on a clock gauge while the forces are the intervals between the moments.

There to there

A rocket traveling near c moved from there to there as positions when its work was measured, on board it has a -𝕚d proper time and a e𝕧 proper length. These are not slowed and contracted respectively on boars, that is because there is no relative force in between the Pythagorean Triangles there large enough for a relativistic change.

There to there and vector addition

When the rocket is seen to go from there to there, it moves towards or away from the observer and can have a slower -𝕚d inertial time from its E𝕍/-𝕚d inertial impulse. It can also have a contracted e𝕧 length from its -𝕀D×e𝕧 inertial work. It can also go from there to there in terms of vector addition and subtraction. When Helen goes on the rocket her journey can be described as there to there, this can be a vector addition of E𝕍 with the E𝕍/-𝕚d inertial impulse or e𝕧 with the -𝕀D×e𝕧.

Durations and moments

The word then can describe a time different from now, just as there is different from here. Helen would move from then to then, this can be added and subtracted as scalars. On a clock gauge a duration of time would be an acceleration, it begins with the clock hand stopped, then it accelerates to rotate then decelerates to stop again. This would be a duration of time between then and then, just as there can moments or instants of time as then.

Here and now

This model can refer to as then and there as part of normal consciousness, but here and now are something else. Here would refer to a part of a Pythagorean Triangle as would here, this would not be observable or measurable as forces without becoming then and there. The concept of a present then in this model refers to here and now, but these are not observable and measurable except as being in between a past and future formed by forces.

Past and future

Also here is not definable except in relation to there was or there will be. In this case they refer to work, the distance is defined in the past or future by the squared spin Pythagorean Triangle side. When there to there is referred to this comes from impulse, a motion in the interval between two positions observed with a clock gauge of time.

The present

That gives a perception of a present, it is not directly observable and measurable however. It is experienced to be different from the past and future in terms of impulse. This present also refers to here, it is experienced to be different from there as a position.

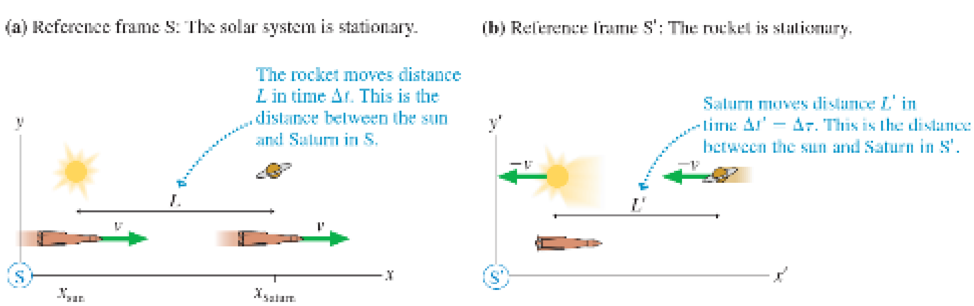
Zero

This here is also not directly experienced, it is similar to the concept of zero. In this model that refers to zero forces, because of this zero cannot be observed or measured. It also means no change, like x+0=x. That means with conservation laws that forces can be added and subtracted as positive and negative spin scalars with a zero. With distances there can also be a zero concept, then they can be added and subtracted as vectors. Another use for zero is where there is no force, like an inertial velocity that is not changing. Because the angle θ of a Pythagorean Triangle does not change there is no observation or measurement, this can be regarded as zero force or zero.

Changing reference frames requires a force

In this model to change from one reference frame to another requires a force, this can then be observable or measurable. Here Saturn observes the rocket's E𝕍/-𝕚d inertial impulse with a -𝕚d inertial time slowing. It also measures its -𝕀D×e𝕧 inertial work with a e𝕧 length contraction. This contraction is not just with the e𝕧 length of the rocket, it is also with the path of the rocket as the points on which it moves. It is like these points are closer together, if these were marks on a clock then the clock hands would also appear to move slower.

FIGURE 36.25 L and L' are the distances between the sun and Saturn in frames S and S'.



A work scale as vectors

In this model e𝕧 is not positive or negative, instead it is measured like vectors. With -𝕀D×e𝕧 inertial work then the distances become vectors, they are not observed. Instead they give probability densities at various inertial positions. When Carmen and Dan do -𝕀D×e𝕧 inertial work then this gives an -𝕀D inertial temporal history. With uncertainty this history becomes a series of probabilities about that past, there can also be probabilities of an event at various positions.

Probability and torque

When a nut is rotated by a wrench this is torque, it can also be regarded as a higher probability the nut will turn. Probabilities can be measured on a clock, for example a 1 might come up on a die 1/6 of the time. If the die was repeatedly thrown, and the moments it came to rest were observed, then this would be impulse. If the 1 side was regarded as a position, then of the times recorded on the clock gauge 1/6 would correspond to the probability. This can appear as a torque, the interval between the moments recorded on the clock gauge can be regarded as a force moving in between those corresponding to 1.

The barn paradox

In this model a variation of the barn paradox has the pole and the barn moving towards each other. Together their relative inertial velocities would add up to greater than c, but this cannot appear in the photons moving between them. To stationary observers each would have a e𝕧 length contraction and their -𝕚d inertial time slowed. In this model that would cancel out, each would observe time not slowed in the other, also no length contraction.

Conservation of time and energy

This is because of a conservation of time and energy, both would appear younger by the same amount to stationary observers. They would then have to be the same age as each other, when they stopped their clocks would have to match. Because of this the pole would not fit inside the barn for either observer and measurer.

Kinetic forces creating a length contraction and time slowing

It is the same problem as Helen accelerating away on a rocket, it appears that George accelerates away from her but does not. Helen accelerates with a E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work from the rocket engines, these react against an overcome the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work of the rocket. It is this active kinetic force which produces the e𝕧 length contraction and the -𝕚d inertial time slowing.

The barn paradox and kinetic forces

In the barn paradox both the pole and the barn would have been accelerated towards each other with a E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work. Because of this there is no difference in their kinetic forces, therefore they would not observe a -𝕚d inertial time slowing or a e𝕧 length contraction in each other.

George has no active forces

George has no active E𝕐/-𝕠d kinetic impulse or -𝕆D×e𝕪 kinetic work, the planet he is on has no acceleration away from Helen. Because of this his E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work is unchanged, Helen does not observe his -𝕚d inertial time slowing but sees it speed up. She also measures his e𝕧 length dilating instead of contracting.

Active gravitational forces

In general relativity there is also an active gravitational force producing a e𝕙 height contraction and +𝕚d gravitational time slowing. Because of this GPS satellites can be programmed for this e𝕙 height contraction on the Earth's surface, as well as a +𝕚d gravitational time slowing. On this surface people do not observe a slower -𝕚d inertial time with the GPS satellite or a e𝕙 height contraction in it. This is because there is no active force in the GPS satellite, it would be moving in a circular orbit for example with no kin2 or -𝕆D×e𝕪 kinetic work being done.

Accelerating a reference frame

In this model there are two active Pythagorean Triangles, the kinetic -𝕠d and e𝕪 Pythagorean Triangle and the gravitational +𝕚d and e𝕙 Pythagorean Triangle. These can create a distance contraction and time slowing, inertia from the -𝕚d and e𝕧 Pythagorean Triangle cannot do this because it only reacts against a change.

The potential reacts against a change

The +𝕠d and e𝕒 Pythagorean Triangle as the proton also cannot do this, the potential only reacts against a change. This allows the electron as the -𝕠d and e𝕪 Pythagorean Triangle to appear to have a e𝕧 length contraction and -𝕚d inertial time slowed in its lower faster orbitals. The +𝕚d and e𝕙 Pythagorean Triangle as gravity can also have a general relativistic effect, with stronger gravity on a planet the electrons can be flattened with a contracted e𝕙 height. Because the +𝕠d and e𝕒 Pythagorean Triangle reacts against gravity, and remains proportional to it, the proton maintains the correct electromagnetic charge between it and the electron.

FIGURE 36.26 Carmen and Dan each measure the length of the other's meter stick as they move relative to each other.

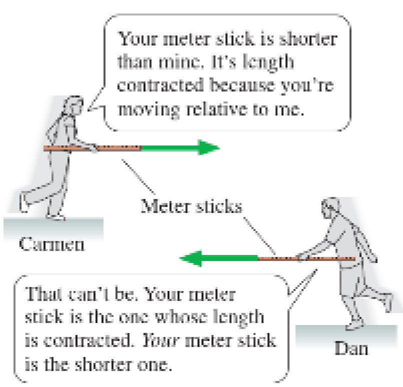
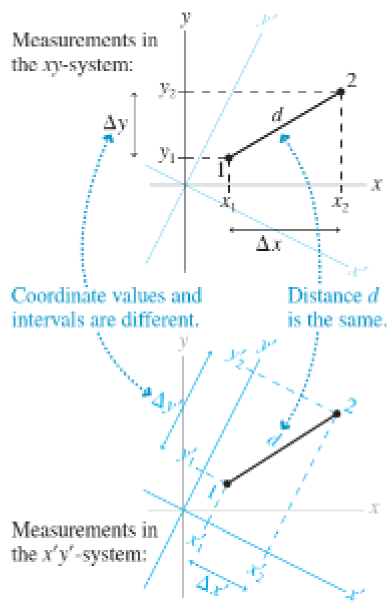


FIGURE 36.27 Distance d is the same in both coordinate systems.



Length and height can be contracted

In this model there are two distances that can be contracted, e𝕧 as a length and e𝕙 as a height. The third dimension of width is not used here, it is not part of a Pythagorean Triangle. It still appears because the e𝕧 length and e𝕙 height can form a mesh which appears to have a width. Because of this the width is invariant, often referred to as s in special relativity.

Width is not contracted

With an inertial velocity e𝕧/-𝕚d orthogonal to this would be the width, but this is not contracted as a rocket approaches c. This means a rocket might appear to be shorter like the pole entering the barn, but its width would not be. This is because the rocket or the pole are not moving at right angles to e𝕧/-𝕚d.

Tensors and width

With general relativity there is a e𝕙 height, orthogonal to this is not contracted as a width. It is modeled as a curved line in the geodesic in general relativity, tensors are used in 3 dimensions. Then a width might be curved with a Christoffel symbol for example. This model does not use tensors except as an approximation, this is because that would include width which is not used.

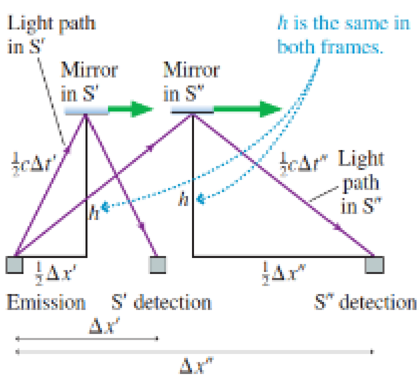
Two dimensional trajectories

This can be illustrated by a projectile fired horizontally from a gun, gravity pulls it down. The projectile here would be moving horizontally with a e𝕧/-𝕚d inertial velocity, however it does not curve to one side as a width. The projectile's motion is in 2 dimensions, a gravitational speed e𝕙/+𝕚d and an inertial velocity e𝕧/-𝕚d.

Chaotic trajectories

Even when a trajectory is complex or chaotic, such as with a 3 body problem involving meteors, there is still no width in this model. The meteors are attracted directly to the center of each other from the +𝕚d and e𝕙 Pythagorean Triangles. They also move with an inertia in one direction from the -𝕚d and e𝕧 Pythagorean Triangles. While a meteor can be turned in approximately a width direction, this can always be explained by the gravitational and inertial directions of e𝕙 height and e𝕧 length.

FIGURE 36.28 The light clock seen by experimenters in reference frames S' and S''.



Lorentz transformation

A Lorent transformation refers to a e𝕧' length x', this comes from an original position e𝕧 or x and a change in inertial velocity as vt. In this model that is e𝕧/-𝕚d × -𝕚d, this reduces to e𝕧 so that e𝕧'=e𝕧+ e𝕧×(-𝕚d/-𝕚d). The inertial velocity can be multiplied so that the two -𝕚d terms are the same.

Changing a position with work

In this model e𝕧 would be a position, to change this requires -𝕆D×e𝕪 kinetic work or +𝕀D×e𝕙 gravitational work as active forces. These would give a change in the -𝕀D×e𝕧 inertial work, here then e𝕧 or x refers to positions in a scale such as a ruler.

Changing a position with a force

This would give e𝕧'=e𝕧 + -𝕀D×e𝕧, the difference is -𝕀D is the force which reacts against the changing in position. This -𝕀D is different to -𝕚d/-𝕚d previously, that is because it refers to an acceleration not an inertial velocity applied for a time.

Work as an integral field

The Lorentz transformation could be rewritten as e𝕧'=e𝕧 + e𝕧/-𝕚d × 1/-𝕚d, this can be done for example by applying a change for a fraction of a second. That gives an acceleration of e𝕧/-𝕀D in meters/second^2. In this model that is written as -𝕀D×e𝕧 or seconds^2×meters because this represents a wave or field. It is equivalent to meters/second^2, for example if these seconds were a fraction of a minute it would become meters/minute^2.

Spin as time or mass

It is written as a multiplication because the -𝕀D×e𝕧 inertial work comes from an integral, there is not slope being observed like with e𝕧/-𝕚d and so there is no division sign. The integral area is -𝕀D as seconds^2, but in this model -𝕀D is measured as a force like mass or magnetism. With the E𝕍/-𝕚d inertial impulse there is a force E𝕍 as meters^2/second. This can be rewritten as meters/second^2, that would be an approximation where -𝕚d was a unit of time not mass or magnetism. The Lorentz transformation is the same in value, using forces means it includes an acceleration instead of a velocity.

A Lorentz transformation in time

An equivalent transformation can be done with time, for example -𝕚d'=-𝕚d+ (-𝕚d/e𝕧 ×e𝕧}. This would start at a given time, then there is a -𝕚d/e𝕧 inertial velocity written inverted. This continues for a e𝕧 length which ends at a given inertial time -𝕚d'. That would use the E𝕍/-𝕚d inertial impulse instead of -𝕀D×e𝕧 inertial work, in this model it would become -𝕚d'=-𝕚d + -𝕚d/E𝕍. Here the inertial impulse is in seconds/meter^2.

A constant Pythagorean Triangle area and transformations

At the starting -𝕚d inertial time there is the -𝕚d/E𝕍 inertial impulse, this is observed on a clock gauge in -𝕚d inertial time. After the force ends there is the -𝕚d' final inertial time. The answer is again the same as with the Lorentz transformation, this is because the Pythagorean Triangles have a constant area.

Inverting the transformation

Here e𝕧' is inverted to become 1/e𝕧 which is -𝕚d assuming a constant Pythagorean Triangle area of 1. Then the remaining terms are all inverted and the other Pythagorean Triangle side used. This gives a second derivative of the -𝕚d and e𝕧 Pythagorean Triangle with respect to e𝕧, that makes E𝕍 a square.

F=ma

The inversion gives a correct E𝕍/-𝕚d inertial impulse according to this model, but the -𝕀D×e𝕧 inertial work used as e𝕧/-𝕀D in meters/second^2 is an approximation only. This becomes like F=ma where m is the -𝕚d inertial mass here times e𝕧/-𝕀D. Together that is e𝕧'/-𝕚d' =e𝕧/-𝕚d + -𝕚d×e𝕧/-𝕀D, there is then an initial inertial velocity which increases to a second inertial velocity after work is done on the -𝕚d inertial mass.

Inertial magnetism

Here -𝕚d acts as an inertial mass because -𝕀D×e𝕧 inertial work is done, in this model -𝕚d is a mass or inertial magnetism with an integral. This is because an integral is a field or area, the mass or magnetism then extends around an iota. This can be a +𝕚d gravitational mass with a field, there is also a -𝕚d inertial field around an electron. That is proportional to its -𝕠d kinetic magnetic field, also from the integral.

Gravity changes inertia

When the acceleration is in the form -𝕚d/E𝕍 this is seconds/meter^2 which refers to an observation of an object or particle. When work is used this can describe the +𝕚d gravitational field around a planet, when impulse is used it can describe the force needed to change the inertia of an object.

36.8 The Lorentz Transformations

The Galilean transformation $x' = x - vt$ of classical relativity lets us calculate the position x' of an event in frame S$'$ if we know its position x in frame S. Classical relativity, of course, assumes that $t' = t$. Is there a similar transformation in relativity that would allow us to calculate an event's spacetime coordinates (x', t') in frame S' if we know their values (x, t) in frame S? Such a transformation would need to satisfy three conditions:

1. Agree with the Galilean transformations in the low-speed limit $v \ll c$.
2. Transform not only spatial coordinates but also time coordinates.
3. Ensure that the speed of light is the same in all reference frames.

Meter-seconds/second

This uses vt as a transformation of e𝕧/-𝕚d × -𝕚d or meter-seconds/second. In this model meter-seconds would be -𝕚d×e𝕧 which would be the integral area of the -𝕚d and e𝕧 Pythagorean Triangle. That is the first integral with respect to -𝕚d. There is also e𝕧/-𝕚d in e𝕧/-𝕚d × -𝕚d, that refers to meters/second and is the first derivative or slope of the -𝕚d and e𝕧 Pythagorean Triangle with respect to e𝕧. Together they allow the Lorentz transformation to refer to work or impulse as the force used.

Derivative and integral in a photon

In this model light comes from the e𝕪 and -𝕘d Pythagorean Triangle, this can be e𝕪/-𝕘d the first derivative with respect to e𝕪. It can also be the -𝕘d×e𝕪 first integral with respect to -𝕘d. The photons can then move as both the derivative and the integral, as a particle and a wave, because they are not being observed or measured. There are no forces in the derivative and integral, they are two attributes of the Pythagorean Triangle itself.

A photon collides with an electron

The photon would be observed for example by bouncing off an electron, this is where it has a e𝕪/-𝕠d kinetic velocity and so its acts as a particle. The photon also acts as a particle, its e𝕪/-𝕘d derivative would change its ratio of the e𝕪 kinetic electric charge and the -𝕘d rotational frequency in a collision. This would change the electron's e𝕪/-𝕠d kinetic velocity and proportionally its e𝕧/-𝕚d inertial velocity.

Lorentz transformation as a derivative or integral

The Lorentz transformation below refers to a particle e𝕪/-𝕘d as a photon, its e𝕧/-𝕚d inertial velocity is a constant at c but its derivative ratio is different. If the Lorentz transformation refers to a e𝕪×-𝕘d photon as an integral, that would be an area moving not a particle. The difference is the e𝕪×-𝕘d photon moves as an integral with a specific area, that changes according to the integral area +𝕚d×e𝕙 around a planetary mass.

Roy and Biv can be different

When Roy electromagnetism and Biv space-time have different angles θ, this is mediated by changes in the e𝕪×-𝕘d photons and +𝕘d×e𝕓 gravis. If a photon goes near a planet, its angle θ can change as the -𝕘d rotational frequency slows. This can affect the mediation of orbital changes in the same element.

Redshifting at different heights

If an element emits e𝕪×-𝕘d photons which move upwards in a +𝕚d gravitational field, the photons can be redshifted enough so that they can be absorbed by the same element with a larger e𝕙 height. These differences in Roy and Biv are mediated by the -𝕘d rotational frequency slowing and the e𝕪 kinetic electric charge contracting in a +𝕚d gravitational field. When the photons leave this gravitational field they can regain the same angles θ they had before entering it.

Gravis bending around a nucleus

The +𝕘d×e𝕓 gravis mediate the changes in the +𝕚d and e𝕙 Pythagorean Triangle gravity, this can be a e𝔹/+𝕘d gravis impulse or +𝔾D×e𝕓 gravis work. In different Roy electromagnetic environments these can also be affected like the photon, going near a nucleus the +𝕠d and e𝕒 Pythagorean Triangles as protons react against the gravis like with gravitational waves. That causes the +𝔾D×e𝕓 gravis work as a field to bend around the nucleus as it does with gravitational lensing.

Gravis and photons are conserved

When e𝕪×-𝕘d photons go around a galaxy their path can be bent, +𝔾D×e𝕓 gravis work can also be bent so they are both conserved in relation to each other. If this was not so, the gravitational influence of a galaxy behind another would become stronger or weaker than how much it bends photons itself.

Gravis in an asteroid belt

The +𝕀D×e𝕙 gravitational work of a planet, and proportionally the changes to this mediated by +𝔾D×e𝕓 gravis work, cause the photon to bend around in the gravitational geodesic. If the gravis were not proportional to the photons then as the +𝕚d gravitational field changed, such as with an asteroid belt bending photons as the asteroids shifted, then the photons would bend more or less than they should with that +𝕚d gravitational mass.

The photosphere

This bending is related to the circular orbits around a gravitational mass, also the electrons in orbitals around a proton. When the photon bends its trajectory, this can reach a circular orbit above an event horizon called the photosphere. Because -𝕘d is the rotational frequency of the photon this refers to spin, so -𝔾D×e𝕪 light work from the -𝔾D light torque causes the photon to bend in the gravitational field.

Photons colliding with electrons in gravity

This -𝔾D×e𝕪 light work is measured according to e𝕪 as the straight Pythagorean Triangle side, this is proportional to e𝕧 as the wavelength. These e𝕪/-𝕘d photons can also collide with free electrons near a planet, these must also be consistent and conserved with the e𝕪×-𝕘d photons bending in their path. That happens because the e𝕐/-𝕘d light impulse has its -𝕘d rotational frequency slowed, the photons slow down and like a slowing rocket they are captured more by the +𝕚d gravitational time. The -𝔾D×e𝕪 light work bands because the e𝕧 path contracts, that also slows the photons so they bond more towards the planet.

Redshift from frequency or wavelength changes

When the photon acts as a particle this is e𝕪/-𝕘d, the photon can become redshifted or blueshifted from the Eℍ/+𝕚d gravitational impulse of a planet. This is because of the e𝕐/-𝕘d light impulse, as with the E𝕍/-𝕚d inertial impulse it is observed on a clock gauge. With relativistic changes the e𝕪/-𝕘d photons have this -𝕘d light time dilate with a blueshift or contract with a redshift.

Redshift in a straight line

Because of this there can be a blueshift or redshift in a straight-line, e𝕪/-𝕘d photons coming directly up a gravitational well can be redshifted from the Eℍ/+𝕚d gravitational impulse. When the e𝕪×-𝕘d photons are moving in a geodesic then this bending is by definition not a straight line. With -𝔾D×e𝕪 light work this causes the e𝕪 kinetic electric charge and proportionally the e𝕧 wavelength to contract or dilate.

We'll continue to use reference frames in the standard orientation of FIGURE 36.29. The motion is parallel to the x- and x'-axes, and we *define* $t = 0$ and $t' = 0$ as the instant when the origins of S and S' coincide.

The requirement that a new transformation agree with the Galilean transformation when $v \ll c$ suggests that we look for a transformation of the form

$$x' = \gamma(x - vt) \quad \text{and} \quad x = \gamma(x' + vt') \qquad (36.20)$$

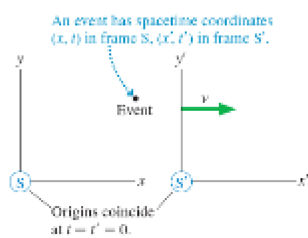
where γ is a dimensionless function of velocity that satisfies $\gamma \to 1$ as $v \to 0$.

To determine γ, we consider the following two events:

Event 1: A flash of light is emitted from the origin of both reference frames ($x = x' = 0$) at the instant they coincide ($t = t' = 0$).

Event 2: The light strikes a light detector. The spacetime coordinates of this event are (x, t) in frame S and (x', t') in frame S'.

FIGURE 36.29 The spacetime coordinates of an event are measured in inertial reference frames S and S'.



Relativistic from history changes

In this model the Pythagorean Triangles are relativistic by their nature, this comes from their constant Pythagorean Triangle area. When the -𝕀D inertial temporal history is larger, this causes the e𝕧 length to contract, when the E𝕍 inertial displacement history is larger that causes the -𝕚d inertial time to slow.

Pythagorean Triangles and γ

γ in (36.22) is the same as in this model. As the angle θ changes in each Pythagorean Triangle, also with photons and gravis, there are changes in γ as a straight Pythagorean Triangle side can contract and a spin Pythagorean Triangle side can slow.

$$\gamma = \frac{1}{\sqrt{1 - v^2/c^2}} = \frac{1}{\sqrt{1 - \beta^2}} \tag{36.22}$$

Positive and negative spin

The two columns below have a negative sign on the left, referring to the -𝕚d and e𝕧 Pythagorean Triangle and special relativity. The positive sign on the right refers to the +𝕚d and e𝕙 Pythagorean Triangle and general relativity.

Negative spin and hyperbolic geometry

The minus sign comes from the hyperbolic equation where two squares are subtracted. In this model that means the -𝕠d and e𝕪 Pythagorean Triangle as the electron, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia, are in hyperbolic geometry.

Positive spin from circular geometry

The positive sign comes from the circle equation where two squares are added. That means the +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the +𝕚d and e𝕙 Pythagorean Triangle as gravity, are in circular geometry. This is not referred to as spherical geometry because the +𝕚d and e𝕙 Pythagorean Triangle is in two dimensions only.

Comparing angles θ to c's angle

In this model γ comes from the relative values of two angles θ from a Pythagorean Triangle. For an observer and measurer approximately at rest, a rocket approaching c has a different e𝕧 length contraction and -𝕚d inertial time slowing compared to them. When two rockets are accelerated then this also gives the relative e𝕧 and -𝕚d differences between them, the two rockets would see a different e𝕧 length contraction and -𝕚d time slowing according to their E𝕍 inertial displacement histories and -𝕀D inertial temporal histories.

Subtracting Pythagorean Triangles in special relativity

In special relativity there are two squares subtracted, if this is set to a constant value of γ then it gives a hyperbola as the two velocities are varied. The speed of light can be slowed in a +𝕚d gravitational field, so that allows for a hyperbola if the e𝕧/-𝕚d inertial velocity was changed to give this constant γ. That would be written as $E\mathbb{V}_c/-\mathbb{I}D_c$ - $E\mathbb{V}_v/-\mathbb{I}D_v$ =γ. This need not be a constant, if a rocket was flying through a denser medium as a -𝕚d inertial field then c might be slower there. The special relativity equation can be rewritten as $\sqrt{}(E\mathbb{V}_c/-\mathbb{I}D_c$ - $E\mathbb{V}_v/-\mathbb{I}D_v)$. The hyperbola is not significant, γ gives the e𝕧 length contraction and -𝕚d inertial time slowing between them.

Adding Pythagorean Triangles in general relativity

In general relativity this comes E𝕙/+𝕀D + E𝕙/+𝕀D =γ as the equation for a circle. This becomes $\sqrt{}($ $E\mathbb{H}_c/+\mathbb{I}D_c$ + $E\mathbb{H}_s/+\mathbb{I}D_s)$ as the equivalent formula for a gravitational field, the subscript s refers to speed while with special relativity v refers to velocity. This also need not be a constant, c can be slower around a +𝕚d gravitational field. In this model speed is not in a straight-line as in conventional physics, a satellite can then move with a e𝕙/+𝕚d gravitational speed in a circle. A e𝕧/-𝕚d inertial velocity moves in a straight-line. The equation for a circle is again not significant, γ comes from the different angles θ they have.

Gravitational speed above c

√(Eℍ$_c$/+𝕀D$_c$ + Eℍ$_s$/+𝕀D$_s$) refers to the +𝕚d and e𝕙 Pythagorean Triangle, this also has a constant Pythagorean Triangle area. Because of this c is a value of e𝕙/+𝕚d, c is not referred to as 1 here or the hypotenuse. That means as the angle θ opposite +𝕚d contracts then there can be a gravitational speed above c, in conventional physics that would mean the relativity equation changes.

Rocket dives into an event horizon

For example a rocket diving into an event horizon could travel faster than c as a gravitational speed. If this was not so then the energy used in accelerating the rocket would not be conserved. It could not be observed and measured by e𝕪×-𝕘d photons, instead the rocket would disappear earlier than it would from free falling into the event horizon.

Comparing the gravitational speed to c

The positive sign here is adding the squares in the circle equation, but the relativity equation works the same. This would be the same +𝕚d and e𝕙 Pythagorean Triangle with two angles θ, one corresponding to c and the other the e𝕙/+𝕚d gravitational speed corresponding to for example the surface of a planet. This can be adjusted to match an actual e𝕙 height, but different planets have different numbers of +𝕚d and e𝕙 Pythagorean Triangles at different e𝕓 depths inside them.

γ at different heights

The ratio of the Eℍ$_c$ and Eℍ$_v$ values gives γ, that would with the Eℍ/+𝕚d gravitational impulse refer to the +𝕚d gravitational time being slowed at the surface as γ. Inverse to this is the 1/+𝕀D$_c$ and 1/+𝕀D$_s$ values, however because they are both created from the Eℍ gravitational displacement history and the +𝕀D gravitational temporal history they are both reduced. This is instead of the inverse relationship from a constant Pythagorean Triangle area, then with a e𝕙 height contraction the +𝕚d gravitational time would speed up not slow down.

$$\begin{aligned} x' &= \gamma(x - vt) & x &= \gamma(x' + vt') \\ y' &= y & y &= y' \\ z' &= z & z &= z' \\ t' &= \gamma(t - vx/c^2) & t &= \gamma(t' + vx'/c^2) \end{aligned} \qquad (36.23)$$

Path integrals and work

In this model a e𝕧 length can also refer to the path integral. The -𝕀D×e𝕧 inertial work is the -𝕀D inertial probability as an integral with respect to a position e𝕧. With different e𝕧 positions this gives a path corresponding to the integral inertial probabilities there. A rocket would have a e𝕧 length contraction because it is on this path, as it moves along the path then it retains its e𝕧 length contraction.

Muon decay

A muon or other short lived iotas has a slower -𝕚d inertial time to decay, this is because its -𝕚d inertial clock gauge is observed to be slower. This gives a -𝕚d inertial timeline, along it the inertial time is slowed. This is like the e𝕧 path which is also contracted where it corresponds to the changing e𝕧 positions of a rocket or an iota.

A contracted path

Because the e𝕧 path is contracted, the iota would probably decay after moving a shorter e𝕧 distance. This can be regarded as a ruler along this path, before decaying it might move a meter when its e𝕧/-𝕚d inertial velocity is slow. When it approaches c this ruler is contracted, so that meter might appear as 10 meters on it. That allows for the iota to travel further than it normally would, normal here refers to the -𝕀D inertial probability of it decaying. This is where the iota is like a wave not a particle with work being measured.

A slower time before decaying

When observed as a particle, the iota has an E𝕍/-𝕚d inertial impulse, with a larger E𝕍 inertial displacement history the -𝕚d inertial time is slowed. That allows the iota to continue for a longer inertial time before decaying, this would be a deterministic result while measuring work would be probabilistic.

Unpredictable and probable

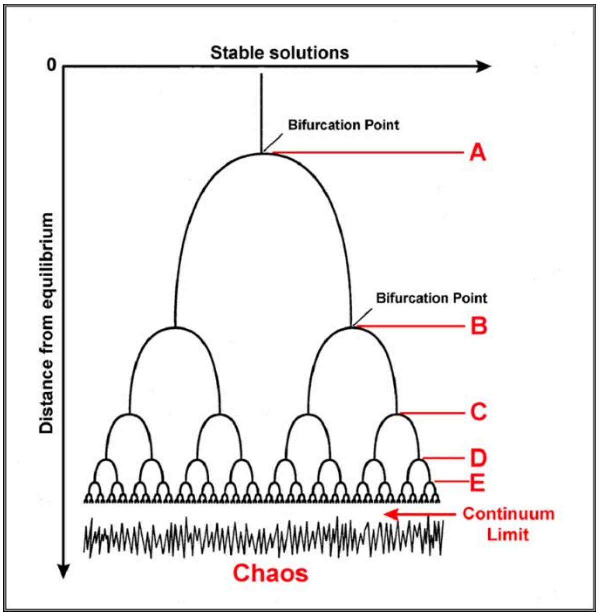
Being deterministic does not mean it is always predictable, it can also move chaotically or unpredictably. With the -𝕀D×e𝕧 inertial work being probabilistic the two together give an uncertainty, that comes from the uncertainty principle and the constant Pythagorean Triangle area. When one Pythagorean Triangle side is smaller, such as with the e𝕧 length contracted or the -𝕚d inertial time slowed, then the other is much larger as a force.

Chaos and impulse

With the E𝕍/-𝕚d inertial impulse there can then be a strong chaotic force E𝕍, with -𝕀D×e𝕧 inertial work there can be a strong -𝕀D inertial torque or probability making the observation and measurement more uncertain.

Two Fiegenbaum numbers

In this model there are two kinds of chaos with Fiegenbaum numbers, δ is associated with the universal parabolic constant as cascades. β is associated with 2π and randomness. δ then approaches parabolas, these can be associated with an E𝕍/-𝕚d inertial impulse of a projectile or -𝕀D×e𝕧 inertial work as the integral area under the parabola. δ can approach either of these to be observed or measured.



Tines and quantized orbitals

β is the width of tines formed by parabolas, these regular spacings are associated with the line or latis rectum of the near parabola. It then approaches a radius, a circle of a circumference √1 would have a radius of √(2π). They can be regarded as quantized intervals of e𝕒 from the proton, that associates them with α. From these different radii multiples there can be different sizes of parabolas where an electron might move up from an orbital and down again.

Irregular spacings between orbitals

When there is chaotic motion that would be irregular quantized spacings, this can be where an electron has a different -𝕆D kinetic probability outside these regular quantized values. That would also give parabolic paths that are in between the circular geometry of the +𝕠d and e𝕒 Pythagorean Triangle proton and the -𝕠d and e𝕪 Pythagorean Triangle electron. These need not be observable as particles because they are derivative slopes, they don't have a squared straight Pythagorean Triangle side like E𝕐.

Transition from chaos to randomness

Because this is approaching 1/(2π) as -𝕆D×e𝕪 kinetic work, it gives a transition from chaotic motion of electrons in an atom to their quantized values. These do exist because the -𝕆D×e𝕪 kinetic work has some values which deviate from the quantized values in an electron cloud. Because this is motion in between the circular and elliptical orbitals, balanced by the hyperbolic tendency of electrons, it can only come from parabolic geometry and the δ constant. When there is a prefect parabola that is where an electron can move to a higher circular orbital, then fall again.

Deriving conic sections from chaos

The values of α then give the quantized orbital values, the β values approach regular spacings between those orbitals. The δ values approach a regular parabolic transition between orbitals. As β becomes regular this gives π in circular geometry, along with α this gives e in hyperbolic geometry. As δ becomes regular it also gives the third conic section of the parabola with a universal constant called κ here to differentiate it from β.

No simultaneous observations

In this model there can be no simultaneous observations, this is not a measurement because a particle has an E𝕍/-𝕚d inertial impulse on a clock gauge. Simultaneous refers to two -𝕚d inertial times the same which is not allowed, there would be no -𝕚d value between these observations and so no Pythagorean Triangle could exist. Also there cannot be two measurements in the same position, then e𝕧 would be zero and the Pythagorean Triangle could not have a constant area. This also follows from no simultaneity, in zero time there could be no motion to a different position.

Appearance of a contracted Pythagorean Triangle area

There can be the appearance of a contracted Pythagorean Triangle area, for example e𝕪×-𝕘d photons near an event horizon. This is because the e𝕐/-𝕘d light impulse has a large E𝕐 light displacement history and so the -𝕘d rotational frequency of the e𝕪/-𝕘d photons would be redshifted. With the -𝔾D×e𝕪 light work there would also be a large -𝔾D light probability, this would contract e𝕪 proportionally to e𝕧 as a wavelength.

Climbing out of a gravitational well

But the two cannot happen together, an individual photon can be measured with a redshift in climbing out of a gravitational well. It also has a contracted e𝕧 path so that the photon is overall moving more slowly. The e𝕧 length between photons would also be longer compared to where the light was being emitted. This is because the photons deeper in the well are moving with a slower -𝕘d light time, also they are moving on a more contracted e𝕧 path.

Gravitational wells and history

When they rise higher in the gravitational well the photons speed up as c increases towards its vacuum inertial velocity relatively free of gravitational forces. This is the same effect seen by Helen in moving away from George in her rocket ship, as she accelerates the -𝕘d light time and e𝕪 light distance in between the photons increases. This is because her E𝕐 light displacement history and -𝔾D light temporal history are both increasing, that causes -𝕘d to slow and e𝕪 to contract.

Length

We've already introduced the idea of length contraction, but we didn't precisely define just what we mean by the *length* of a moving object. The length of an object at rest is clear because we can take all the time we need to measure it with meter sticks, surveying tools, or whatever we need. But how can we give clear meaning to the length of a moving object?

A reasonable definition of an object's length is the distance $L = \Delta x = x_R - x_L$ between the right and left ends when the positions x_R and x_L are measured *at the same time t*. In other words, length is the distance spanned by the object at *one instant* of time. Measuring an object's length requires *simultaneous* measurements of two positions (i.e., two events are required); hence the result won't be known until the information from two spatially separated measurements can be brought together.

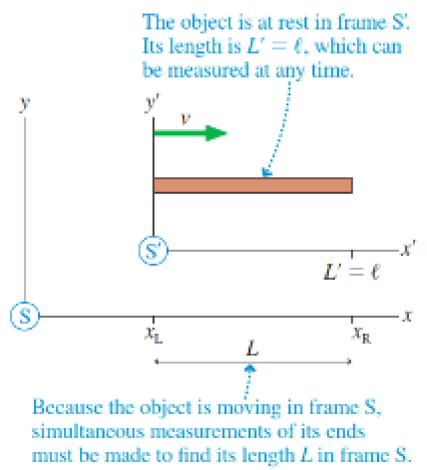
Length as positions

In this model e𝕧 length is a series of positions, the distance between two points is the displacement as a force. That is because it implies starting at one point and ending at another as a motion. A rule can have e𝕧 positions that have an even e value between them, this need not come from measuring the work to go from one position to another. A e𝕧 length would be an infinitesimal, that implies in between any two there would be an infinite number of e𝕧 positions. That is similar to Zeno's paradox of how many points there are on a line. Here then the line would be a displacement in between two points. That needs a clock gauge and impulse to have a displacement force.

A reference frame with one or two Pythagorean Triangles

In the diagram the object is moving relative to two distances, in this model e𝕙 as height could be the vertical axis and e𝕧 as the length in the horizontal axis. The y axis could also be -𝕚d inertial time, then the objects e𝕧/-𝕚d inertial velocity would correspond to the slope of a Pythagorean Triangle. If this e𝕧 length is contracted, then two measurements of -𝕀D×e𝕧 inertial work along this path would give the e𝕧 length contraction.

FIGURE 36.32 The length of an object is the distance between *simultaneous* measurements of the positions of the end points.



Mass and time equivalence

In this model mass and magnetism comes from an integral, it affects other iotas as a field causing them to spin. For example magnets in an electric motor can cause it to turn with a -Of Kinetic torque. Electrons in a planet's magnetic field can move as spirals. A satellite arriving at a planet will have its trajectory bent or spin, sometimes into an orbit. Time comes from a derivative, it acts in relation to a particle and not as a field. There it is used to observe a particle in terms of spin on a clock gauge.

Four kinds of momentum

In this model there are four main kinds of momentum: Kinetic, potential, inertial, and gravitational. The inertial momentum is -𝕚d×e𝕧/-𝕚d where -𝕚d acts as the inertial mass and the inertial time. A rocket for example has an inertial momentum, double the -𝕚d inertial mass and it will take twice as long to accelerate it to a given e𝕧/-𝕚d inertial velocity. This comes from the mass time equivalence, doubling the -𝕚d inertial mass in the numerator is to double an integral area. With the inertial momentum this is -𝕚d×e𝕧. This also doubles the time to bring the rocket to rest with the same force, the denominator also has double the value as 1/-𝕚d with inertial time.

Doubling the inertial mass and inertial time

For example a rocket might weigh 1,000,0000 kilograms and reaches the target inertial velocity in 1,000,000 seconds, if this is doubled to 2,000,000 kilograms then it would reach this inertial velocity in 2,000,000 seconds. With the -𝕚d×e𝕧/-𝕚d inertial momentum if the -𝕚d inertial mass was doubled, this would also double the denominator and the -𝕚d inertial time. That would halve the e𝕧/-𝕚d inertial momentum so that the rocket reaches half the -𝕚d inertial velocity when its -𝕚d inertial mass is doubled. This is with the same force from the rocket motor as an E𝕍/-𝕚d inertial impulse or -𝕀D×e𝕧 inertial work.

Kinetic and inertial momentum

To gain a e𝕧/-𝕚d inertial velocity it has a kinetic momentum -𝕠d×e𝕪/-𝕠d, the -𝕠d term in the numerator acts as the kinetic magnetic field in the rocket fuel. It is also the -𝕠d kinetic time in the denominator. In the previous example the -𝕠d kinetic mass can be doubled, now the rocket's thrust is doubled and it reaches the target e𝕧/-𝕚d in half the -𝕚d inertial time.

Action/reaction pairs

This is because the -𝕚d and e𝕧 Pythagorean Triangle is a reaction to the active -𝕠d and e𝕪 Pythagorean Triangle and its forces, when this -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse increases then the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work reacts less against it and the rocket kinetically accelerates.

Proper kinetic and inertial time

In the rocket the proper -𝕚d inertial time, and -𝕠d kinetic time, is inside it. There is no significant acceleration in between iotas in the rocket, even if overall the rocket is accelerating. For example people might feel the kinetic acceleration from the rocket fuel burning, but they do not accelerate relative to each other. They would feel the kinetic acceleration by reacting against this with an inertial acceleration.

The same history inside the rocket

This represents the E𝕐 kinetic displacement history and -𝕆D kinetic temporal history, but in comparing the atoms in the rocket each has approximately the same history relative to each other. Because of this there is no more distance contraction and time slowing that the people can observe and measure in each other.

Proper time and distance

The -𝕚d inertial time is not significantly slowed in between them so it acts as a proper time. There is also a proper distance in this model, that is where the e𝕧 length and e𝕪 kinetic electric charge is not contracted in between the people there.

In this model the kinetic and inertial momentum are consistent with special relativity. As the angle θ contracts the rocket would increase its e𝕧/-𝕚d inertial velocity. This is like its -𝕚d×e𝕧/-𝕚d inertial momentum increasing, e𝕧 grows larger and -𝕚d smaller as the angle θ opposite -𝕚d contracts. When the rocket approaches c there is a relativistic slowing of the -𝕚d inertial time, there is also a contraction in its -𝕚d inertial mass. This maintains the same proportions in the -𝕚d×e𝕧/-𝕚d inertial momentum.

A contracted kinetic and inertial mass

There is a contraction in the -𝕠d kinetic mass or kinetic magnetic field as well, this is proportional to the electrons in the rocket fuel as if they were in lower orbitals. Because of this they would be measured as needing more -𝕆D×e𝕪 kinetic work to make the rocket fuel ignite. This is because the electrons would need more -𝕆D kinetic torque for the same chemical reactions. The -𝕚d inertial time slows on the rocket, also with the contracted -𝕚d inertial mass it is more difficult to push the rocket faster.

Position and momentum

Taking this model's interpretation of the inertial momentum, this is -𝕚d×e𝕧, the denominator is removed because this is a derivative of the -𝕚d and e𝕧 Pythagorean Triangle. The position and momentum of an iota cannot be observed simultaneously, this is from the uncertainty principle. Because the inertial momentum is -𝕚d×e𝕧/-𝕚d and the position is e𝕧, this is equivalent to the e𝕧 position cannot be observed with the E𝕍/-𝕚d inertial impulse while the -𝕀D×e𝕧 inertial work and e𝕧 are measured.

Canceling out inertial time and inertial mass

Because the -𝕚d inertial mass and -𝕚d inertial time can cancel out, this only leaves a e𝕧 position and so the inertial momentum is uncertain. It cannot go to zero because of the constant area of the Pythagorean Triangles in this model. If the inertial momentum is used for observing an E𝕍/-𝕚d inertial impulse, this uses the denominator as the -𝕚d inertial time on a clock gauge. That is a derivative so it cannot also measure the -𝕚d×e𝕧 integral field. Conversely if this integral is measured it becomes -𝕀D×e𝕧 inertial work, then the position acts like a ruler but the inertial time cannot be observed.

Rewriting momentum

The inertial momentum can be written as e𝕧×-𝕚d/e𝕧, now -𝕚d/e𝕧 is still the inertial velocity in seconds/meter instead of meters/second. In the numerator e𝕧 can represent an inertial mass, for example a metal rod doubles its inertial mass when its e𝕧 length is doubled.

Length as part of an integral field

Now when the e𝕧 position decreases the rod decreases in size, also the inertial momentum slows. The e𝕧 in the numerator is part of the integral field, it is like a ruler where the -𝕀D×e𝕧 inertial work is measured. In the denominator e𝕧 is not part of an integral field, instead it represents a particle that can have an E𝕍 displacement. A particle then has a position defined with a derivative slope such as with -𝕚d/e𝕧 as the inertial velocity. This is where a particle has this inertial velocity. The integral field has a length, but these are like points in the field not points where a particle is observed.

Changing the units of mass

Because a Pythagorean Triangle has a constant area, the inertial or another momentum can be inverted like this. Each Pythagorean Triangle side becomes its inverse, going from -𝕚d×e𝕧/-𝕚d to e𝕧×-𝕚d/e𝕧. In this model -𝕚d×e𝕧/-𝕚d can represent F=ma as -𝕚d×e𝕧/-𝕀D, this is -𝕀D×e𝕧 inertial work where for example the grams in -𝕀D×e𝕧 inertial work might have the units changed into kilograms so -𝕀D becomes a fraction.

Gravitational momentum

Using e𝕧×-𝕚d/e𝕧 as the inverse can represents gravitational momentum, then the inverse of the -𝕚d×e𝕧/-𝕚d inertial momentum is e𝕙×-𝕚d/e𝕙. Now e𝕙 in the numerator can represent the height in the +𝕚d×e𝕙 gravitational field. As this increases, like the radius of a planet's gravitational integral field, the +𝕚d gravitational mass decreases as its inverse. This is seen with Newton's gravitational equation, the denominator as the distance between a planet and its moon is used. This is instead of in F=ma where the denominator uses -𝕚d inertial time as the inverse of the e𝕙 height.

Inertial work and gravitational impulse

In the equation below r^2 is Eℍ, this would be the gravitational displacement from the Eℍ/+𝕚d gravitational impulse. As the denominator increases as a square this gives the inverse square rule. With only the planet there would be a single +𝕚d gravitational mass in the numerator, this can be written as +𝕚d/Eℍ instead of Eℍ/+𝕚d. F=ma would then be measuring e𝕪/-𝕆D kinetic work and e𝕧/-𝕀D inertial work, the gravitational equation would be observing the +𝕚d/Eℍ gravitational impulse and the +𝕠d/E𝔸 potential impulse proportionally with the protons in the planet.

$$F_g = \frac{G m_1 m_2}{r^2}$$

Satellites are slower in higher orbits

The gravitational momentum as e𝕙×+𝕚d/e𝕙 means that when the e𝕙 height is doubled the +𝕚d gravitational field halves. Also a satellite in orbit around the planet would have a faster -𝕚d/e𝕙 or e𝕙/-𝕚d gravitational speed, e𝕙 increases and -𝕚d contracts as in e𝕙/-𝕚d meters/second. That gives the change in the satellite's e𝕧/-𝕚d inertial velocity, this is slower because it decreases inversely to the gravitational speed.

Electrons are slower in higher orbitals

Proportionally it also means that electrons have a slower e𝕪/-𝕠d kinetic velocity in orbits with a higher e𝕒 altitude. The inverse is that they have a faster e𝕒/+𝕠d potential speed. In (36.32) below, this can then represent the kinetic, inertial, gravitational or potential momentum. Each Pythagorean Triangle side can also be inverted as described, then the inverse square law is shown. The +𝕠d×e𝕒/+𝕠d equation can represent the +𝕆D×e𝕒 potential work more easily as a field. The e𝕒×+𝕠d/e𝕒 equation can be used for the E𝔸/+𝕠d potential impulse.

Momentum conservation is such a central and important feature of mechanics that it seems unlikely to fail in relativity.

The classical momentum, for one-dimensional motion, is $p = mu = m(\Delta x/\Delta t)$. Δt is the time to move distance Δx. That seemed clear enough within a Newtonian framework, but now we've learned that experimenters in different reference frames disagree about the amount of time needed. So whose Δt should we use?

One possibility is to use the time measured *by the particle*. This is the proper time $\Delta\tau$ because the particle is at rest in its own reference frame and needs only one clock. With this in mind, let's redefine the momentum of a particle of mass m moving with velocity $u = \Delta x/\Delta t$ to be

$$p = m\frac{\Delta x}{\Delta \tau} \tag{36.32}$$

We can relate this new expression for p to the familiar Newtonian expression by using the time-dilation result $\Delta\tau = (1 - u^2/c^2)^{1/2}\Delta t$ to relate the proper time interval measured by the particle to the more practical time interval Δt measured by experimenters in frame S. With this substitution, Equation 36.32 becomes

$$p = m\frac{\Delta x}{\Delta \tau} = m\frac{\Delta x}{\sqrt{1 - u^2/c^2}\,\Delta t} = \frac{mu}{\sqrt{1 - u^2/c^2}} \tag{36.33}$$

Increasing inertial and kinetic velocity

The -ⅈd and e𝕧 Pythagorean Triangle in this model has a constant area, when the e𝕧/-ⅈd inertial velocity increases then e𝕧 grows and -ⅈd contracts. That means more kilometers are traveled in a given time of seconds. Here for example if the kilometers as e𝕧 double the -ⅈd inertial time as seconds halves giving 4 times more. That keeps the Pythagorean Triangle area constant, any angle θ can be converted into any inertial velocity as e𝕧/-ⅈd. This inertial velocity is determined by the slope of the -ⅈd and e𝕧 Pythagorean Triangle, this is whether the area is constant or not.

Comparing two angles θ

Here the value of γ comes from two squared Pythagorean Triangle sides, such as $E\mathbb{V}_c$ and $E\mathbb{V}_r$ where the subscript c comes from the inertial velocity of light. This is then comparing two angles θ from an E𝕍/-ⅈd inertial impulse, the two E𝕍 values are subtracted and the result is taken as a square root. It then compares two inertial velocities as squares, one here is c though it might also apply to rockets approaching each other at relativistic inertial velocities.

$$\gamma_p = \frac{1}{\sqrt{1 - u^2/c^2}} \tag{36.34}$$

where the subscript p indicates that this is γ for a particle, not for a reference frame. In frame S', where the particle moves with velocity u', the corresponding expression would be called γ'_p. With this definition of γ_p, the momentum of a particle is

$$p = \gamma_p mu \tag{36.35}$$

Faster than c

In this model an iota, such as Helen's rocket, can exceed the inertial velocity c. This is because it has a reaction drive, the gases expelled from the rocket cause it to move forward. From its own inertial reference frame it might be close to c, then the rocket's thrust would continue to push them without their own -ⅈd inertial proper time being frozen.

Forces cause a distance contraction and slower time

Looking back from the rocket to George's planet they would see other clocks speeding up, also e𝕧 lengths being dilated. This is because the rocket's inertial time is slowed and its e𝕧 length is contracted. With this model only acceleration causes a relativistic change, the rocket has a E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work which causes it to be observed with its -𝕚d inertial time slowed and its e𝕧 length contracted.

Faster time and distance dilation

This is the same as with Helen in the rocket, she arrives back on the planet younger than George who got left behind. Here she can also observe George seeming to move faster and age more quickly than her. She then sees a faster -𝕚d inertial time for George, also the planet appears to have a e𝕧 length dilation from her inertial reference frame.

Observing photons past c

When the rocket reaches c then the e𝕪×-𝕘d photons from George's planet would be unable to catch up to it. Helen should then see only a dark area behind the rocket, she should however be able to observe and measure photons coming into the rocket from the sides. George should see the rocket's inertial clock slow and its e𝕧 length contract, when the rocket's photons have -𝕘d lower than the ground state they could not be absorbed as -𝔾D×e𝕪 light work. They may still be observable as they bounce off electrons, such as with the Compton effect.

Conserving inertial time slowing

If Helen's rocket decelerates to under c again, it should become visible to George again with -𝔾D×e𝕪 light work. The inertial velocity above c would still be proportional to the slowed -𝕚d inertial time and e𝕧 length contraction, for example Helen should be even younger when she returns than if her inertial velocity remained below c. In this model the -𝕚d and e𝕧 Pythagorean Triangle does not flip over so that e𝕧 length becomes imaginary as -𝕚d inertial time.

Infinite distance and velocity is not possible

Instead, the angle θ would continue to contract, there should be a limit so an infinite inertial velocity is not possible. This is like the limit of the universe from a stationary reference frame, the angle θ in the +𝕚d and e𝕙 Pythagorean Triangle reaches a minimum. That preserves the constant Pythagorean Triangle area. That is the same for any position so in this model the universe would be unending.

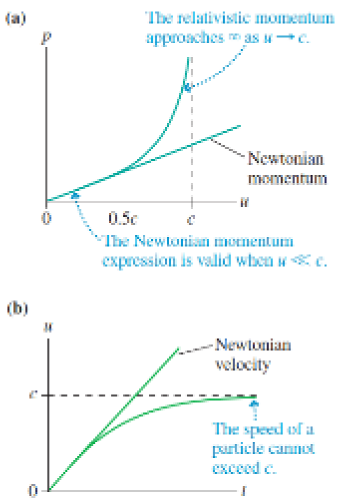
Slower time and shorter length in approaching a planet

Looking forward Helen might also see a second planet, say with another person Irene on it, speed up as Irene would also observe Helen's -𝕚d inertial time slow and her e𝕧 length contract. This is because with -𝕀D×e𝕧 inertial work there is no -𝕚d inertial time only -𝕀D inertial probability. That gives a contracted e𝕧 length. With the E𝕍/-𝕚d inertial impulse there is no difference between going towards or away from Irene, this is a displacement and so Irene sees Helen's -𝕚d inertial time is slowed. This is the same as Helen returning from her journey and still having a e𝕧 length contraction and -𝕚d inertial time slowed.

Cerenkov radiation

When Helen's inertial velocity went above c she should see more powerful photons coming from the front, they could collide with a e𝕐/-𝕘d light impulse while slowing down in the rocket's -𝕚d inertial field. There may be a Cerenkov related radiation.

FIGURE 36.34 The speed of a particle cannot reach the speed of light.



Cause and effect in time

In this model the e𝕐/-𝕘d light impulse can have a causal effect, this is because it is observed on a light clock gauge. That gives instants of time on it, there can then be a cause at one instant and an effect at another instant. This comes from the particle nature of impulse, also called determinism. For example free electrons act as particles with a E𝕐/-𝕠d kinetic impulse, they can collide with and bounce off e𝕪/-𝕘d photons with a e𝕐/-𝕘d light impulse.

Determinism

This deterministic process of cause and effect is observed on the kinetic clock gauge for the electron as -𝕠d instants, also proportionally on the inertial clock gauge as -𝕚d moments or fluxions. They do not observe a duration of time, they observe the displacement of a straight Pythagorean Triangle side squared. This can be E𝕍 as an inertial displacement force, it can also be E𝕐 as a kinetic displacement force. With e𝕪/-𝕘d photons it can be E𝕐 as a light displacement, in this model it is the same as E𝕐 with electrons. This means they can bounce off each other.

Cause and effect faster than c

The inertial velocity e𝕧/-𝕚d of light then gives a cause and effect relationship, but in this model a particle moving faster than c can also collide with e𝕪/-𝕘d photons. These are not like tachyons, here their inertial velocity comes from a smaller angle θ than that of c. Taking c as a standard inertial velocity then implies nothing can go faster than it, except for entanglement in some way. That also happens with Cerenkov radiation where c is slower in a medium. In this model there are higher inertial velocities than c with smaller angles θ.

Time travel and determinism

From that follows the concept of time travel, with a e𝕐/-𝕘d light impulse colliding with electrons then there were past collisions and will be future collisions. If the model only had impulse, then this clock might be rewound to a past moment on the light clock gauge. Here the E𝔸/+𝕠d potential impulse and Eℍ/+𝕚d gravitational impulse travel backwards in time, this conserves the changes of the Pythagorean Triangles in relation to each other.

No simultaneity in determinism

It also means that deterministically the e𝕐/-𝕘d light impulse would occur at different light moments on a light clock gauge, from that there is a principle of relativity. In this model they could not be simultaneous and be observed, this would imply a e𝕪 and -𝕘d Pythagorean Triangle that had a zero time difference of -𝕘d. Then it could not have a constant Pythagorean Triangle area.

The clock gauge turns between observations

When there is a collision a clock gauge turns in observing it, forward in time with the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle, backward in time with the +𝕠d and e𝕒 Pythagorean Triangle and +𝕚d and e𝕙 Pythagorean Triangle. There is no simultaneity because the clock gauge would always turn in between one observation and another.

Probability has no time direction

With -𝔾D×e𝕪 light work there is no deterministic series of light moments on a light clock gauge. Instead, there is -𝔾D as a light probability. This means there is no actual moment or instant of light time, only a duration between moments. Because this duration can occur at any time it does not define when the -𝔾D×e𝕪 light work occurred. +𝕀D as a gravitational backwards duration is one way in that it increases as the e𝕙 height decreases. -𝕀D is a forwards inertial durations as it decreases when the e𝕧 length increases.

Forwards and downwards

Instead of forward and backward in time, with work there is e𝕧 length and e𝕙 height. With -𝕀D×e𝕧 inertial work there is a single direction of e𝕧 length, with +𝕀D×e𝕙 gravitational work there is a single direction of downwards. Gravity only works in one direction, of reducing e𝕙 height, inertia in a single direction of increasing e𝕧 length.

Increasing gravity and decreasing inertia

As a e𝕙 height reduces then +𝕀D as the gravitational probability increases as a square. This gives an increasing gravitational acceleration to falling iotas, with an increasing e𝕧 length then the -𝕀D inertial probability decreases as a square. The -𝕀D×e𝕧 inertial work is reactive only, so as it reacts against -𝕆D×e𝕪 kinetic work for example then this -Id inertial probability becomes weaker.

Hyperbolic trajectory

This gives the hyperbolic trajectory, the -𝕀D inertial probability decreases with a greater e𝕧 length and an asteroid for example slows. When e𝕧 remains constant then this -𝕀D inertial probability causes matter to continue in a straight-line as in Newton's first law of motion.

The circle and hyperbola as inverses

The tendency of a satellite is then to move away from gravity, as the e𝕧 length increases then the -𝕀D inertial probability driving it decreases. With an electron it also tends to increase its e𝕪 kinetic electric charge as its -𝕆D kinetic probability decreases above the ionization boundary. The -𝕚d and e𝕧 Pythagorean Triangle as inertia is the inverse of the +𝕚d and e𝕙 Pythagorean Triangle as gravity. This creates the circular and hyperbolic geometry as two conic sections.

Roy electromagnetism as inverses

With Roy electromagnetism there is also hyperbolic geometry with the electron as the -𝕠d and e𝕪 Pythagorean Triangle. The proton as the +𝕠d and e𝕒 Pythagorean Triangle does +𝕆D×e𝕒 potential work, as e𝕒 decreases then the +𝕆D potential torque or probability increasingly reacts against other forces. This can be +𝕀D×e𝕙 gravitational work and -𝕆D×e𝕪 kinetic work. The e𝕪 kinetic electric charge is proportional to increasing e𝕧 length, the e𝕒 altitude is proportional to decreasing e𝕙 height.

Two directions in Biv spacetime

The two directions combine in Biv space-time, e𝕙 height decreases but the increasing e𝕧 length can work against this as an inverse. A higher orbit has a smaller e𝕧 length in its e𝕧/-𝕚d inertial velocity, if this is drawn down to a lower orbit then this e𝕧 value increases as the -𝕀D inertial torque decreases. That happens as the e𝕙 height decreases and the +𝕀D gravitational probability increases.

Two directions do not conflict

These two directions do not conflict with each other, matter can move downwards but this cannot be confused with forwards. That is because e𝕙 height is in circular geometry and e𝕧 length is in hyperbolic geometry. With the appearance of a big bang matter moved outwards or forwards as sideways motion overcome the downward direction towards the center.

Subtracting spin and vectors

This is like how -𝕚d as forwards in inertial time does not conflict with +𝕚d as backwards in gravitational time. They are subtracted, with the e𝕧 length and e𝕙 height they use vector subtraction where one increases as the other decreases.

Causal influence and simultaneity

Instead of a firecracker observed before or after a balloon burst is observed with a e𝕐/-𝕘d light impulse, with -𝔾D×e𝕪 light work one can be closer than the other. With a constant inertial velocity of light this is approximately equivalent, the difference is e𝕪/-𝕘d photons move with an inertial velocity of c and -𝕘d×e𝕪 photons move with an inertial velocity of c proportional to -𝕚d×e𝕧.

Closer in time or length

This gives the same answer because the e𝕧 lengths define where the events happen. They do not change from using -𝕘d to observe when they happen. These cannot be observed simultaneously or measured at the same position because of the uncertainty principle. The two remain conserved in relation to each other because of the constant area of the e𝕪 and -𝕘d Pythagorean Triangle. e𝕐/-𝕘d light impulse measurements could be converted approximately into -𝔾D×e𝕪 light work measurements.

The speed c is a "cosmic speed limit" for material particles. A force cannot accelerate a particle to a speed higher than c because the particle's momentum becomes infinitely large as the speed approaches c. The amount of effort required for each additional increment of velocity becomes larger and larger until no amount of effort can raise the velocity any higher.

Actually, at a more fundamental level, c is a speed limit for *any* kind of **causal influence.** If I throw a rock and break a window, my throw is the *cause* of the breaking window and the rock is the *causal influence*. If I shoot a laser beam at a light detector that is wired to a firecracker, the light wave is the *causal influence* that leads to the explosion. A causal influence can be any kind of particle, wave, or information that travels from A to B and allows A to be the cause of B.

For two unrelated events—a firecracker explodes in Tokyo and a balloon bursts in Paris—the relativity of simultaneity tells us that they may be simultaneous in one reference frame but not in others. Or in one reference frame the firecracker may explode before the balloon bursts but in some other reference frame the balloon may burst first. These possibilities violate our commonsense view of time, but they're not in conflict with the principle of relativity.

Causal influence and light impulse

This refers to a causal influence, that would be deterministic with the e𝕐/-𝕘d light impulse. In Biv space-time the e𝕧/-𝕚d inertial velocity is constant in free space, if e𝕪/-𝕘d photons collide with electrons then energy is conserved by the angle θ of the e𝕪 and -𝕘d Pythagorean Triangle changing. For example, if an electron is moving at a high inertial velocity, a photon might collide and reduce its inertial velocity. That changes the e𝕪/-𝕘d light ratio of the photon and its angle θ, -𝕘d as the rotational frequency would increase and the e𝕪 kinetic electric charge would decrease.

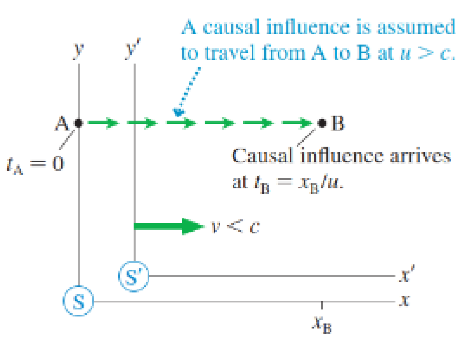
The rolling wheel as the photon

In this model this uses the rolling wheel model, the wheel would rotate faster yet maintain the same inertial velocity on a surface. This happens by the e𝕪 radius of the wheel contracting inversely to the -𝕘d rotational frequency increasing.

Conserving the changes in the collisions

The cause and effect collisions are then mediated by this change in the wheel's rotation frequency and radius, that conserves the changes in the electron's e𝕪/-𝕠d kinetic velocity and e𝕧/-𝕚d inertial velocity. If some photons had a different inertial velocity, such as 2c, then they would not conserve the changes in the collisions.

FIGURE 36.35 Assume that a causal influence can travel from A to B at a speed $u > c$.



Using c=1

In the Lorentz transformation at (36.36) this assumes that c acts as 1 in the equation. Because of this when the e𝕧/-𝕚d inertial velocity of a rocket becomes greater than 1 it can no longer be subtracted, it can only be added. That would cause time to go into reverse.

Comparing two inertial velocities

In this model c is not 1, it is an inertial velocity corresponding to an angle θ in the -𝕚d and e𝕧 Pythagorean Triangle. The negative sign does not refer to two different sides of a Pythagorean Triangle as in the relativity equation below. It refers to two different -𝕚d and e𝕧 Pythagorean Triangles with different angles θ. When their -𝕚d inertial time is compared with the E𝕍/-𝕚d inertial impulse, this comes from the two -𝕚d and e𝕧 Pythagorean Triangles superimposed on each other.

No change in sign

They have the same Pythagorean Triangle areas, with an inertial velocity faster than c the rockets e𝕧 Pythagorean Triangle side would be larger than that of e𝕧/-𝕚d as c. Conversely the rocket's -𝕚d Pythagorean Triangle side would be smaller for the rocket than for c. The two can still be compared to give a value for γ, that gives the e𝕧 length contraction and -𝕚d inertial time slowing for the rocket.

Conserving causality and energy

This uses the same -𝕚d and e𝕧 Pythagorean Triangle as with matter and photons, the difference is these are two angles θ. When this is used there is no longer a causal contradiction, matter could move faster than c with the e𝕧 length contraction and -𝕚d inertial time slowing remaining consistent and energy being conserved.

> Suppose there exists some kind of causal influence that *can* travel at speed $u > c$. **FIGURE 36.35** shows a reference frame S in which event A occurs at position $x_A = 0$. The faster-than-light causal influence—perhaps some yet-to-be-discovered "z ray"—leaves A at $t_A = 0$ and travels to the point at which it will cause event B. It arrives at x_B at time $t_B = x_B/u$.
>
> How do events A and B appear in a reference frame S′ that travels at an ordinary speed $v < c$ relative to frame S? We can use the Lorentz transformations to find out.

Different inertial velocities and causality

The photons mediate the changes in inertial velocity greater than c, these would be like the sound behind a jet at faster than the inertial velocity of sound. As an example, the news used to be carried by trains that had an approximately constant inertial velocity. If a message was sent by carrier pigeon it could arrive at a stock exchange with news before the train arrived with it.

Erasing the past

After the train left a speculator could change the news, for example repair a factory that news had been sent of it breaking down causing an economic loss. Then this news of a repair would be sent by carrier pigeon. It would appear as if someone went back in time to repair the factory, the original event of the breakdown would be erased.

Front running

Another example is with current stock exchanges, some can front run orders using optic fibers that go in a straight-line between the exchanges. When a first person makes an order this is transmitted by optic fiber to the next exchange, a second person then buys shares to sell at a profit when the order arrives at a slower inertial velocity. It appears as if the second person went back in time, caused the first person to make the order or watched them, and then went forward in time to buy the shares to sell to them. The effect is like reading tomorrow's newspaper with its stock prices.

Because $x_A = 0$ and $t_A = 0$, it's easy to see that $x'_A = 0$ and $t'_A = 0$. That is, the origins of S and S′ overlap at the instant the causal influence leaves event A. More interesting is the time at which this influence reaches B in frame S′. The Lorentz time transformation for event B is

$$t'_B = \gamma\left(t_B - \frac{vx_B}{c^2}\right) = \gamma t_B\left(1 - \frac{v(x_B/t_B)}{c^2}\right) = \gamma t_B\left(1 - \frac{vu}{c^2}\right) \qquad (36.36)$$

where we first factored out t_B, then made use of the fact that $u = x_B/t_B$ in frame S.

We're assuming that $u > c$, so there exist ordinary reference frames, with $v < c$, for which $vu/c^2 > 1$. In that case, the term $(1 - vu/c^2)$ is negative and $t'_B < 0$. But if $t'_B < 0$, then event B happens *before* event A in reference frame S′. In other words, if a causal influence can travel faster than c, then there exist reference frames in which the effect happens before the cause. We know this can't happen, so our assumption $u > c$ must be wrong. **No causal influence of any kind—particle, wave, or yet-to-be-discovered z rays—can travel faster than c.**

Relativistic energy

Kinetic energy

In this model there is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy which is equivalent to the kinetic energy in conventional physics. This is not allowed here because there are two sides of the -𝕠d and e𝕪 Pythagorean Triangle which are squared, also in the same equation. Because of the uncertainty principle an iota cannot be observed and measured simultaneously, also not in the same position.

Kinetic energy and kinetic impulse

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy here is an approximation, there can be a E𝕐/-𝕠d kinetic impulse where the E𝕐 kinetic electric force is being observed. Then the -𝕆D in the denominator becomes -𝕠d, that acts as a kinetic clock gauge to observe the time of the particle with.

Uncertainty in kinetic energy

The -𝕆D×e𝕪 kinetic work is the other half of this equation, there the -𝕆D kinetic probability is being measured. In Newtonian mechanics it is assumed there can be simultaneous observations of particles, it is also an assumption in special relativity. When these are put together in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, that means it is necessary to introduce this uncertainty in another way.

The uncertainty as h

In conventional physics that is done by using h, the minimum size in the Heisenberg uncertainty principle. That is also the area of the e𝕪 and -𝕘d Pythagorean Triangle as the photon. This is sometimes written as Δ=h/2π, but the 2π refers to a probability related to the circumference of a circle and the radius. That is because h is often used with angular momentum.

1/(2π)as β^2

In this model ½π is β^2 as the second Fiegenbaum number. It is the width between tines, the linear orbitals would be related to these tines here as a limit. It is squared because there is an observation of the E𝕐/-𝕠d kinetic impulse, these tines become n^2 as a squared -𝕆D probability or E𝕐 squared kinetic displacement.

Joule seconds and impulse

In this model h refers to the area of the e𝕪 and -𝕘d Pythagorean Triangle which is a constant. It is observed when an electron moves from one orbital to another, that is originally a change in its -𝕆D×e𝕪 kinetic work. But h is observing an electron as a particle, its dimensional analysis is joule seconds. This is the same as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy except that the ½ factor is removed, also the -𝕆D denominator becomes -𝕠d. This is because the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is in joules, multiplying it by kinetic time in seconds as -𝕠d changes the denominator as shown.

Magnetism and mass

By using the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy this can be converted into other approximations, according to this model. Here the kinetic momentum is -𝕠d×e𝕪/-𝕠d, that is equivalent to p=mu where m is the -𝕠d kinetic mass or the kinetic magnetic field. This is referred to as proportional to the -𝕚d inertial mass, that follows from the conversion of mass into energy. Also in this model a magnetic field acts in a similar way to mass, it can attract other iotas and its can resist being moved like inertia.

Rewriting kinetic energy

Another way of writing the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is $K=p^2/2m$ where in the kinetic momentum -𝕠d×e𝕪/-𝕠d this is squared so each Pythagorean Triangle side because a squared force. Then this is divided by 2 to give the ½ factor, and then divided by m or -𝕠d to turn -𝕆D back into -𝕠d as the kinetic mass.

Space-time interval

The space-time interval s^2 here equals c^2 initially, that is E𝕍/-𝕀D with its associated angle θ in the -𝕚d and e𝕧 Pythagorean Triangle. Then this is multiplied by -𝕀D to give a value E𝕍, still associated with c^2. From this is subtracted $(\Delta x)^2$ which is E𝕍, so s^2 is E$𝕍_c$-E$𝕍_v$. When the -𝕚d and e𝕧 Pythagorean Triangle is used c is associated with a given angle θ, so e𝕧 can be squared as E𝕍 when a particle is observed with the E𝕍/-𝕚d inertial impulse.

Comparing inertial velocity to c

Because this is comparing two E𝕍/-𝕚d inertial impulse observations, one of c from the inertial velocity of a e𝕪/-𝕘d photon, and the other a particle moving more slowly, then this gives an invariant value between them. A e𝕧 length contraction of a path can be compared to this invariant e𝕧 value in c. The γ value of the length contraction is also proportional to this inertial velocity. This is true also when c corresponds to a fixed angle θ in the -𝕚d and e𝕧 Pythagorean Triangle.

Displacement over an invariant length

In this model the E𝕍/-𝕚d inertial impulse does not have E𝕍 contracted, instead it is observed with a slowness of the -𝕚d inertial time on an inertial clock gauge. With particles then there must be an invariant value of s^2 here. This is an interval only, or a displacement. That means an E𝕍 force is needed to move from one e𝕧 position to another.

Duration and an invariant time

Conversely when the -𝕀D×e𝕧 inertial work is measured there must be an invariant of -𝕀D as inertial time squared or the inertial probability. For example, there can be a rocket approaching c, its e𝕧 length can be contracted as can the distance between positions along its path. This related to an inertial path integral because -𝕀D is an integral area. The duration between the rocket's -𝕀D inertial probability and the inertial time from c^2 is also invariant, a slowing of -𝕚d inertial time comes from 1/γ in the relativity equation.

Invariance from a constant Pythagorean Triangle area

Because E𝕍 and -𝕀D are both invariant, then so is -𝕀D×E𝕍, and -𝕚d×e𝕧. That is the same in this model as the area of the -𝕚d and e𝕧 Pythagorean Triangle being constant. The area of the e𝕪 and -𝕘d Pythagorean Triangle as the photon is also constant, that means a distance e𝕪 is proportional to a number of e𝕧 wavelengths between events. Also the -𝕘d rotational frequency observes the number of cycles, or turns on a light clock gauge, in between events.

Circumference from the spoke

With the rolling wheel model there is a constant inertial velocity e𝕧/-𝕚d of c. Here that corresponds to a rotational frequency of -𝕚d like a turning clock gauge. The e𝕧 length is like a spoke of the wheel, as a radius this corresponds to the circumference in a revolution by multiplying it by 2π. This is also $1/\beta^2$ as a limit of the tine widths.

Different angles θ

When the rolling wheel photon has a different -𝕘d rotational frequency to -𝕚d then the photon is different in Roy electromagnetism to Biv space-time. This maintains the same c inertial velocity, if the -𝕘d rotational frequency spins faster for example the e𝕪 spoke contracts inversely maintaining the same e𝕪/-𝕘d photon velocity.

Electron rolling wheels

In this model electrons are also rolling wheels, they move slower than c and collisions with photon rolling wheels change their inertial velocity. When the electrons are observed they would have a shorter e𝕪 spoke and proportionally a shorter e𝕧 length. That is related to their deBroglie wavelength, these maintain the same ratio of the -𝕠d and e𝕪 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle unlike the photon.

Torque in entering an atom

This e𝕪 and e𝕧 contraction is measured according to γ in the relativity equation according to the invariant motion of the photon rolling wheel. With this measurement the -𝕆D kinetic torque of the electron axle is measured as a force, this torque allows the electrons to enter an orbital where the torque becomes its orbital spin.

Electron as a spring

When the electron is observed the e𝕪 spoke is observed like a spring, there is no longer a rotation of the electron. Instead it can strike a target like a spring causing an E𝕍 displacement which is observed as an impulse. The -𝕠d Pythagorean Triangle side of the electron now acts like a clock gauge with no torque. Because this clock is not itself being measured there is no rotary component like a wave or a probability. This is proportional to 1/γ in the relativity equation, its e𝕧 length contraction and -𝕚d inertial time slowing is compared to the invariant c rolling wheel.

Increasing the kinetic torque of an electron

This photon rolling wheel is measured with -𝔾D×e𝕪 light work, then the -𝔾D light torque can impart this spin force to an electron when it is absorbed into an atom. That causes the electron to move to a higher orbital, it is like a satellite around a planet getting more -𝕀D inertial torque which raises its orbit. As a rolling wheel this is measuring the -𝔾D light torque of the photon axle.

Impulse has no torque

When the e𝕐/-𝕘d light impulse is observed there is no torque as with the electron. Instead the e𝕪 kinetic electric charge can be observed as an E𝕐 displacement like a spring which exerts a force onto a target. The -𝕘d rotational frequency is no longer a torque, it acts like a light clock gauge keeping the time of the photon.

Invariant but not constant

The invariance of c can then be where the e𝕪 spoke has varying sizes, the distance between a star and a planet then can be a value e. When divided by 2π this gives the number of circumferences e/2π in between the star and the planet. Inversely to this the -𝕘d rotational frequency can also change, the time between the star and the planet then depends on how fast this light clock gauge is turning. A higher -𝕘d rotational frequency will mean there are more rotations between them, inversely to the shorter e𝕪 spokes. Each remains invariant unless the photon changes, such as from being near a +𝕚d gravitational field.

In Newtonian mechanics, a particle's kinetic energy $K = \frac{1}{2}mu^2$ can be written in terms of its momentum $p = mu$ as $K = p^2/2m$. This suggests that a relativistic expression for energy will likely involve both the square of p and the particle's mass. We also hope that energy will be conserved in relativity, so a reasonable starting point is with the one quantity we've found that is the same in all inertial reference frames: the spacetime interval s.

Let a particle of mass m move through distance Δx during a time interval Δt, as measured in reference frame S. The spacetime interval is

$$s^2 = c^2(\Delta t)^2 - (\Delta x)^2 = \text{invariant}$$

We can turn this into an expression involving momentum if we multiply by $(m/\Delta\tau)^2$, where $\Delta\tau$ is the proper time (i.e., the time measured by the particle). Doing so gives

$$(mc)^2\left(\frac{\Delta t}{\Delta\tau}\right)^2 - \left(\frac{m\,\Delta x}{\Delta\tau}\right)^2 = (mc)^2\left(\frac{\Delta t}{\Delta\tau}\right)^2 - p^2 = \text{invariant} \qquad (36.37)$$

where we used $p = m(\Delta x/\Delta\tau)$ from Equation 36.32.

E=mc^2

In this model E=mc^2 comes from the ½×-𝕠d× e𝕐/-𝕠d linear kinetic energy and proportionally the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. With c^2 dimensional analysis is the same with E𝕍/-𝕀D, that comes with a particular angle θ in the -𝕚d and e𝕧 Pythagorean Triangle. The -𝕚d inertial mass is multiplied with this, because the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia are proportional in this model then so are the Pythagorean Triangle sides. There is no ½ factor because it is a constant. Kinetic energy is from one velocity to another as an average, they are added together and ½ is this average.

Inertial mass kinetic electric charge equivalence

That means -𝕚d as the inertial mass is proportional to -𝕠d as the kinetic electric charge and so matter is converted into energy according to this fixed formula. This also happens with lower inertial velocities here, when an electron for example moves with a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy this is an approximation for its E𝕐/-𝕠d kinetic impulse. That is proportional to its E𝕍/-𝕚d inertial impulse, that makes -𝕠d proportional to -𝕚d at any inertial velocity.

Gravitational mass potential electric charge equivalence

This mass energy equivalence also occurs with the ½×+e𝔸/+𝕆d ×+𝕠d rotational energy and the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation. These are referred to as rotational because both are in circular geometry, but the structure of the formulae is the same. The +𝕠d potential magnetic field is proportional to and works like the +𝕚d gravitational mass.

Action/reaction pairs

One difference is the +𝕠d potential mass or potential magnetic field is reactive only, but the +𝕚d gravitational mass is active. This is the opposite of the -𝕠d kinetic mass or kinetic electric charge which is active, and the -𝕚d inertial mass which is reactive. Here gravity is an active force with the +𝕀D×e𝕙 gravitational work, that force is proportional to in the +𝕆D×e𝕒 potential work as +𝕆D. It means the gravitational mass of the proton can be converted into a form of energy, just as with the inertial mass of the electron.

The potential is proportional to gravitation

This also occurs with lower velocities than c, that is because the +𝕠d and +𝕚d Pythagorean Triangle sides as factors in the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation still remain proportional. A proton then can gain potential energy proportionally from gravitation, for example in moving down a gravitational well to different e𝕙 heights above a planet. This allows for electrons to move closer to the proton with a stronger gravitational field. If not then chemical reactions would work differently under gravity, atoms might split apart.

Velocity and speed

In this model there is a kinetic velocity e𝕪/-𝕠d, the inertial velocity e𝕧/-𝕚d, the potential speed e𝕒/+𝕠d, and the gravitational speed e𝕙/+𝕚d. The difference between velocity and speed is that velocity can move in a straight-line, that comes from the straight Pythagorean Triangle side. This is also the limit of hyperbolic geometry with the -𝕠d and e𝕪 Pythagorean Triangle as the electron and the -𝕚d and e𝕧 Pythagorean Triangle as inertia.

Speed has no straight-line direction

Speed as in conventional physics does not refer to a direction. Here this refers to a circular or other curved orbit where the +𝕠d and e𝕒 Pythagorean Triangle as the proton, or the +𝕚d and e𝕙 Pythagorean Triangle as gravity dominate. An electron then cam move at a potential speed in an orbital, a satellite can move with a gravitational speed around a planet.

Four kinds of energy

There are four different kinds of energy, these refer to the format of these equations. Energy is more usually associated with impulse, this is because it observes an object. There is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, the ½×e𝕍/-𝕀d ×-𝕚d linear inertia, the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, and the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation.

Four kinds of momentum

There are also four kinds of momentum, the kinetic momentum is -𝕠d×e𝕪/-𝕠d, the inertial momentum -𝕚d×e𝕧/-𝕚d, the potential momentum +𝕠d×e𝕒/+𝕠d, and the gravitational momentum +𝕚d×e𝕙/+𝕚d.

γ used with four kinds of Pythagorean Triangles

These in turn are associated with the 4 formulae below. $E=\gamma_p mc^2$ refers to different angles θ in a Pythagorean Triangle. With special relativity a rocket can have a ½×e𝕍/-𝕀d ×-𝕚d linear inertia, this converts to the formula by making E𝕍/-𝕀D equal to c. Then γ can give the amount of -𝕚d inertial time slowed or e𝕧 length contraction. This is proportional to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy where γ also gives the difference to the e𝕪 kinetic electric charge and the -𝕠d kinetic magnetic field of a rocket for example.

Potential similar to gravity

This can also be used with the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy where γ is the amount of e𝕒 altitude contraction and +𝕠d potential time slowing, this would be proportional to the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation such as on the surface of a large planet.

γ and four kinds of momentum

The same γ can be used in p=γmu which is the kinetic momentum -𝕠d×e𝕪/-𝕠d, the inertial momentum -𝕚d×e𝕧/-𝕚d, the potential momentum +𝕠d×e𝕒/+𝕠d, and the gravitational momentum +𝕚d×e𝕙/+𝕚d.

Momentum squared and energy squared

Where $E^2 - (pc)^2 = E_0^2$ this is where the momentum p such as the inertial momentum -𝕚d×e𝕧/-𝕚d times c as e𝕧/-𝕚d is squared, that gives -𝕚d×E𝕍/-𝕀D which is the same as the ½×e𝕍/-𝕀d ×-𝕚d linear inertia without the ½ factor. That is because ½ is already used in both of E^2 so the difference cannot use ½.

Change of the inertial mass as γ

The inertial momentum $p=\gamma_p mu$ where mu is -𝕚d×e𝕧/-𝕚d. Multiplying this by γ means there is a change in the -𝕚d inertial mass as a square root as the inertial velocity increases between near zero and c. This follows from the relativity equation, it is also derived from the constant area of the -𝕚d and e𝕧 Pythagorean Triangle. As the angle θ decreases the inertial velocity e𝕧/-𝕚d increases, e𝕧 dilates and -𝕚d contracts inversely to this.

Observing the displacement history and γ

When the E𝕍/-𝕚d inertial impulse is observed there is a square E𝕍, that increases faster then -𝕚d contracts, this causes an observation of a slower -𝕚d inertial time proportionally as γ. This E𝕍 value also comes from the E𝕍 inertial displacement history, this remains even if the inertial momentum means the matter is no longer inertially accelerating. The observation of the E𝕍/-𝕚d inertial impulse then is of this displacement history.

Inertial mass and inertial impulse

From this comes e=mc^2 in the form of the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. γ is also here because -𝕚d has slowed as inertial time or decreased with the increasing inertial velocity. That gives the E𝕍/-𝕚d inertial impulse because the -𝕚d inertial mass cancels out one of the -𝕚d inertial time factors in the denominator. This is because they change with the same γ, the -𝕚d inertial time slows as the -𝕚d inertial mass contracts.

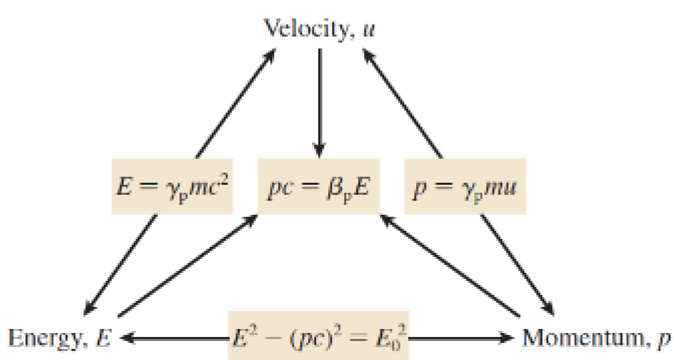
Inertial time equals inertial mass

That is because they are the same sides in the -𝕚d and e𝕧 Pythagorean Triangle, inertial time is from a derivative and the inertial mass is from an integral. They are together because the inertial velocity is a combination of the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work.

Maximum and minimum values

Here pc has the same dimensions as the ½×e𝕍/-𝕀d ×-𝕚d linear inertia, it comes from the -𝕚d×e𝕧/-𝕚d inertial momentum × c as e𝕧$_c$/-𝕚d$_c$. With E there is a maximum E𝕍$_c$/-𝕀D$_c$ and a minimum E𝕍$_0$/-𝕀D$_0$ at near rest. In between this is e𝕧$_0$/-𝕚d$_0$ × e𝕧$_c$/-𝕚d$_c$ which as inverses equals one. With -𝕚d$_0$ and -𝕚d$_c$ there is also a middle value. Here β_p can convert the ½×e𝕍/-𝕀d ×-𝕚d linear inertia from rest to that of c. With this middle value then E^2-E_0^2=(pc)^2. This becomes -𝕀D$_c$ - -𝕀D$_0$ = -𝕀D$_{pc}$.

FIGURE 36.37 The velocity-energy-momentum triangle.



Inertial mass and kinetic magnetism equivalence

In this model the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×eV×-𝕚d are proportional to each other, this enables the exchange of one by the other through e𝕪×-𝕘d photons. For example photons near a large enough +𝕚d gravitational field can create an electron -𝕠d and a positron +𝕠d. The difference between -𝕠d and +𝕠d is the same as with electron orbitals above the proton. This is quantized and can decay according to α in quantum electrodynamics.

Gravitational mass and potential magnetism equivalence

Also the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation can be exchanged, for example in a star with nuclear fusion. The gravity crushes the protons together with +𝕀D×e𝕙 gravitational work, this is proportionally reacted against by the repulsion in +𝕆D×e𝕒 potential work. That causes the emission of e𝕪×-𝕘d photons and +𝕘d×e𝕓 gravitational waves or gravis. Both occur because the proton contains two +𝕠d with d=2/3 up quarks and a -𝕠d d=1/3 down quark.

> There's ample experimental evidence that energy is conserved, so there must be a flaw in our reasoning. The statement of energy conservation is
>
> $$E_f = Mc^2 = E_i = 2mc^2 + 2K \qquad (36.47)$$
>
> where M is the mass of clay after the collision. But, remarkably, this requires
>
> $$M = 2m + \frac{2K}{c^2} \qquad (36.48)$$
>
> In other words, **mass is not conserved.** The mass of clay after the collision is larger than the mass of clay before the collision. Total energy can be conserved only if kinetic energy is transformed into an "equivalent" amount of mass.

Electron absorption as a wave

In this model the e𝕪 and -𝕘d Pythagorean Triangle is the difference between the quantized -𝕆D×e𝕪 kinetic work of the electron in an atom. So when the e𝕪×-𝕘d photon reaches an atom this is a wave, it does -𝔾D×e𝕪 light work which adds to the number of oscillation in the electron wave with its -𝕆D×e𝕪 kinetic work.

Kinetic impulse knocks out an electron

When an electron is aimed at an atom it can also be observed with a E𝕐/-𝕠d kinetic impulse, this comes from it colliding with e𝕪/-𝕘d photons with their e𝕐/-𝕘d light impulse. Because of this its angle θ in the -𝕠d and e𝕪 Pythagorean Triangle has changed, e𝕪 is larger as the kinetic electric charge and -𝕠d as the kinetic time is smaller. That is proportional to its e𝕧/-𝕚d inertial velocity meaning the electron is moving faster.

Compton scattering

When this reaches the atom it can be a collision between electrons as particles with a E𝕐/-𝕠d kinetic impulse, this is seen with Compton scattering. It can also be from -𝕆D×e𝕪 kinetic work, the second electron cannot fit in the atom because its -𝕆D kinetic probability is too large. The probability then is it will be expelled.

Electrons and positrons

The difference in this collision can be e𝕪×-𝕘d or e𝕪/-𝕘d photons, it can also be the creation of a -𝕠d and e𝕪 Pythagorean Triangle as an electron and a +𝕠d and e𝕪 Pythagorean Triangle as a positron. This is because the difference between +𝕠d and -𝕠d here is like the orbital levels between the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron.

Photon impulse and work is conserved

This difference means the two original electrons, as well as the created electron and positron have a reduced kinetic velocity e𝕪/-𝕠d for the electrons and a reduced positronic velocity e𝕪/+𝕠d for the positron. This is the same as the e𝕪×-𝕘d or e𝕪/-𝕘d photons in terms of the energy differences.

FIGURE 36.39 shows an experiment that has been done countless times in the last 50 years at particle accelerators around the world. An electron that has been accelerated to $u \approx c$ is aimed at a target material. When a high-energy electron collides with an atom in the target, it can easily knock one of the electrons out of the atom. Thus we would expect to see two electrons leaving the target: the incident electron and the ejected electron. Instead, *four* particles emerge from the target: three electrons and a positron. A *positron*, or positive electron, is the antimatter version of an electron, identical to an electron in all respects other than having charge $q = +e$.

In chemical-reaction notation, the collision is

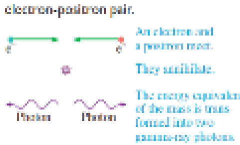
$$e^- \text{ (fast)} + e^- \text{ (at rest)} \rightarrow e^- + e^- + e^- + e^+$$

An electron and a positron have been *created*, apparently out of nothing. Mass $2m_e$ before the collision has become mass $4m_e$ after the collision. (Notice that charge has been conserved in this collision.)

Although the mass has increased, it wasn't created "out of nothing." This is an inelastic collision, just like the collision of the balls of clay, because the kinetic energy after the collision is less than before. In fact, if you measured the energies before and after the collision, you would find that the decrease in kinetic energy is exactly equal to the energy equivalent of the two particles that have been created: $\Delta K = 2m_ec^2$. The new particles have been created *out of energy!*

Particles can be created from energy, and particles can return to energy. **FIGURE 36.40** shows an electron colliding with a positron, its antimatter partner. When a particle and its antiparticle meet, they *annihilate* each other. The mass disappears, and the energy equivalent of the mass is transformed into light. In Chapter 38, you'll learn that light is *quantized*, meaning that light is emitted and absorbed in discrete chunks of energy called *photons*. For light with wavelength λ, the energy of a photon is $E_{photon} = hc/\lambda$, where $h = 6.63 \times 10^{-34}$ J s is called *Planck's constant*. Photons carry momentum as well as energy. Conserving both energy and momentum in the annihilation of an electron and a positron requires the emission in opposite directions of two photons of equal energy.

FIGURE 36.40 The annihilation of an electron-positron pair.



If the electron and positron are fairly slow, so that $K \ll mc^2$, then $E_i \approx E_0 = mc^2$. In that case, energy conservation requires

$$E_f = 2E_{photon} = E_i \approx 2m_ec^2 \qquad (36.49)$$

Hence the wavelength of the emitted photons is

$$\lambda = \frac{hc}{m_ec^2} \approx 0.0024 \text{ nm} \qquad (36.50)$$

Conservation of mass and energy

In this model the total energy would be the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. This is conserved because of the constant Pythagorean Triangle areas, the -𝕚d inertial mass can be converted into e𝕪×-𝕘d photons. This is because -𝕚d is proportional to the -𝕘d rotational frequency of the photons. That was also seen when the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy of an electron colliding with an electron in an atom was converted into an electron and a positron.

Relativistic conservation

The photons emitted when an inertial mass is annihilated, such as with an -𝕠d and e𝕪 Pythagorean Triangle and a +𝕠d and e𝕪 Pythagorean Triangle are the difference between +𝕠d and -𝕠d, the same as with an atom where +𝕠d comes from the proton and -𝕠d from the electron. These photons can be absorbed in another atom, their -𝔾D×e𝕪 light work increases the -𝕠d kinetic magnetic field of the electron there which proportionally increases its -𝕚d inertial mass. In this model that is also relativistic, where there is a higher +𝕚d gravitational mass the e𝕪×-𝕘d photons are slower. When these photons go up the gravitational well, they are more redshifted, so it can appear as if this +𝕚d gravitational mass produces less energy on a planet than above it.

Conservation of Energy

The creation and annihilation of particles with mass, processes strictly forbidden in Newtonian mechanics, are vivid proof that neither mass nor the Newtonian definition of energy is conserved. Even so, the *total* energy—the kinetic energy *and* the energy equivalent of mass—remains a conserved quantity.

> **Law of conservation of total energy** The energy $E = \sum E_i$ of an isolated system is conserved, where $E_i = (\gamma_p)_i m_i c^2$ is the total energy of particle *i*.

Oscillations and waves

Flexing of the molecular bonds

In this model the spring oscillated from the flexing of the molecular bonds as it is compressed. The compression of the spin can be observed as a E𝕐/-𝕠d kinetic impulse pushing it down, it reacts against this with an E𝕍/-𝕚d inertial impulse. In that case the impulse would be observed on a clock gauge, from how many times the spring oscillated on a kinetic and inertial clock gauge.

Oscillation from work

The oscillation comes from rotation, this is where the -𝕆D×e𝕪 kinetic work of pushing down the spring, and the -𝕀D×e𝕧 inertial work reacting against this, makes the spring move up and down over a length e𝕧. This oscillation can be modeled as a circle rotating, that is like the rolling wheel model of an electron and a photon. When a point on the rolling wheel, such as the end of a e𝕪 phasor, is measured, this causes work to be measurable over a distance or e𝕧 length.

Sines and cosines as approximations

In this model there can be sine waves, this is where in trigonometry the sine of the angle θ is the spin Pythagorean Triangle side divided by the hypotenuse ζ. Sines and cosines are not used except as approximations, instead the tangent of θ gives the ratio of the spin Pythagorean Triangle side -𝕠d or -𝕚d here to the straight Pythagorean Triangle side e𝕪 or e𝕧.

A changing hypotenuse size

This model uses constant area trigonometry, this is where the area of the Pythagorean Triangle remains constant. As the angle θ changes then one Pythagorean Triangle side might grow and the other must contract inversely to this. The spring’s sine waves can also use this, the hypotenuse ζ does not remain a constant size. Instead as the angle θ contracts then -𝕠d or -𝕚d contract and e𝕪 or e𝕧 become dilated. With this smaller angle θ the hypotenuse would increase in size, then contract as the angle θ dilated.

Chaos and sawtooth

In Figure 15.1 the sawtooth oscillations would be like electrons and atoms colliding as particles, that would be chaotic not regular. This is because a regular oscillation would be quantized, they could be added with multiples of this frequency like electrons with their -𝕆D×e𝕪 kinetic work are quantized in orbitals. When irregular oscillations are added these are not quantized, they are like the continuous spectrum which can be emitted from a blackbody. The discrete spectrum is like that arising from multiples of -𝕆D×e𝕪 kinetic work and regular oscillations.

Constructive and destructive interference

This is seen in Fourier analysis, when many oscillations of a different for example -𝕚d frequency interfere with each other as -𝕀D×e𝕧 inertial work. Then there is a -𝕀D inertial torque or inertial probability, the constructive and destructive interference sums like path integrals over a distance.

The limit of work as impulse

The limit of this addition of probabilities is the E𝕍/-𝕚d inertial impulse, then they combine to be observed as a particle at a -𝕚d inertial instant. This can also be regarded as an amplitude, that would be like E𝕍 as the inertial displacement. At this inertial time the wave function, composed of many constructively and destructively interfering waves of probability, are said to collapse into an observation.

The collapse of the wavefunction

This is observed as a force, it can be represented as a coefficient or eigenvalue of an exponential function that is a second derivative with respect to e𝕧. For example $e^{e𝕧}$ when a second derivative is taken with respect to e𝕧 becomes E𝕍$e^{e𝕧}$, the coefficient is like a vector force that enables the particle to be observed. With inertia this can be by it reacting against a force.

Eigenvalues and impulse

In this model that is the same as the E𝕍/-𝕚d inertial impulse, where -𝕚d/e𝕧 is a derivative like the inertial velocity. Then the E𝕍/-𝕚d inertial impulse is a force or acceleration of a particle like the Eigenvalue.

Infinitesimals with a 0 exponent

The coefficient is e$𝕧^{0}$, the 0 exponent is implied when there is no other exponent. This is like ni as an exponent in Euler's equation as e^{ni}. The 0 exponent makes e𝕧=1 as an infinitesimal in this model times e, when it becomes the coefficient with a derivative it is e𝕧$e^{e𝕧}$. Here e𝕧 represents a kind of number, it is not positive or negative and adds only as a vector. The second integral gives E$𝕍^{e𝕧}$ which is the E𝕍/-𝕚d inertial impulse of a particle being observed.

E𝕍 as an integer or fraction

Instead of this there can be $e^{E𝕍}$ where this is a square of the square root e𝕧, this can be an integer or fraction because it is the square of a square root e𝕧. Now the first derivative with respect to e𝕧 gives a coefficient E𝕍. This would be allowed in calculus because E𝕍 in the exponent need not be regarded as a square and so there is no 2 as its own exponent.

Spin cannot be observed as a particle

When the exponent is $e^{e𝕧\text{-}𝕚d}$ then e𝕧 can become a derivative, -𝕚d only becomes an integral field. So the first derivative of $e^{-𝕚d}$ with respect to -𝕚d is $e^{-𝕚d}$ so as spin it cannot be observed as a particle with impulse. Taking 1/-𝕚d as the exponent, this can also be regarded as the inverse of e𝕧 with the constant Pythagorean Triangle area. Then the exponent 1/-𝕀D is the inverse of E𝕍 in the exponent, the different values of D give the integral probability curve.

Inverse exponents

The exponent can then be written as $e^{e\mathbb{v}-\mathbb{i}d}$, but it can also be written as either $e^{e\mathbb{v}}$ or $e^{1/-\mathbb{i}d}$ as the same thing. Because only one Pythagorean Triangle side can be observed at an instant, or measured at a position, then $e^{E\mathbb{V}}$ as the inverse of $e^{1/-\mathbb{I}D}$ give an impulse and work respectively. If the impulse is observed, then this changes the work which could be measured because of the uncertainty principle.

Exponentials as the inverse of probability curves

The E𝕍 exponent then is like the integers for example in ascending order, when this gives an exponential curve it follows that the inverse of this will be -𝕀D as exponents as D also increases. The two should then balance, the exponential curve formed from derivatives and the normal curve formed from integrals.

Renormalization

Because exponentials are related to impulse, connected to exponential decay over time, then the inverse exponential is connected to probability and work. When quantum mechanics has exponentials growing to ∞ then this is from observing electrons for example as particles with impulse. That can be corrected by taking a distance from the electron in renormalization, that is the same concept as work at a distance having a probability density.

A quantized distance and renormalization

That stops the exponential growth at a distance or e𝕧 length from the electron, then a particular value is like a quantized distance. In this model that distance is calculated by α, so the probabilities of other particles forming in a Feynman diagram also would come from α and work.

FIGURE 15.1 Examples of oscillatory motion.

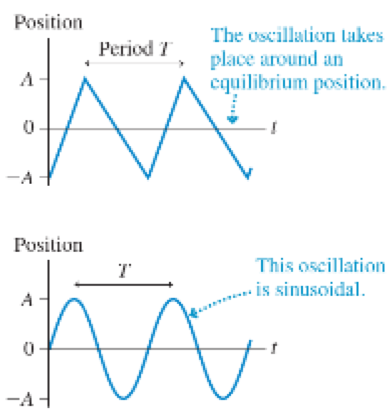
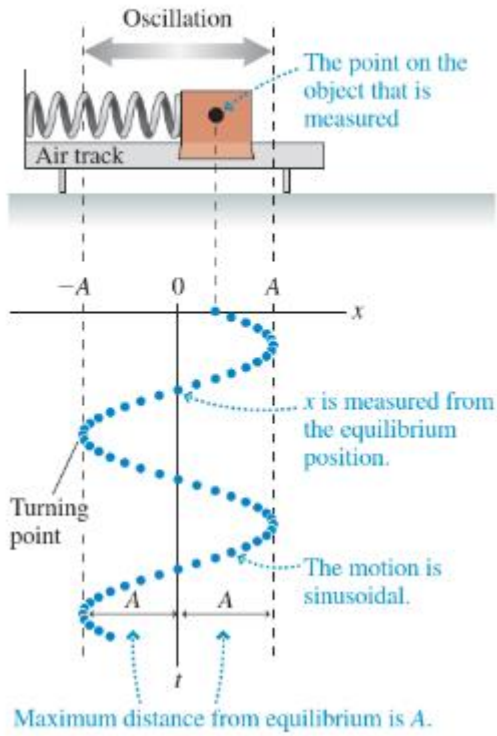


FIGURE 15.2 A prototype simple-harmonic-motion experiment.



π and e are transcendental

In this model π and e are transcendental, because of this they are not themselves observed or measured as Pythagorean Triangles. The exponential e refers to hyperbolic geometry with the -𝕠d and e𝕪 Pythagorean Triangle and the -𝕚d and e𝕧 Pythagorean Triangle, it can be an integral area under the hyperbola. π refers to circular geometry with the +𝕠d and e𝕒 Pythagorean Triangle as the proton and +𝕚d and e𝕙 Pythagorean Triangle as gravity. It can also be an integral as the area of a circle.

Creating a circle and a hyperbola

Each can be derived by motion, the -𝕠d and e𝕪 Pythagorean Triangle as the electron and the -𝕚d and e𝕧 Pythagorean Triangle as inertia can be inserted under a hyperbola. When the Pythagorean Triangle forms a tangent to the curve then its angle θ can be changed with the area remaining constant. When an +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the +𝕚d and e𝕙 Pythagorean Triangle as gravity, are rotated then they can trace out a circle without its area changing.

A circular orbit with an integral area as π

This is for example by the Pythagorean Triangle side e𝕙 being a constant height above a planet, at its end is a satellite in a circular orbit. As the satellite moves it has a gravitational speed of e𝕙/+𝕚d and traces out an integral area of a circle as π.

Deriving e from exponential decay

The exponential e can also be derived in this model from exponential decay. When a radioactive element decays then it has a half-life, this is when half the time as a constant is observed on a kinetic clock gauge as α and β particles are observed. The number of remaining particles decreases as a square over this constant time, this is the same as the formula for the E𝕐/-𝕠d kinetic impulse or the E𝔸/+𝕠d potential impulse for the nucleus.

Probability and work

In this model the normal curve is associated with probability and work, it is a negative exponential because the spin Pythagorean Triangle side is the inverse of the straight Pythagorean Triangle side. The normal curve is derived by negative squares as exponents of e. Here these are +𝕆D, -𝕆D, +𝕀D, and -𝕀D which are squared in the exponent. When these are squared that gives the potential, kinetic, gravitational, and inertial probabilities respectively as work.

Work is probabilistic impulse is deterministic

Because of this the work here is probabilistic, impulse is deterministic because the change in the exponential decay occurs with the straight Pythagorean Triangle side being squared. The spin Pythagorean Triangle side is not squared, it acts as a time on a clock gauge.

No cosine wave

Because the sine wave is associated with the spin Pythagorean Triangle side, with -𝕚d for example opposite the angle θ, then it is derived from a rotating wheel and π. It is also associated with the cross product. There is no cosine wave in this model, that is because the straight Pythagorean Triangle side e𝕧 divided by the hypotenuse ζ, would not have any spin.

Linear and circular polarization

This rotating wheel can be turned for different kinds of polarization. Like a wheel it can be regarded as vertical, horizontal, or any angle in between as it moves. For example in reflecting off a flat lake the different angles change the polarization and reflection of the photons. A circular polarization is where the -𝕘d axle pointing in the direction of motion.

Cosine wave approximation

It can be an approximation, for example with the model of the e𝕪 and -𝕘d Pythagorean Triangle or photon as a rolling wheel. The axle of the wheel is -𝕘d, this would have a sine θ value in constant area trigonometry. Measuring this would give the -𝔾D×e𝕪 light work being done by the photon, but this would absorb it.

Sine waves and tines

In this model 2π is the limit of $1/\beta^2$ as the width of tines in chaos. This acts like the distance in between orbital levels in an atom. The sine wave would then be quantized into these levels as work, in between there would be chaotic motion.

Chaos and impulse

This chaos would be where the photon would be observed with a e𝕐/-𝕘d light impulse, then it acts more like a spring exerting an E𝕐 displacement force with an amplitude not a frequency. This is also seen in a Fourier Transform from a frequency to an amplitude.

Radians and tines

In this model radians are a segment of the circumference as $1/(2\pi)$, this is also the limit of β^2 as the tine width. For a circumference with -𝕆D×e𝕪 kinetic work of 1, as the ground state, this would have a tine width to the next circular orbital upwards. That would also be in increments of ½π, because this is squared and a radius it is the e𝕒 altitude from the +𝕠d and e𝕒 Pythagorean Triangle or proton.

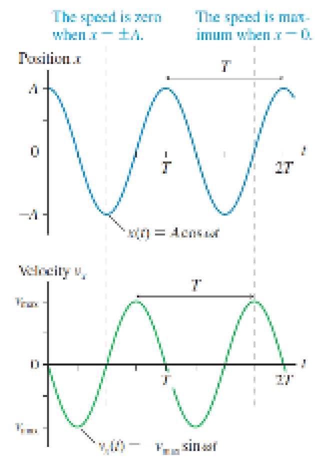


FIGURE 15.3 Position and velocity graphs for simple harmonic motion.

FIGURE 15.3 shows a SHM position graph—such as the one generated by the air-track glider—in its "normal" position. For the moment we'll assume that the oscillator starts at maximum displacement $(x = +A)$ at $t = 0$. Also shown is the oscillator's velocity-versus-time graph, which we can deduce from the slope of the position graph.

- The instantaneous velocity is zero at the instants when $x = \pm A$ because the slope of the position graph is zero. These are the *turning points* in the motion.
- The position graph has maximum slope when $x = 0$, so these are points of maximum speed. When $x = 0$ with a positive slope—maximum speed to the right—the instantaneous velocity is $v_x = +v_{max}$, where v_{max} is the amplitude of the velocity curve. Similarly, $v_x = -v_{max}$ when $x = 0$ with a negative slope—maximum speed to the left.

Although these are empirical observations (we don't yet have any "theory" of oscillation), we can see that the position graph, with a maximum at $t = 0$, is a cosine function with amplitude A and period T. We can write this as

$$x(t) = A\cos\left(\frac{2\pi t}{T}\right) \quad (15.2)$$

where the notation $x(t)$ indicates that x is a *function* of time t.

NOTE The arguments of sine and cosine functions are in *radians*. This will be true throughout our study of oscillations and waves. Be sure to set your calculator to radian mode before doing calculations.

The rolling wheel as a circular orbital

In the model of the rolling wheel, this can also be regarded as a circular orbital around the +𝕠d and e𝕒 Pythagorean Triangle. Here the proton acts like a rolling wheel, like a planet rotates around an axis. This would have a potential speed of e𝕒/+𝕠d, as a derivative of the +𝕠d and e𝕒 Pythagorean Triangle with respect to e𝕒. Because this is a derivative it would have a potential amplitude, this is where the e𝕒 altitude acts like a reactive spring.

Fourier Transform to amplitude

Because of this a Fourier Transform would be more accurate, starting with sin[2πt/T] there represents the rotation of the +𝕠d and e𝕒 Pythagorean Triangle. The t value is rotational frequency, this comes from the +𝕠d potential spin or potential magnetic field. Using ω this is the rotational frequency as 1/+𝕠d. When the E𝔸/+𝕠d potential impulse is observed this would be like a rotating hand on a potential clock gauge.

Coefficient as a force

Here as a coefficient ω represents an observable force, initially there is a position and then a torque causes it to rotate as the sine wave. This is similar to with $e^{e𝕒}$ where taking the derivative gives a coefficient e𝕒, a second derivative would be an observable E𝔸 potential displacement in the E𝔸/+𝕠d potential impulse. A single derivative in this model is not a force, it represents a change in position to that of an orbit in a sine wave.

Sine waves and integration

In this model a derivative is not used with a sine wave, that is because it represents a wave of spin not of direction. Instead, the integral of the +𝕠d and e𝕒 Pythagorean Triangle would be the area of it as a field. The rotation of a sine wave is like a rolling wheel, when around an orbital this would give the integral area of the +𝕠d potential field. This is not observable as a rotating particle, instead the potential field can be further integrated to give a +𝕆D potential probability or torque. This is like the e𝕒 spoke of the rolling wheel increasing its potential speed as e𝕒/+𝕆D.

In between radian multiples as chaos

The 2π value here appears as a radian, also the quantized tine value from chaos. When the tin increase as linear multiples this give quantized orbitals, in between these the $1/\beta^2$ value is not a whole value. Because of this it is like a smaller tine value in chaos approaching 2π with a different behavior to that of +𝕆D×e𝕒 potential work as the number of oscillations in whole numbers. This is also because a fraction is a derivative slope, that means it cannot also be an integral field. In between the quantized orbitals there can only be chaotic motion.

We deduced Equation 15.6 from the experimental results, but we could equally well find it from the position function of Equation 15.2. After all, velocity is the time derivative of position. TABLE 15.2 reminds you of the derivatives of the sine and cosine functions. Using the derivative of the position function, we find

$$v_x(t) = \frac{dx}{dt} = -\frac{2\pi A}{T}\sin\left(\frac{2\pi t}{T}\right) = -2\pi f A \sin(2\pi f t) = -\omega A \sin \omega t \qquad (15.7)$$

Comparing Equation 15.7, the mathematical definition of velocity, to Equation 15.6, the empirical description, we see that the maximum speed of an oscillation is

$$v_{max} = \frac{2\pi A}{T} = 2\pi f A = \omega A \qquad (15.8)$$

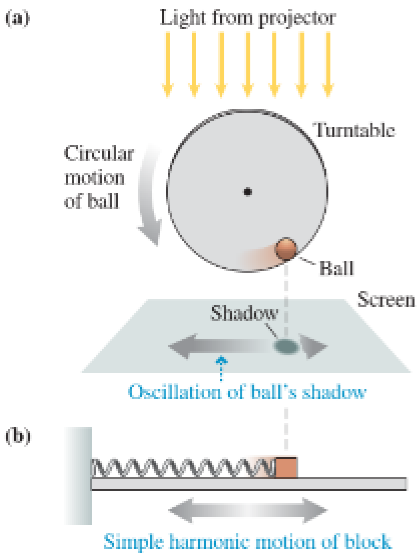
A spring with amplitude

The wheel below can be seen as a spring, this has an amplitude with a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. That comes from a position or particle on the spoke, the displacement between these positions is a force as an amplitude. This is orthogonal to the axis of the wheel, the shadow is derived from selecting one particular e𝕧 position and then observing how this changes over -𝕚d inertial time.

An area has no preferred position

When the wheel is regarded as an integral area, there is no longer a special e𝕧 position on it and so there can be no particle with impulse. Instead this would be measured by trying to slow the wheel, it would react against this with -𝕀D×e𝕧 inertial work and a -𝕀D inertial torque. This work is measured against a position, but with rotary motion there is no preferred position like a particle. Instead any position can be used to measure the work done.

FIGURE 15.4 A projection of the circular motion of a rotating ball matches the simple harmonic motion of an object on a spring.



Constructive and destructive interference

The rolling wheel model gives a phase, this is the angle the e𝕪 spoke is at relative to another rolling wheel for example. With the e𝕪×-𝕘d photons then the -𝔾D×e𝕪 light work would give a constructive or destructive interference depending on this phase when they intersect. This is because the two e𝕪 spokes would have a vector addition, if the spins are in the opposing direction then they can be entangled. This is when the e𝕪 spokes are like a mirror image with the angle when they begin.

Entangled bike wheels

An example of entanglement would be two bike wheels on a common axis. If they spin in opposite directions with gears between them then the overall -𝕀D×e𝕧 inertial work done is zero. These gears act like quantization, there is no possible outcome other than the -𝕀D×e𝕧 inertial work done with each wheel being opposite to the limits of the measurement. The wheels no longer have a -𝕀D inertial torque and so the wheel axis can turn with no inertia. When one wheel has its -𝕀D×e𝕧 inertial work measured then the entangled other wheel has the opposite -𝕀D×e𝕧 inertial work.

Zero inertial impulse

When the E𝕍/-𝕚d inertial impulse is observed this is also zero, the wheels are like two inertial clock gauges spinning with an equal and opposite rotation as -𝕚d inertial time. The wheels then have no tendency to move forward or backwards if they are placed against a flat surface. There would be a torque to one side but this is not the E𝕍/-𝕚d inertial impulse.

Braking one wheel

When this -𝕀D×e𝕧 inertial work is quantized then there is a 100% inertial probability between the two wheels. If one is measured by placing a brake on it, then this would slow the wheel and give a measurement of its -𝕀D inertial torque. With quantization this would slow the other wheel through the gears. Observing this time change would only be done by observing the wheels themselves, they are the only clock gauges in this experiment. According to this when one is observed the other is observed with no time difference.

Opposing inertial torque at a distance

If the two wheels are on a long rod, with one spinning in a clockwise direction on one end, and the other spinning in a clockwise direction on the other end, the cogs would still connect them with a quantization. The -𝕀D×e𝕧 inertial work done by one must be equal and opposite to the other. If one is measured for its -𝕀D inertial torque the other must have the opposing -𝕀D inertial torque.

Comparing spin as opposing clock gauges

If this is observed with a dot on each wheel then this can be regarded as a particle with the spin coming from the integral field of the spin. The two inertial clocks are the only ones allowed to be used, according to them there is no time difference between the observation of one wheel and the opposing observation of the other. For example if 100 rotations occurred in an hour, then the opposing wheel would have -100 rotations as a -hour. Because neither clock gauge is preferred then no time change can be observed.

Entangled photons

When there are two entangled e𝕪 and -𝕘d Pythagorean Triangles as photons, these also would do equal and opposite -𝔾D×e𝕪 light work. When the first photon is measured this has a -𝔾D light probability or torque, the second photon must have the opposing light probability or torque. These are also quantized like with the cogs between the wheels.

Rotational frequency of the photons

This is because of the -𝕘d rotational frequency of the photons, it cannot be altered with observing their e𝕐/-𝕘d light impulse or measuring their -𝔾D×e𝕪 light work. The entanglement of two light clock gauges, one turning clockwise and the other counterclockwise, cannot deviate from this. The inertial probabilities must measure as opposites, this is because it is only measuring what the photons did. There is no other clock gauge available then with the e𝕐/-𝕘d light impulse as with the two bike wheels.

Differentiation is impulse

If it is not possible for entanglement to exist, with a small difference between them, then there is no quantization with -𝔾D×e𝕪 light work. So this entanglement comes from quantization, if there was only impulse with a continuous spectrum then there would always be some difference between the photon as a e𝕐/-𝕘d light impulse. This is like there always being a small motion in the wheel cogs differentiating one wheel from another. But differentiation itself comes from derivatives and impulse, so work itself cannot be differentiated.

Phase and spoke positions

The phase of the sine wave comes from the rotating e𝕪 and -𝕘d Pythagorean Triangle for example as the photon. Because it is a rotating Pythagorean Triangle forming the wheel, there is always a spoke which has the phase. This allows the measurement of the spoke positions to do -𝔾D×e𝕪 light work, the -𝔾D light probability or torque interfere according to the spoke positions.

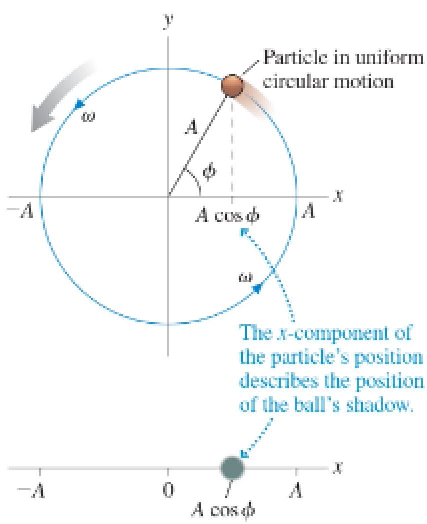
Adding torque gives an interference pattern

That gives a constructive and destructive interference in a double slit experiment. The spoke is measured at different positions or angles when it reaches the screen for measurement. The overall -𝔾D light torque or probability is where these are added up, when destructive they are like the opposing spins of the bike wheels so no -𝔾D×e𝕪 light work can be measured. That gives a dark area. If both wheels were spinning in the same direction then the -𝔾D light probability and torque would be doubled which gives a brighter area on the screen.

Observing which slit collapses the field

If there is an attempt to observe which slit the photons go through, that would be observing them as particles with a e𝕐/-𝕘d light impulse. That is because a field does not act like a particle in going through one slit. Because of this the e𝕐/-𝕘d light impulse as E𝕐 squared as the kinetic displacement force, it is not spin or a probability. Because of this the interference field disappears, the photons are only observed when they go through the slits and their -𝔾D light probability or torque is not measured. This can be regarded as collapsing the integral field by making a derivative observation.

FIGURE 15.5 A particle in uniform circular motion with radius A and angular velocity ω.



Derivatives and cosines not sines

In this model sin θ is associated with, for example, the area of the -𝕚d and e𝕧 Pythagorean Triangle. When tan θ is used this is a derivative slope, that is associated with the cosine but not the sine. The -𝕚d and e𝕧 Pythagorean Triangle would begin with neither the slope or the area being observed or measured respectively. Taking the first derivative with respect to e𝕧 this would give -𝕚d/e𝕧, that can also be the inertial velocity in seconds/meter.

First and second derivatives

This is not observed however, that would be with the E𝕍/-𝕚d inertial impulse, in accordance with the conventions of derivatives it would be written as -𝕚d/E𝕍. With the e𝕪 and -𝕘d Pythagorean Triangle as the photon this would be moving as a rolling wheel, the axle would be the -𝕘d rotational frequency and the e𝕪 kinetic electric charge the spoke. But the slope of this Pythagorean Triangle as a first derivative is not being observed, nor is the area as a field or integral being measured.

Antiderivative of the derivative

Taking the antiderivative of the inertial velocity -𝕚d/e𝕧 would give -𝕚d/e𝕧^{0} and so this only refers to the -𝕚d spin Pythagorean Triangle side. That is like the -𝕚d inertial clock gauge with nothing to observe with it. The e𝕧^{0} term is like an infinitesimal in this model, with the derivative there is a -𝕚d inertial clock gauge but e𝕧^{0} is too small to observe. This is still a derivative slope however.

Two states

A Pythagorean Triangle then exists in two states, here as -𝕚d/e𝕧^{0} as a derivative and -𝕚d^{0}×e𝕧 as an integral field. Here -𝕚d^{0} is a fluxion or instant in this model. There can be a measurement with e𝕧 as a scale but there is nothing to measure.

Infinitesimals

Together this gives two states of the -𝕚d and e𝕧 Pythagorean Triangle or whatever Pythagorean Triangle is being used, it allows for conventional calculus to work with this model. When the -𝕚d and e𝕧 Pythagorean Triangle is regarded as a derivative there is no actual derivative taken, it appears as a virtual slope. Because the e𝕧^{0} side is an infinitesimal then when the derivative is taken with respect to e𝕧 it gives -𝕚d/e𝕧.

Fluxions

When the Pythagorean Triangle is regarded as an integral field it is in the form -𝕚d^{0}×e𝕧 where -𝕚d^{0} is a fluxion or instant, then when the first integral is taken with respect to -𝕚d it becomes -𝕚d×e𝕧. This is still not measured, it is a field which can exist and be measured as -𝕀D×e𝕧 inertial work.

A derivative or integral

This process is consistent with conventional calculus, the infinitesimal e𝕧^{0} and fluxion -𝕚d^{0} are not actually part of a velocity or field. Instead they can become one of these, the e𝕪 and -𝕘d Pythagorean Triangle as the photon can be regarded as being in either of these two states as well. It still has a constant Pythagorean Triangle area.

Tanθ and intθ

The changing from cos θ to sin θ below comes from the x and y axes being distances, like two e𝕧 lengths. This model works where one axis is a distance and the other is spin, tan θ works with the derivative and the integral of the tanθ Pythagorean Triangle is called int θ here. Tan θ can be converted into int θ through the constant Pythagorean Triangle area, the area does not change but the ratios of the Pythagorean Triangle sides do change. There is a similar constraint with tanθ in this model, the constant Pythagorean Triangle area means that as the angle changes one side must change inversely to the other.

Antiderivatives and integrals

The antiderivative can be taken from -𝕚d/e𝕧 as -𝕚d×e𝕧$^{-1}$ to give -𝕚d/e𝕧^{0} as a state, then -𝕚d×e𝕧$^{+1}$ as an integral with respect to -𝕚d would be the inertial momentum.

Antiintegrals and derivatives

Conversely the inertial momentum can be written as -𝕚d×1/e𝕧$^{-1}$ which with an antiintegral with respect to e𝕧 gives -𝕚d/e𝕧^{0} and the derivative with respect to e𝕧 is -𝕚d/e𝕧$^{+1}$.

Changing cosθ into sinθ

When cosθ is used this for particles and impulse, like the particle at the end of the rotating spoke. There is no force and so there is no actual observation, this can be converted into sinθ. Taking e𝕧/ζ, here ζ is the hypotenuse, this is equivalent to 1/(-𝕚d×ζ) because the inverse of e𝕧 is -𝕚d. This gives -𝕚d×ζ as an integral field, in this model that would be an approximation because only the straight and spin Pythagorean Triangle sides can be observed and measured.

Sinθ to cosθ as an approximation

This can also be -𝕚d/ζ as an approximation because this would be -𝕚d×ζ as an integral, taking it as a derivative -𝕚d/ζ means that 1/(e𝕧×ζ) is approximately an integral. In some calculations this would be unimportant, the problem comes when work is to be measured or impulse observed.

Making a Pythagorean Triangle side a fraction

The two can be distinguished by regarded 1/-𝕚d × ζ as sinθ, the spin side would be a fraction according to some scale. For example if this was in degrees then using a scale of 60° increments might make it a fraction. Also e𝕧 can be 1/e𝕧 by changing the scale from meters to kilometers for example. This can keep the derivative and integral separate.

Initial Conditions: The Phase Constant

Now we're ready to consider the issue of other initial conditions. The particle in Figure 15.5 started at $\phi_0 = 0$. This was equivalent to an oscillator starting at the far right edge, $x_0 = A$. FIGURE 15.6 shows a more general situation in which the initial angle ϕ_0 can have any value. The angle at a later time t is then

$$\phi = \omega t + \phi_0 \quad (15.13)$$

In this case, the particle's projection onto the x-axis at time t is

$$x(t) = A\cos(\omega t + \phi_0) \quad (15.14)$$

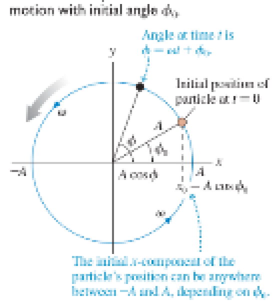
If Equation 15.14 describes the particle's projection, then it must also be the position of an oscillator in simple harmonic motion. The oscillator's velocity v_x is found by taking the derivative dx/dt. The resulting equations,

$$x(t) = A\cos(\omega t + \phi_0)$$
$$v_x(t) = -\omega A\sin(\omega t + \phi_0) = -v_{max}\sin(\omega t + \phi_0) \quad (15.15)$$

are the two primary kinematic equations of simple harmonic motion.

The quantity $\phi = \omega t + \phi_0$, which steadily increases with time, is called the **phase** of the oscillation. The phase is simply the *angle* of the circular-motion particle whose shadow matches the oscillator. The constant ϕ_0 is called the **phase constant.** It is determined by the *initial conditions* of the oscillator.

FIGURE 15.6 A particle in uniform circular motion with initial angle ϕ_0.



Spring compression and decompression

When the block moves below this is like a spring compressing and decompressing. The phase is the starting position, from there the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse can have different values.

Torque in molecular bonds

The torque on the molecular bonds causes the spring to twist and untwist. There can then be a different E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse at different phases of the spring, that would be at a given kinetic or inertial time depending on the phase. This twisting comes from -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work.

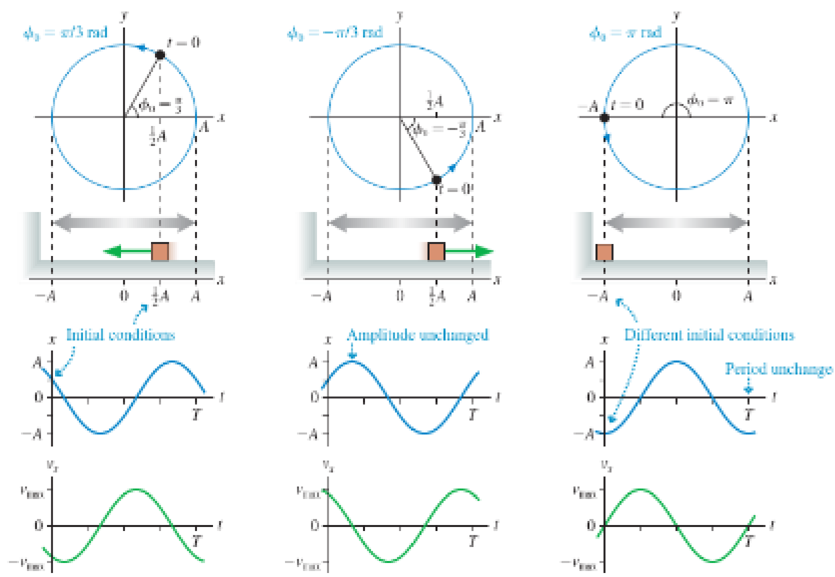
Impulse is not regular

The oscillation comes from -𝕆D×e𝕪 kinetic work because it is a regular motion, impulse would be chaotic. For example if two springs were connected together than, like a double pendulum, the motion comes more from the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. This occurs because some of the spin is opposed and cancels out, that leaves more impulse and irregular motion.

Discrete and continuous spectrums

This can be seen with a spectrum, the discrete spectrum comes from the -𝕆D×e𝕪 kinetic work of the electrons and the -𝔾D×e𝕪 light work of the photons. That appears from whole numbers because a fraction would be from a derivative. If the e𝕐/-𝕘d light impulse was also like a spring oscillating, then the discrete spectrum would also be quantized. When there is chaotic motion the different periods as -𝕠d kinetic time and -𝕚d inertial time fill in the gaps between the oscillations of the spring.

FIGURE 15.7 Different initial conditions are described by different values of the phase constant.



Potential and kinetic work and impulse

In this model the potential comes from the protons, there would be +𝕆D×e𝕒 potential work done as a reaction like inertia. The kinetic energy comes from -𝕆D×e𝕪 kinetic work, the two are flexing the molecular bonds causing an oscillation. This is represented in the diagram as two parabolas, that comes from +𝕆D as the squared potential magnetic torque and -Od as the squared kinetic magnetic torque.

Excessive oscillation

The oscillation causes the +𝕆D potential probability to have the -𝕆D kinetic probability subtracted from it. The overall value corresponds to the how much the molecular bonds of the electrons are stretched. When -𝕆D is larger than +𝕆D then an electron can leave the atom, breaking a molecular bond. This is why an excessive oscillation can break the spring.

Magnetic oscillation

The spring could also be oscillated by a magnetic field, this would be where the weight on the end was a magnet for example. Then the -𝕀D kinetic magnetic probability causes the electrons in the magnet to move where they are most probably to be found. This is the active force of the magnet, the same process also happens in between the +𝕆D potential magnetic probability of the protons and the -𝕆D kinetic magnetic probability of the electrons in the molecular bonds. This can also happen with the rotary motion of a motor, this is like the circle above. That can drive a piston converting work to impulse.

Parabolas as work and impulse

The diagram compares two parabolas, in this model they are formed with one Pythagorean Triangle being squared and the other being linear as $y=x^2$. This can be either work or impulse, a projectile might move in a parabola as a particle with an E𝕍/-𝕚d inertial impulse. It would be pulled downwards by a Eℍ/+𝕚d gravitational impulse. When this is work it forms an integral field, for example +𝕀D×eℍ gravitational work around a planet varies according to the inverse square rule.

Exponentials, normal curves and parabolas

In this model when -𝕆D increases as a square, then e𝕪 decreases as a square root giving an exponential curve. When the force is regarded as an inverse as squared spin terms such as -𝕆D, this gives an inverse exponential curve which here is a probability curve. That comes from -𝕆D being an exponent to base e.

Exponential harder to observe or measure

When motion or gravity is not relativistic, then the exponential is not as easy to observe or measure. It appears in galaxies for example where the changing angles θ form a logarithmic spiral shape. In this model that is like modified gravity, also with a planetary system they tend to form an exponential or Fibonacci spiral in association with the inverse square force of gravity.

Parabolas in between normal curves in a spiral

With the parabola as an integral this gives quantized orbitals, in this model there is also a quantized gravitational effect in a galaxy. This is where the redshift is quantized according to various eℍ heights from the galactic center. The spiral is also formed with the inverse as the Eℍ/+𝕚d gravitational impulse, this allows it to form a logarithmic spiral where the outside edges are slowing down. The quantized +𝕀D×eℍ gravitational work gives normal curves which are quantized levels, in between these there can be a parabola where stars can rise or fall to another quantized level.

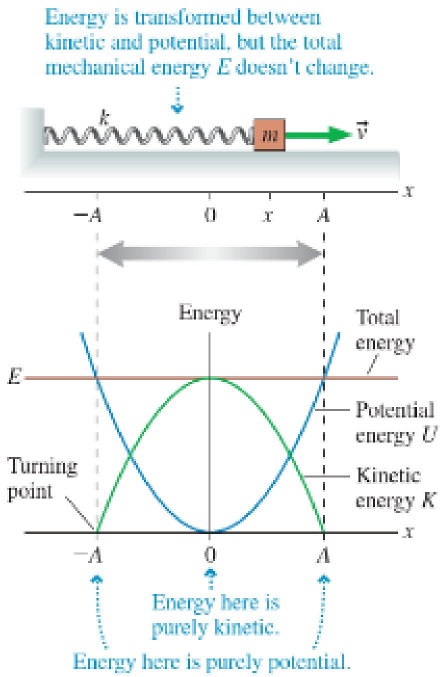
Opposing parabolas as δ

In this model the parabola is the limit of δ as the first Fiegenbaum number, this forms cascades of near parabolas in chaos. It is close to the universal parabolic constant here called κ. The balancing of two parabolas in harmonic motion is like two opposing irregular chaotic forces, when they are unbalanced there is more irregular motion. They are in between the normal curve work forming regular oscillations, also the exponentials such as the spiral.

Electron clouds of work

With quantum mechanics these squared forces give probability densities when the work is measured. The electron clouds for example are being measured with their own distances of e𝕪 as the kinetic electric charge and e𝕧 as lengths. This measures where the electrons clouds are probably found, not an external distance in a laboratory. When they act like particles they form a more irregular motion in this cloud with impulse. This is for example where they would move towards another orbital then fall back again approaching a parabola.

FIGURE 15.8 Energy transformations during SHM.



Potential and kinetic energy

This would be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy being observed, but these can also be measured over a distance as a e𝕙 height and a e𝕧 length. That comes from the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. This is because there are two forces as squares being divided, in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy for example there is E𝕐 from the E𝕐/-𝕠d kinetic impulse and -𝕆D from -𝕆D×e𝕪 kinetic work. The distance in which the spring compresses and decompresses is inverse to the time taken, that allows for the period of the oscillation to be used or the amplitude in observing or measuring the energy.

Potential and kinetic energy as inverses

The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy are inverses of each other, this comes from the constant Pythagorean Triangle areas of the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the -𝕠d and e𝕪 Pythagorean Triangle as the electron. Because these sum to an approximate constant, it gives a maximum ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy when the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy is a minimum but not zero. That is because a constant Pythagorean Triangle area cannot have a zero side, then the area would also be zero.

You can see that **the particle has purely potential energy at $x = \pm A$ and purely kinetic energy as it passes through the equilibrium point at $x = 0$.** At maximum displacement, with $x = \pm A$ and $v = 0$, the energy is

$$E(\text{at } x = \pm A) = U = \tfrac{1}{2}kA^2 \qquad (15.19)$$

At $x = 0$, where $v = \pm v_{max}$, the energy is

$$E(\text{at } x = 0) = K = \tfrac{1}{2}m(v_{max})^2 \qquad (15.20)$$

The system's mechanical energy is conserved because the surface is frictionless and there are no external forces, so the energy at maximum displacement and the energy at maximum speed, Equations 15.19 and 15.20, must be equal. That is

$$\tfrac{1}{2}m(v_{max})^2 = \tfrac{1}{2}kA^2 \qquad (15.21)$$

Spring constant

The dimensions of the spring constant k are m/s^2 or mass divided by the square of time. With the molecular bonds this is the +𝕠d potential mass divided by +𝕆D as the potential time squared to give 1/+𝕠d. Then this is divided by the +𝕚d gravitational mass to give 1/(+𝕠d×+𝕚d), proportionally that can be written as 1/+𝕆D or 1/+𝕀D.

Speed from the spring constant

The square root is taken of this to give 1/+𝕠d or 1/+𝕚d, then this is multiplied by the amplitude A which can be e𝕒 as the altitude or e𝕙 as the height. This can then give the potential speed as e𝕒/+𝕠d or the gravitational speed as e𝕙/+𝕚d.

Kinetic energy and the spring constant

This can also be written in terms of the kinetic energy of the electrons and their inertia as an inverse. The stronger the molecular bonds are the stronger the potential is, and the stronger the gravity of the protons is. Then the kinetic energy of the electrons is inversely lower as is their inertia. That gives -𝕚d as the inertial mass divided by -𝕀D as the inertial time squared, that is divided by the -𝕚d inertial mass to give 1/(-𝕠d×-𝕠d) or 1/(-𝕚d×-𝕚d). The square root is taken which gives 1/-𝕠d or 1/-𝕚d, then this is multiplied by the e𝕪 kinetic electric charge or e𝕧 length to give the kinetic velocity e𝕪/-𝕠d which is proportional to the inertial velocity e𝕧/-𝕚d.

Height and length look the same

These are inverses of each other, but generally the -𝕚d inertial mass of a material is equivalent to its +𝕚d gravitational mass. This is because there are an approximately equal number of +𝕠d protons and -𝕠d electrons. The e𝕙 height appears the same as the e𝕧 length in the macro world, because of the constant Pythagorean Triangle areas that makes the +𝕚d gravitational mass appear to be the same as the -𝕚d inertial mass.

The spring constant in the macro world

The spring constant is a macro world value, the electrons as the -𝕠d and e𝕪 Pythagorean Triangle have a different behavior to protons as the +𝕠d and e𝕒 Pythagorean Triangle. This is seen in quantum mechanics.

Thus the maximum speed is related to the amplitude by

$$v_{max} = \sqrt{\frac{k}{m}}A \tag{15.22}$$

This is a relationship based on the physics of the situation.

Earlier, using kinematics, we found that

$$v_{max} = \frac{2\pi A}{T} = 2\pi fA = \omega A \tag{15.23}$$

Comparing Equations 15.22 and 15.23, we see that frequency and period of an oscillating spring are determined by the spring constant k and the object's mass m:

$$\omega = \sqrt{\frac{k}{m}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad T = 2\pi\sqrt{\frac{m}{k}} \tag{15.24}$$

These three expressions are really only one equation. They say the same thing, but each expresses it in slightly different terms.

Equations 15.24 tell us that the period and frequency are related to the object's mass m and the spring constant k. It is perhaps surprising, but **the period and frequency do not depend on the amplitude A.** A small oscillation and a large oscillation have the same period.

Total impulse is a constant

The total mechanical energy E is a constant, this comes from the constant Pythagorean Triangle areas. When the E𝕐/-𝕠d kinetic impulse as E𝕐 increases, then with the E𝔸/+𝕠d potential impulse E𝔸 decreases inversely. This gives E𝔸-E𝕐 as a constant. This would be with vector subtraction, e𝕒 and e𝕪 are not themselves positive or negative. This means the total impulse is a constant.

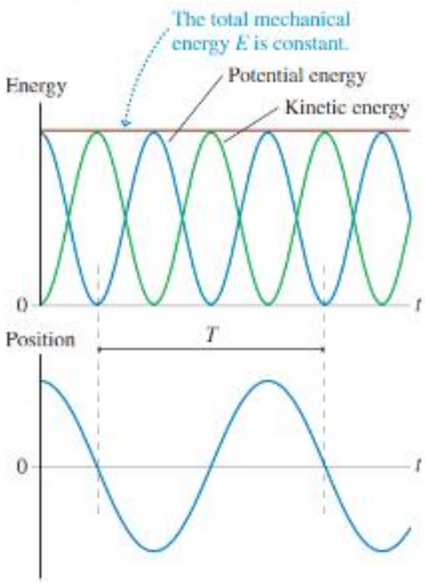
Total work is a constant

From this with the +𝕆D×e𝕒 potential work and the -𝕆D×e𝕪 kinetic work, +𝕆D is inversely proportional to -𝕆D. That means the total work is also a constant. Because the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy are made up of impulse and work, this means that summing them is also a constant.

Inertial velocity

In equation (15.26) the e𝕧/-𝕚d inertial velocity would be [(-𝕚d/-𝕀D × 1/-𝕚d)(E𝕍$_i$-E𝕍$_f$)]$^{1/2}$. E𝕍$_i$-E𝕍$_f$, in this model is a displacement from an initial e𝕧 position to a final e𝕧 position. In the equation this has the E𝕍 displacement force, but also a e𝕧 position as the final answer of a e𝕧/-𝕚d inertial velocity. Subtracting two squares gives a square as E𝕍, because these are starting and final positions then E𝕍 represents an acceleration between the two. This is also equal to ω(E𝕍$_i$-E𝕍$_f$)]$^{1/2}$, then ω is the frequency as 1/t or 1/-𝕚d.

FIGURE 15.9 Kinetic energy, potential energy, and the total mechanical energy for simple harmonic motion.



Conservation of Energy

Because energy is conserved, we can combine Equations 15.18, 15.19, and 15.20 to write

$$E = \tfrac{1}{2}mv^2 + \tfrac{1}{2}kx^2 = \tfrac{1}{2}kA^2 = \tfrac{1}{2}m(v_{max})^2 \quad \text{(conservation of energy)} \quad (15.25)$$

Any pair of these expressions may be useful, depending on the known information. For example, you can use the amplitude A to find the speed at any point x by combining the first and second expressions for E. The speed v at position x is

$$v = \sqrt{\frac{k}{m}(A^2 - x^2)} = \omega\sqrt{A^2 - x^2} \quad (15.26)$$

FIGURE 15.9 shows graphically how the kinetic and potential energy change with time. They both oscillate but remain *positive* because x and v are squared. Energy is continuously being transformed back and forth between the kinetic energy of the moving block and the stored potential energy of the spring, but their sum remains constant. Notice that K and U both oscillate *twice* each period; make sure you understand why.

The dynamics of SMH

The simple harmonic motion below comes from the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work being done in the spring. It is also from the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, the spring tends to be compressed by its own gravity and its inertia reacts against this.

Oscillation and work

In this model the vectors shown would be the straight Pythagorean Triangle sides as scales or rulers. They would not be an acceleration or force, this is because only work is associated with oscillation not impulse. As an approximation squared vectors can be used, to represent the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse as a reaction action pair. Also the Eℍ/+𝕚d gravitational impulse and the E𝕍/-𝕚d inertial impulse as an action reaction pair.

Observing impulse in the macro world

In the macro world this would be observing parts of the spring with how they move as an impulse. Also parts can be measured with work, in the molecular bonds these would be separated. Then the molecular bonds would do work over a distance as a scale or ruler. There would also be some collisions in between molecules where there was impulse. However this impulse is not oscillating but represents individual chaotic collisions between particles.

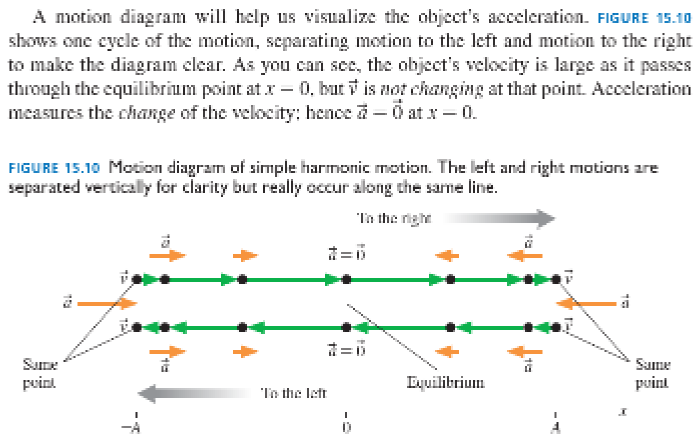

A motion diagram will help us visualize the object's acceleration. FIGURE 15.10 shows one cycle of the motion, separating motion to the left and motion to the right to make the diagram clear. As you can see, the object's velocity is large as it passes through the equilibrium point at $x = 0$, but $\vec{v}$ is *not changing* at that point. Acceleration measures the *change* of the velocity; hence $\vec{a} = \vec{0}$ at $x = 0$.

FIGURE 15.10 Motion diagram of simple harmonic motion. The left and right motions are separated vertically for clarity but really occur along the same line.

Positive and negative acceleration

In this model the terms positive and negative acceleration are avoided, this is because positive is associated with the +𝕠d and e𝕒 Pythagorean Triangle as the proton and gravity as the +𝕚d and e𝕙 Pythagorean Triangle. Negative is the electron as the -𝕠d and e𝕪 Pythagorean Triangle and inertia as the -𝕚d and e𝕧 Pythagorean Triangle.

Acceleration and impulse

In conventional physics acceleration usually refers to meters/second^2, but in this model that is work. The macro world has objects being observed as they accelerate with F=ma, and also with gravitational acceleration. Here meters/second^2 can be converted into meters^2/second, that gives impulse which is where these particles are observed. Work refers to quantization and waves here.

Work and oscillation

The oscillation of the spring happens because of the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work according to this model, because of that it must be an oscillation. The active forces here come from the -𝕆D×e𝕪 kinetic work and the +𝕀D×e𝕙 gravitational work, with the +𝕆D×e𝕒 potential work and -𝕀D×e𝕧 inertial work reacting only.

Spring unlikely to break

When the spring decompresses the -𝕆D×e𝕪 kinetic work is growing, but in the molecular bonds +𝕆D is larger as the potential probability than the -𝕆D kinetic probability. This means the spring is unlikely to break itself in its oscillation, +𝕆D holds it together. This means the atoms are stable with outer electrons being shared as waves of kinetic probabilities to make molecular bonds.

Oscillation as action and reaction

The +𝕆D×e𝕒 potential work is stronger when the spring is fully decompressed, it then reacts against the motion of the spring to return the molecular bonds to their proper shape. This overreacts because these bonds are all themselves oscillations, electrons in orbitals do -𝕆D×e𝕪 kinetic work only. The spring cannot return to stop in the middle because of the -𝕀D×e𝕧 inertial work, this is proportional to the -𝕀D×e𝕧 inertial work being done.

Spring oscillation and Carnot engines

This is like electrons going to a higher orbital, then emitting e𝕪×-𝕘d photons to drop back down. The spring has heated up from being flexed, this causes the electrons to lose their -𝕆D×e𝕪 kinetic work and have a higher kinetic probability of returning to a lower orbital. When the spring recompresses with the -𝕀D×e𝕧 inertial work it becomes smaller, this is analogous to the compression phase of a Carnot engine.

Compression and emitting photons

Then the molecular bonds become too compressed, the electrons can emit e𝕪×-𝕘d photons to shrink their orbital sizes. That causes the heat in the spring to be expelled and absorbed as photons over and over. The same would happen with a gas in a Carnot engine, it might be connected to a large spring which causes the engine to oscillate. Then the compression phase would cause e𝕪×-𝕘d photons to be emitted, then reabsorbed as the spring caused the gas to expand again.

Springs and the Boltzmann constant

This would connect the spring and the Carnot engine with the Boltzmann constant, in this model the statistical nature of this is associated with torque on the gas molecules as well as an oscillation. Here the constant k is -𝕠d ×e𝕪/-𝕆d, there is -𝕆D×e𝕪 kinetic work being measured. When the spring oscillates this is again from the -𝕆D×e𝕪 kinetic work. The -𝕆D kinetic torque is where the molecular bonds are being flexed rather than gas molecules bouncing off each other.

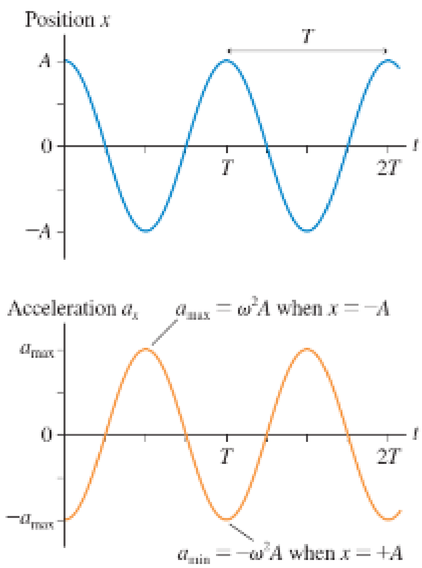
Integrals and work, derivatives and impulse

In this model the integral would be taken of the -𝕚d×e𝕧 inertial momentum to give the -𝕀D×e𝕧 inertial work. Taking the derivative of the -𝕚d/e𝕧 inertial velocity would give -𝕚d/E𝕍 as the E𝕍/-𝕚d inertial impulse. This is inverted to be consistent with the derivative rule but the answer is the same.

Sine waves not cosine waves

Here sinωt is the frequency of a Pythagorean Triangle as it changes, this does not use the cosine here because that is only with the E𝕐/-𝕠d kinetic impulse. When the frequency ω as 1/t, or 1/-𝕚d is squared that gives 1/-𝕀D as the same term in the -𝕀D×e𝕧 inertial work. The wave is then changing as an integral field not a derivative here.

FIGURE 15.11 Position and acceleration graphs for an oscillating spring. We've chosen $\phi_0 = 0$.



In contrast, the velocity is changing rapidly at the turning points. At the right turning point, $\vec{v}$ changes from a right-pointing vector to a left-pointing vector. Thus the acceleration $\vec{a}$ at the right turning point is large and *to the left*. In one-dimensional motion, the acceleration component a_x has a large *negative* value at the right turning point. Similarly, the acceleration $\vec{a}$ at the left turning point is large and *to the right*. Consequently, a_x has a large positive value at the left turning point.

Our motion-diagram analysis suggests that the acceleration a_x is most positive when the displacement is most negative, most negative when the displacement is a maximum, and zero when $x = 0$. This is confirmed by taking the derivative of the velocity:

$$a_x = \frac{dv_x}{dt} = \frac{d}{dt}(-\omega A \sin \omega t) = -\omega^2 A \cos \omega t \qquad (15.27)$$

then graphing it.

Kinetic work begins the oscillation

In this model the positive sign of +𝕠d would be restoring or reactive. The negative sign of -𝕠d would be an active value. So initially there might be active -𝕆D×e𝕪 kinetic work done on the spring, this can be in pulling it out further or compressing it. That is measured according to a distance e𝕪 as the kinetic electric charge on a scale, proportional to that is the e𝕧 length. The positive reactive value tends to restore the molecular bonds to their most probable positions, this is when the back and forward oscillations are dissipated by the emission of e𝕪×-𝕘d photons.

Springs slow down from work

A spring slows down because work comes from probability and randomness. Instead of impulse where collisions are elastic, here work generates heat as waves. That causes a spring to work like a Carnot engine, the compression and expansion can pump heat over a distance. This also happens with a bicycle pump for example, the air molecules are forced together in compression. This causes e𝕪×-𝕘d photons to be emitted as the electrons are moved to lower orbitals.

Spring constant and kinetic energy

The spring force here is given by kx which is e𝕧/-𝕀D × e𝕧. This makes the forces the same as in the ½×e𝕍/-𝕀d ×-𝕚d linear inertia, after multiplying this by the -𝕚d inertial mass. The heavier the spring with its -𝕠d kinetic mass or -𝕚d inertial mass then then the more force it has. This can be more -𝕆D×e𝕪 kinetic work as -𝕆D is a square as the inertial probability. Conversely it has a smaller E𝕍/-𝕚d inertial impulse because it has a lower inertial acceleration, this is because work and impulse are inverses. A lighter spring can then accelerate faster but do less work.

Hooke's law

Hooke's Law in (15.29) is E𝕍/-𝕀D so this changes with the -𝕚d inertial mass of the spring. The inertial acceleration from the ½×e𝕍/-𝕀d ×-𝕚d linear inertia is e𝕧/-𝕀D, that is multiplied by x as e𝕧, then the -𝕚d inertial mass is divided to remove it from the equation.

$$a_x = -\omega^2 x \qquad (15.28)$$

That is, **the acceleration is proportional to the negative of the displacement.** The acceleration is, indeed, most positive when the displacement is most negative and is most negative when the displacement is most positive.

Recall that the acceleration is related to the net force by Newton's second law. Consider again our prototype mass on a spring, shown in FIGURE 15.12. This is the simplest possible oscillation, with no distractions due to friction or gravitational forces. We will assume the spring itself to be massless.

You learned in Chapter 9 that the spring force is given by Hooke's law:

$$(F_{Sp})_x = -k\,\Delta x \qquad (15.29)$$

The minus sign indicates that the spring force is a **restoring force,** a force that always points back toward the equilibrium position. If we place the origin of the coordinate system at the equilibrium position, as we've done throughout this chapter, then $\Delta x = x$ and Hooke's law is simply $(F_{Sp})_x = -kx$.

The x-component of Newton's second law for the object attached to the spring is

$$(F_{net})_x = (F_{Sp})_x = -kx = ma_x \qquad (15.30)$$

Equation 15.30 is easily rearranged to read

$$a_x = -\frac{k}{m}x \qquad (15.31)$$

Work as a fraction

In this model the inertial acceleration comes from -𝕀D×e𝕧 inertial work, this can be written as e𝕧/-𝕀D by changing the units of inertial time or inertial mass. For example making the inertial mass tons or the inertial time years would make it a fraction. Here it remains work as a field, the fraction does not mean it is a second derivative.

Velocity and impulse

With the 𝔼𝕍/-𝕚d inertial impulse this is approximately the same as e𝕧/-𝕀D in the macro world, the difference is in impulse the squared force comes from 𝔼𝕍 not -𝕀D. This has an initial inertial velocity -𝕚d/e𝕧 as seconds/meter, in this form the second derivative becomes seconds/meter^2 as -𝕚d/𝔼𝕍. There is then a first derivative with respect to e𝕧 which is not observable as a force, then there is an observable inertial acceleration from the -𝕚d/𝔼𝕍 inertial impulse.

$$a_x = \frac{dv_x}{dt} = \frac{d^2x}{dt^2}$$

Acceleration is the second derivative of position with respect to time. If we use this definition in Equation 15.31, it becomes

$$\frac{d^2x}{dt^2} = -\frac{k}{m}x \quad \text{(equation of motion for a mass on a spring)} \qquad (15.32)$$

Equation 15.32, which is called the **equation of motion,** is a second-order differential equation. Unlike other equations we've dealt with, Equation 15.32 cannot be solved by direct integration. We'll need to take a different approach.

Integrals and derivatives of the angle θ

In this model a Pythagorean Triangle has an angle θ opposite the spin Pythagorean Triangle side, the angle ϕ is opposite the straight Pythagorean Triangle side. Sine and cosine are not used except as an approximation, this is because ζ or the hypotenuse, varies in size as the angle θ changes. This is to maintain the constant Pythagorean Triangle area.

Unitary Pythagorean Triangle sides

The -𝕚d and e𝕧 Pythagorean Triangle as an example can be regarded as having straight Pythagorean Triangle sides of e𝕧^0 and -𝕚d^0. This makes each unitary, then 𝕧^0 is multiplied by e and -𝕚^0 is multiplied by d. This is like the term ni used in conventional calculus, i is the square root of -1 times n. That is like -$\mathbb{i}^0$d where this is the negative square root of -1 times d instead of n. Here e$\mathbb{v}^0$ has $\mathbb{v}^0$ as a kind of unitary value, it can still be multiplied by e to give different values. With the +$\mathbb{o}$d and e$\mathbb{a}$ Pythagorean Triangle as the proton there is then +$\mathbb{o}^0$d as the positive square root of -1 and so on with +$\mathbb{i}^0$d and -$\mathbb{o}^0$d, e$\mathbb{a}^0$, e$\mathbb{h}^0$, and e$\mathbb{y}^0$.

Fluxions and infinitesimals

Because -$\mathbb{i}d^0$ and e$\mathbb{v}^0$ are unitary in different ways, this can be regarded as a definition here of a fluxion or instant, and an infinitesimal or position respectively. They can become an integral field such as -$\mathbb{i}d^1$×e$\mathbb{v}^0$ or a derivative particle -$\mathbb{i}d^0$×e$\mathbb{v}^{-1}$ without being observed or measured as forces. This can happen by changing the multiplication and division signs, -$\mathbb{i}d^1$×e$\mathbb{v}^0$ as an integral with respect to -$\mathbb{i}$d uses e$\mathbb{v}^0$ as positions on a ruler or scale because the exponent remains zero.

Changing from fluxions and infinitesimals

But the exponent of -$\mathbb{i}d^1$ means this has changed, not as a force but as a field relative to this scale. The spin Pythagorean Triangle side here is no longer a fluxion but is a linear value. With the derivative -$\mathbb{i}d^0$×e$\mathbb{v}^{-1}$ with respect to e$\mathbb{v}$ this has become a fraction, e$\mathbb{v}$ is no longer an infinitesimal and is part of the inertial velocity -$\mathbb{i}^0$d/e$\mathbb{v}$.

A velocity in an instant

It can then represent a distance or length while -$\mathbb{i}d^0$ is inertial time on a clock gauge in instants, or fluxions. The word moment can be confusing as it refers to a torque in conventional physics. For example -$\mathbb{I}$D could be regarded as a moment of torque, here it is also referred to as a duration.

Definitions for physics and calculus

This has the advantage of giving definitions here for infinitesimals and fluxions, they are compatible or convertible with calculus. It is not intended to substitute these for the calculus rules in mathematics, instead to show how they work in this model to describe physics.

Squared infinitesimals and fluxions

This also allows for a squared force to be an exponent, -$\mathbb{i}$d would become -$\mathbb{I}$D for example where D is the square of d. With e$\mathbb{v}$ it becomes E$\mathbb{V}$ as a squared force, a capital letter then is a convention for a square. With int θ then that go from the inertial momentum -$\mathbb{i}$d×e$\mathbb{v}^0$ to -$\mathbb{I}$D×e$\mathbb{v}^0$ inertial work. With tan θ that would be the same as the -$\mathbb{i}d^0$/e$\mathbb{v}^1$ inertial momentum here, with another derivative with respect to e$\mathbb{v}$ that is the E$\mathbb{V}$/-$\mathbb{i}d^0$ inertial impulse. As a convention here, -$\mathbb{i}$d would again be -$\mathbb{i}d^0$ and e$\mathbb{v}$ would be e$\mathbb{v}^{0.}$

Amplitude as distance

In (15.33) the amplitude A would be a straight Pythagorean Triangle such as the e$\mathbb{v}$ wavelength with inertia, the e$\mathbb{y}$×-$\mathbb{g}$d photons, and the -$\mathbb{o}$d and e$\mathbb{y}$ Pythagorean Triangle electron. A would be the e$\mathbb{h}$ height with an ocean wave for example, also the e$\mathbb{a}$ altitude or potential electric charge of the proton. This is x(t), it would be varying as the cosine angle changes in an oscillation.

Approximations with sines and cosines

With this model the cosine would not be used, instead it would be associated with intθ as a field or sinθ using the spin Pythagorean Triangle side divided by the hypotenuse as an approximation. As shown earlier, the cosine can be converted approximately into the sine. These can also be equivalent as before with a change of units, instead of intθ as -𝕚d×ζ it can be ζ/-𝕚d where the seconds of -𝕚d becomes hours for example. These approximations can be used as long as the difference between integrals and derivatives is tracked.

Inverting Pythagorean Triangle sides in trigonometry

Inverting terms like -𝕚d/ζ to ζ/-𝕚d can also be like cosecants for example, these are intended to be transformations between derivatives and integrals. If the units are defined these should not be confused. ζ is also not defined, it can be regarded as being a distance or spin or a combination of both.

The rolling wheel with sines and cosines

In (15.34) there is a change from cosines to sines, in this model that would be an approximation because sines are associated with waves and cosines with amplitude. Beginning with a derivative -𝕚d/e𝕧 this can use the rolling wheel model. There the axle is -𝕚d and the spoke is e𝕧, this gives a constant velocity as it rolls. The tip of the spoke can trace out a cosine wave, however this would be observing its motion as the E𝕍/-𝕚d inertial impulse. That would comes from -𝕚d/E𝕍 as the second derivative with respect to e𝕧.

Tracing out sines and cosines

If this rolling wheel is regarded as a field then the integral of its motion is -𝕚d×e𝕧, this refers to the end of the e𝕧 spoke tracing out the circle's area as it turns. This gives a sine wave in terms of intθ as the Pythagorean Triangle area or integral. The cosine wave comes from observing this point in the horizontal plane like a piston moving backwards and forwards. When this is forward it is like the peak of the cosine wave, but with the sine wave this is where the spoke end is moving the fastest.

The sine and cosine waves are not measurable or observable

When there is a constant e𝕧/-𝕚d inertial velocity, or a constant -𝕚d×e𝕧 inertial momentum, there are no forces. The tracing out of the sine and cosine waves are not measurable or observable. This happens with the second derivative being an observation of the E𝕍/-𝕚d inertial impulse and the second integral being a measurement of the -𝕀D×e𝕧 inertial work.

Observing the cosine as a piston

Instead the cosine wave is observable only as the impulse of this piston like motion over time on an inertial clock gauge. This is like a steam piston on a train, if the track moved up a hill then this piston would slow down as its E𝕍/-𝕚d inertial impulse took longer in -𝕚d inertial time to move backwards and forwards.

Measuring the sine as torque

The sine wave is measurable only as the twisting or torque as it moves the spoke around. When this spoke is constantly turning there is no torque, if the wheel moved onto a hill then it would slow and the -𝕀D inertial torque would react against this. There would be a measurable change in the rolling wheel with its -𝕀D inertial torque, if it was attached to a car then the engine might exert more kinetic torque to kinetically accelerate up the hill.

Work and the square of time

In (15.34) this is referring to work because of t^2 but it is written as a second derivative. Changing from a sine wave to a cosine wave in this model is done by preserving the difference between an integral field and a cosine particle.

The inertial velocity would then be a cosine not a sine, this is equivalent by changing the Pythagorean Triangle side used. Here a sine uses the angle θ opposite the spin Pythagorean Triangle side such as -𝕚d.

Converting sines into cosines

Beginning with x this would be e𝕧, the rolling wheel would have $-𝕚^0$d×e𝕧 as this position times a fluxion or instant. When the derivative was taken with respect to -𝕚d that would give $-𝕚^{-1}$d×e𝕧 or e𝕧/-𝕚d. A second derivative to get back to a sine wave means that there is a force, this can be regarded as the -𝕀D×e𝕧 inertial work written as e𝕧/-𝕀D which in this model refers to the -𝕀D inertial torque of the rolling wheel axle.

Phase with time and distance

The phase refers to an angle the spoke is at on the rolling wheel. If the wheel began with this spoke at a given angle that would be the phase. This would change the -𝕀D×e𝕧 inertial work the rolling wheel would do with the spoke, conversely the phase would change the motion of the piston with a different starting point. This could be regarded as defining a different starting instant for the piston, for the axle it can refer to a different position on the road corresponding to this angle. That preserves the difference between impulse with time and work with distance using phase.

Angular frequency and the spring constant

ωt becomes √(k/m), this is the spring constant k as mass divided by time squared, then divided by the mass. Because ω^2 is a square this is $1/t^2$ or 1/-𝕀D, then √(k/m) is √(-𝕚d/-𝕚d × 1/-𝕚d) = √ (1/-𝕀D) = 1/-𝕚d so k/m=1/-𝕀D the same as ω^2.

We know from experimental evidence that the oscillatory motion of a spring appears to be sinusoidal. Let us *guess* that the solution to Equation 15.32 should have the functional form

$$x(t) = A\cos(\omega t + \phi_0) \tag{15.33}$$

where A, ω, and ϕ_0 are unspecified constants that we can adjust to any values that might be necessary to satisfy the differential equation.

If you were to guess that a solution to the algebraic equation $x^2 = 4$ is $x = 2$, you would verify your guess by substituting it into the original equation to see if it works. We need to do the same thing here: Substitute our guess for $x(t)$ into Equation 15.32 to see if, for an appropriate choice of the three constants, it works. To do so, we need the second derivative of $x(t)$. That is straightforward:

$$\begin{aligned} x(t) &= A\cos(\omega t + \phi_0) \\ \frac{dx}{dt} &= -\omega A\sin(\omega t + \phi_0) \\ \frac{d^2x}{dt^2} &= -\omega^2 A\cos(\omega t + \phi_0) \end{aligned} \tag{15.34}$$

If we now substitute the first and third of Equations 15.34 into Equation 15.32, we find

$$-\omega^2 A\cos(\omega t + \phi_0) = -\frac{k}{m}A\cos(\omega t + \phi_0) \tag{15.35}$$

Equation 15.35 will be true at all instants of time if and only if $\omega^2 = k/m$. There do not seem to be any restrictions on the two constants A and ϕ_0—they are determined by the initial conditions.

So we have found—by guessing!—that *the* solution to the equation of motion for a mass oscillating on a spring is

$$x(t) = A\cos(\omega t + \phi_0) \tag{15.36}$$

where the angular frequency

$$\omega = 2\pi f = \sqrt{\frac{k}{m}} \tag{15.37}$$

is determined by the mass and the spring constant.

Vertical oscillations

Vertical oscillations occur with +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work. Because the +𝕠d and e𝕒 Pythagorean Triangle as the proton is reactive like inertia, and the +𝕚d and e𝕙 Pythagorean Triangle as gravity is active like kinetic energy, then the same process occurs here. The proton as +𝕆D×e𝕒 potential work is reactive only like inertia, it reacts against the -𝕆D×e𝕪 kinetic work of the electrons in the molecular bonds of the spring. Vertically this is another action/reaction pair.

Kinetica, inertia, potential, and gravity

The work kinetica can be used here for the -𝕠d and e𝕪 Pythagorean Triangle as the electron. It comes from kinetikos in latin and kinetic energy, this makes it a nound instead of an adjective. This means the word energy need not be used, kinetica can be composed of work and impulse. Inertia and iners are proportional to this with the -𝕚d and e𝕧 Pythagorean Triangle. Potentia refers to the proton as the +𝕠d and e𝕒 Pythagorean Triangle and gravity or gravis as the +𝕚d and e𝕙 Pythagorean Triangle.

Four action/reaction pairs

Gravity is an active force, this acts while the proton reacts against this as an action/reaction pair. With molecular bonds, as they move, gravity tends to twist them with a +𝕀D gravitational torque. The +𝕆D potential torque reacts against this proportionally. The -𝕀D inertial torque also reacts against gravity, so there are two reactive forces against an active one. Adding the -𝕆D kinetic torque there are then two reactive forces, the +𝕆D potential torque and the -𝕀D inertial torque, and two active forces as the +𝕀D gravitational torque and the -𝕆D kinetic torque.

Spring scales and gravity/potentia

+𝕀D×e𝕙 gravitational work pulls the spring down while the +𝕆D×e𝕒 potential work reacts against this to restore the molecular bonds to their original position. If this spring is a spring scale, then this is measuring the +𝕀D gravitational weight over a change in e𝕙 height. Because of the equivalence principle a rising elevator would measure the -𝕀D×e𝕧 inertial work, then there is the -𝕀D inertial weight being measured over a e𝕧 length as the spring compresses.

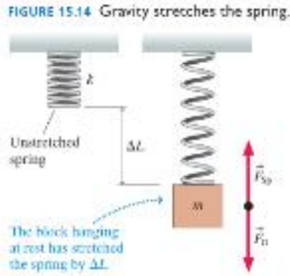
Molecular bonds and the equivalence principle

In the spring there is also the +𝕆D potential weight, where the molecular bonds can be measured with how much they react against both of these forces. The -𝕆D kinetic weight would be for example the energy used to move the elevator upwards, also to hang the spring up as shown below.

Hooke's law as Roy or Biv

This gives two components of Hooke's law in Biv spacetime, gravity from the +𝕚d and e𝕙 Pythagorean Triangle and inertia from the -𝕚d and e𝕧 Pythagorean Triangle. It can also be regarded in Roy electromagnetism as the molecular bonds from the +𝕠d and e𝕒 Pythagorean Triangle protons and the -𝕠d and e𝕪 Pythagorean Triangle electrons. Each of these can be written as work over a distance ΔL, this would be measured with a vector subtraction of e𝕙 and e𝕧, also e𝕒 and e𝕪.

FIGURE 15.14 Gravity stretches the spring.



We have focused our analysis on a horizontally oscillating spring. But the typical demonstration you'll see in class is a mass bobbing up and down on a spring hung vertically from a support. Is it safe to assume that a vertical oscillation has the same mathematical description as a horizontal oscillation? Or does the additional force of gravity change the motion? Let us look at this more carefully.

FIGURE 15.14 shows a block of mass m hanging from a spring of spring constant k. An important fact to notice is that the equilibrium position of the block is *not* where the spring is at its unstretched length. At the equilibrium position of the block, where it hangs motionless, the spring has stretched by ΔL.

Finding ΔL is an equilibrium problem in which the upward spring force balances the downward gravitational force on the block. The y-component of the spring force is given by Hooke's law:

$$(F_{sp})_y = -k\Delta y = +k\Delta L \qquad (15.38)$$

Hooke's law in the y axis

Equation (15.42) is the same as (15.30), this is because it is another action reaction pair using the vertical y axis. That was -𝕆D×e𝕪 kinetic work from initially compressing the spring, then an inertial reaction from the -𝕀D×e𝕧 inertial work. This has an active +𝕀D×e𝕙 gravitational work and a reactive -𝕀D×e𝕧 inertial work. The spring force here F_{sp} is e𝕙/-𝕀D × (e𝕙-e𝕧 in vector subtraction).

Gravitational and inertial mass

Then there is +𝕀D×e𝕙 gravitational work from one e𝕙 height to another, and -𝕀D×e𝕧 inertial work from one e𝕧 position to another. The mass here is the +𝕚d gravitational mass which is equivalent to the -𝕚d inertial mass over this change in e𝕙 height, so it can be removed to leave the work functions. Also mass is implied in the +𝕀D gravitational torque and -𝕀D inertial torque of the molecular bonds. In Roy electromagnetism this can also be written as the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work.

Let the block oscillate around this equilibrium position, as shown in FIGURE 15.15. We've now placed the origin of the y-axis at the block's equilibrium position in order to be consistent with our analyses of oscillations throughout this chapter. If the block moves upward, as the figure shows, the spring gets shorter compared to its equilibrium length, but the spring is still *stretched* compared to its unstretched length in Figure 15.14. When the block is at position y, the spring is stretched by an amount $\Delta L - y$ and hence exerts an *upward* spring force $F_{Sp} = k(\Delta L - y)$. The net force on the block at this point is

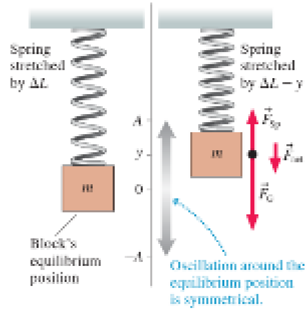
$$(F_{net})_y = (F_{Sp})_y + (F_G)_y = k(\Delta L - y) - mg = (k\,\Delta L - mg) - ky \qquad (15.41)$$

But $k\,\Delta L - mg$ is zero, from Equation 15.40, so the net force on the block is simply

$$(F_{net})_y = -ky \qquad (15.42)$$

Equation 15.42 for vertical oscillations is *exactly* the same as Equation 15.30 for horizontal oscillations, where we found $(F_{net})_x = -kx$. That is, the restoring force for vertical oscillations is identical to the restoring force for horizontal oscillations. The role of gravity is to determine where the equilibrium position is, but it doesn't affect the oscillatory motion around the equilibrium position.

FIGURE 15.15 The block oscillates around the equilibrium position.



A pendulum and circular geometry

In this model circular geometry comes from the +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the +𝕚d and e𝕙 Pythagorean Triangle as gravity. The potential has reactive forces in orbitals, gravity has active forces in orbits. A pendulum can be actively driven by +𝕀D×e𝕙 gravitational work, because it is a regular oscillation this comes from work.

Impulse and chaos

This can also be regarded as partially the Eℍ/+𝕚d gravitational impulse, then the period of the pendulum is observed in +𝕚d gravitational time. With a chaotic pendulum two are joined together, then opposing spins move it with more Eℍ/+𝕚d gravitational impulse.

Roy electromagnetism and atomic clocks

In Roy electromagnetism a pendulum could move with -𝕆D×e𝕪 kinetic work, this is similar to in an atom with an elliptical orbital. Electrons can oscillate like a pendulum in atomic clocks, the +𝕆D×e𝕒 potential work reacts against this. This kind of pendulum is quantized, the atomic clock could jump to another orbital with a different oscillation distance. The quantization from +𝕀D×e𝕙 gravitational work is too small to be measured according to this model, the gravitational waves from it would also be quantized.

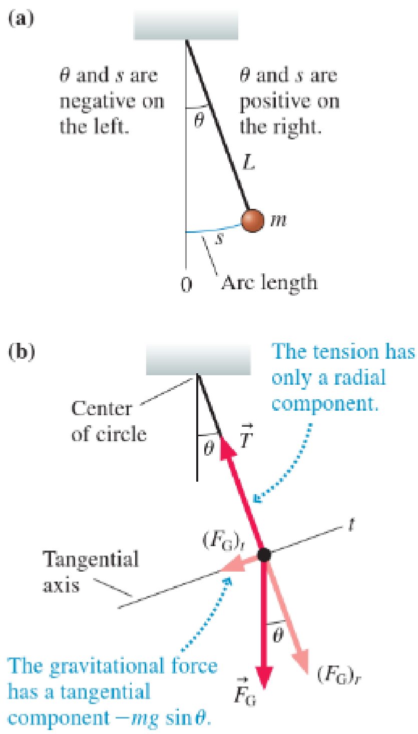
A magnetic pendulum

Another example would be where the pendulum is a magnet with north pointing downwards, this comes from -𝕆D×e𝕪 kinetic work with the magnetic spin of aligned electrons. The pendulum kinetically accelerates towards the south pole of a second magnet pointing upwards, this also does -𝕆D×e𝕪 kinetic work.

The potential reacts against the magnetic alignment changing

The +𝕆D×e𝕒 potential work comes from the protons holding the atoms and electrons from turning, they remain in separate domains pointing in one direction. If not then the spin of the bottom magnet would turn and point to the upper magnet in each oscillation. This would work in orbit without gravity, however the protons are also held in place with their own gravity from the +𝕚d and e𝕙 Pythagorean Triangle. This attracts the inertia of the electrons keeping them aligned.

FIGURE 15.17 Pendulum motion



A pendulum and an integral field

The equation (15.45) has time squared, this can be -𝕀D×e𝕧 inertial work written as e𝕧/-𝕀D in meters/second^2. The pendulum would trace out an integral area as part of a circle, this would use sinθ. In (15.44) this comes from F=ma, that also uses -𝕀D×e𝕧 inertial work where a is e𝕧/-𝕀D. Then multiplied by -𝕠d as the kinetic mass, this is proportional to the -𝕚d inertial mass to give e𝕧/-𝕚d. This is the inertial velocity, a kinetic or gravitational force could act against this reactive inertia.

15.6 The Pendulum

Now let's look at another very common oscillator: a pendulum. FIGURE 15.17a shows a mass m attached to a string of length L and free to swing back and forth. The pendulum's position can be described by the arc of length s, which is zero when the pendulum hangs straight down. Because angles are measured ccw, s and θ are positive when the pendulum is to the right of center, negative when it is to the left.

Two forces are acting on the mass: the string tension $\vec{T}$ and gravity $\vec{F}_G$. As we did with circular motion, it will be useful to divide the forces into tangential components, parallel to the motion, and radial components parallel to the string. These are shown on the free-body diagram of FIGURE 15.17b.

Newton's second law for the tangential component, parallel to the motion, is

$$(F_{\text{net}})_t = \sum F_t = (F_G)_t = -mg\sin\theta = ma_t \tag{15.44}$$

Using $a_t = d^2s/dt^2$ for acceleration "around" the circle, and noting that the mass cancels, we can write Equation 15.44 as

$$\frac{d^2s}{dt^2} = -g\sin\theta \tag{15.45}$$

This is the equation of motion for an oscillating pendulum. The sine function makes this equation more complicated than the equation of motion for an oscillating spring.

Small angle approximation

The small angle approximation is where sinθ approaches tanθ, in this model α is written as -𝕚d/e𝕧 which is tanθ. Sinθ would be -𝕚d/ζ. This also means cosθ approaches 1 where e𝕧≈ζ. Here sines and cosines are not used except as approximations, because of this there is no small angle approximation in the Pythagorean Triangles themselves.

The Small-Angle Approximation

Suppose we restrict the pendulum's oscillations to *small angles* of less than about 10°. This restriction allows us to make use of an interesting and important piece of geometry.

FIGURE 15.18 shows an angle θ and a circular arc of length $s = r\theta$. A right triangle has been constructed by dropping a perpendicular from the top of the arc to the axis. The height of the triangle is $h = r\sin\theta$. Suppose that the angle θ is "small," which, in practice, means $\theta \ll 1$ rad. In that case there is very little difference between h and s. If $h \approx s$, then $r\sin\theta \approx r\theta$. It follows that

$$\sin\theta \approx \theta \quad \text{if} \quad \theta \ll 1 \text{ rad}$$

The result that $\sin\theta \approx \theta$ for small angles is called the **small-angle approximation.** We can similarly note that $l \approx r$ for small angles. Because $l = r\cos\theta$, it follows that

$$\cos\theta \approx 1 \quad \text{if} \quad \theta \ll 1 \text{ rad}$$

Finally, we can take the ratio of sine and cosine to find $\tan\theta \approx \sin\theta \approx \theta$. We will have other occasions to use the small-angle approximation throughout the remainder of this text.

NOTE The small-angle approximation is valid *only* if angle θ is in radians!

How small does θ have to be to justify using the small-angle approximation? It's easy to use your calculator to find that the small-angle approximation is good to three significant figures, an error of $\leq 0.1\%$, up to angles of ≈ 0.10 rad ($\approx 5°$). In practice, we will use the approximation up to about 10°, but for angles any larger it rapidly loses validity and produces unacceptable results.

The period determined by distance

The length of the pendulum is the e𝕙 height of the +𝕚d and e𝕙 Pythagorean Triangle, it moves with +𝕀D×e𝕙 gravitational work. When the e𝕙 height or e𝕧 length of the string is fixed then so is the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work. This means that changing the +𝕚d gravitational mass or -𝕚d inertial mass of the pendulum makes not difference, there is just a different amount of mass moving with the same work.

Galileo and different weights

That is like Galileo discovering how different weights fall together, they could be connected together by a string and represent one big weight still falling with the same gravitational acceleration.

$$(F_{net})_t = -mg\sin\theta \approx -mg\theta = -\frac{mg}{L}s$$

where, in the last step, we used the fact that angle θ is related to the arc length by $\theta = s/L$. Then the equation of motion becomes

$$\frac{d^2s}{dt^2} = \frac{(F_{net})_t}{m} = -\frac{g}{L}s \qquad (15.46)$$

This is *exactly* the same as Equation 15.32 for a mass oscillating on a spring. The names are different, with x replaced by s and k/m by g/L, but that does not make it a different equation.

Because we know the solution to the spring problem, we can immediately write the solution to the pendulum problem just by changing variables and constants:

$$s(t) = A\cos(\omega t + \phi_0) \quad \text{or} \quad \theta(t) = \theta_{max}\cos(\omega t + \phi_0) \qquad (15.47)$$

The angular frequency

$$\omega = 2\pi f = \sqrt{\frac{g}{L}} \qquad (15.48)$$

is determined by the length of the string. The pendulum is interesting in that **the frequency, and hence the period, is independent of the mass.** It depends only on the length of the pendulum. The amplitude A and the phase constant ϕ_0 are determined by the initial conditions, just as they were for an oscillating spring.

A spring oscillation as work

The spring oscillates like a wheel rotating, the amplitude is the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. The motion of the spring comes from the torque applied to the spring's molecular bonds.

Spring length and pendulum string length

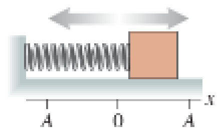
With the pendulum the +𝕚d gravitational mass and -𝕚d inertial mass were independent of the e𝕙 height or e𝕧 length of the string. This meant the period remained the same if the pendulum was swung with more or less torque, that is like a greater amplitude. With the spring the change in amplitude is like the pendulum, the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work being done are according to the size of the spring itself like the e𝕧 length of the pendulum string.

Impulse and work must remain inverses

This must also be consistent with the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse of the spring, they are inverses of the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. The period of the oscillation is the -𝕠d kinetic time and the -𝕚d inertial time. When this remains the same then there is a -𝕆D kinetic displacement force and a -𝕀D inertial displacement force increasing as a square. If the period of the spring changed then inversely the work being done on the spring would also have to change. But this cannot because the e𝕧 length of the spring is the same. Conversely if the spring was shortened then the spring's oscillation time in impulse would increase inversely.

Simple harmonic motion

For any system with a restoring force that's linear or can be well approximated as linear.



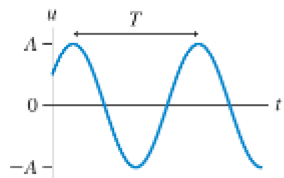
- Motion is SHM around the equilibrium position.
- Frequency and period are independent of the amplitude.
- Mathematically:
  - For an appropriate position variable u, the equation of motion can be written

    $$d^2u/dt^2 = -Cu$$

    where C is a collection of constants.
  - The angular frequency is $\omega = \sqrt{C}$.
  - The position and velocity are

    $$u = A\cos(\omega t + \phi_0) \quad v_u = -v_{max}\sin(\omega t + \phi_0)$$

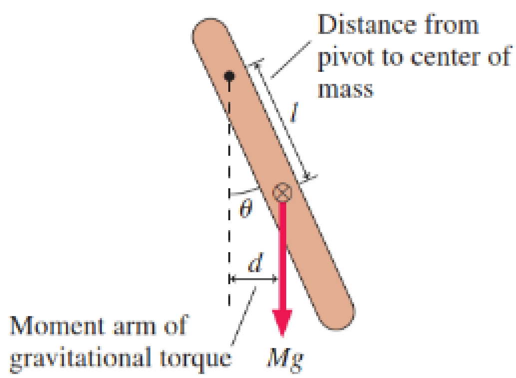
    where A and ϕ_0 are determined by the initial conditions.
  - Mechanical energy is conserved.
- Limitations: Model fails if the restoring force deviates significantly from linear.



The physical pendulum and moments

In this model a moment of torque would refer to a squared spin Pythagorean Triangle side, for example -𝕆D as the kinetic moment or -𝕀D as the inertial moment. It relates to moments on a clock gauge, a duration where a clock hand starts or stops moving with a force. A -$𝕚^0$d value would be an instant or fluxion, a -𝕚d value would be a square root of spin but not as a force. This could be from the -𝕚d×e𝕧 inertial momentum of a hand spinning around the clock gauge. This would have begun with -𝕀D×e𝕧 inertial work and a -𝕀D inertial torque or moment, after this the spin would continue with inertia as -𝕚d.

FIGURE 15.20 A physical pendulum.



Gravitational torque[3]

The +𝕀D gravitational torque is Mgd, this is +𝕚d×e𝕙/+𝕀D × e𝕙 or Eℍ/+𝕚d as the Eℍ/+𝕚d gravitational impulse. This is approximately the e𝕙/+𝕀D gravitational work which is also the acceleration of g as meters/second^2. In this model work would be used because this is a regular oscillation, also +𝕀D is the gravitational torque or moment. This is also written below as -Mglsinθ, the value of +𝕀D changes with the angle θ.

Newton's second law for rotary motion

Newton's second law for rotational motion is τ/l which here is +𝕀D/e𝕙, the dt^2 factor is +𝕀D here. The angle θ changes the +𝕀D gravitational torque because it is in circular geometry pointing to the center of a planet.

Inertial and gravitational work as inverses

When the pendulum is pointing straight down the +𝕀D gravitational torque or moment is weakest, inversely to this the -𝕀D inertial torque is strongest in -𝕀D×e𝕧 inertial work. When the pendulum pauses the -𝕀D×e𝕧 inertial work goes to a minimum, there the +𝕀D×e𝕙 gravitational work is inversely the strongest.

A mass on a string is often called a *simple pendulum*. But you can also make a pendulum from any solid object that swings back and forth on a pivot under the influence of gravity. This is called a *physical pendulum*.

FIGURE 15.20 shows a physical pendulum of mass M for which the distance between the pivot and the center of mass is l. The moment arm of the gravitational force acting at the center of mass is $d = l\sin\theta$, so the gravitational torque is

$$\tau = -Mgd = -Mgl\sin\theta$$

The torque is negative because, for positive θ, it's causing a clockwise rotation. If we restrict the angle to being small ($\theta < 10°$), as we did for the simple pendulum, we can use the small-angle approximation to write

$$\tau = -Mgl\theta \qquad (15.49)$$

Gravity exerts a linear restoring torque on the pendulum—that is, the torque is directly proportional to the angular displacement θ—so we expect the physical pendulum to undergo SHM.

From Chapter 12, Newton's second law for rotational motion is

$$\alpha = \frac{d^2\theta}{dt^2} = \frac{\tau}{I}$$

where I is the object's moment of inertia about the pivot point. Using Equation 15.49 for the torque, we find

$$\frac{d^2\theta}{dt^2} = \frac{-Mgl}{I}\theta \qquad (15.50)$$

The equation of motion is of the form $d^2\theta/dt^2 = -C\theta$, so the model for simple harmonic motion tells us that the motion is SHM with angular frequency

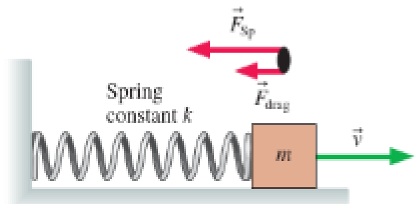
$$\omega = 2\pi f = \sqrt{\frac{Mgl}{I}} \qquad (15.51)$$

It appears that the frequency depends on the mass of the pendulum, but recall that the moment of inertia is directly proportional to M. Thus M cancels and the frequency of a physical pendulum, like that of a simple pendulum, is independent of mass.

Damped oscillations

A drag force comes from randomness, the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work are from torque and so work against straight-line motion. This causes the spring to slow its E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, random heat is emitted as e𝕪×-𝕘d photons.

FIGURE 15.21 An oscillating mass in the presence of a drag force.



Exponential decay and Boltzmann's constant

In equation (15.55) there is an exponential decay, this is negative and as a spin exponent as -iω. With this model that is -𝕚d for example as inertia. When this is a square it is measurable as work, that gives a normal curve integral. The randomness from this normal curve is related to the Boltzmann constant as e𝕪 /-𝕆d ×-𝕠d, the -𝕆D kinetic torque means there is spin in different directions.

Squared Pythagorean Triangle side and linear side

That degrades the back and forth motion from the E𝕐/-𝕠d kinetic impulse and E𝕍×-𝕚d. In this model an exponential function comes from the constant Pythagorean Triangle area, for example when -𝕀D as the inertial probability increases as a square then e𝕧 as a length decreases linearly. As the e𝕧 length decreases with the motion of the spring, that increases the -𝕀D inertial probability giving off random heat.

Dampened impulse and exponential decay

When written as the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, the exponential decay function decreases with -𝕠d kinetic time and -𝕚d inertial time. As this time increases linearly then the E𝕐 and E𝕍 displacement decreases as a square, the exponential function then causes the spring to slow as a dampened oscillator.

Shortened distance and increased randomness

These two are inverses of each other, the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work increases the random motion as the spring's oscillation e𝕧 length decreases. As the -𝕚d inertial time increases the E𝕐 and E𝕍 displacement forces decrease as a square. This is related to a gas pressure for example, it might push a bike pump to restore its original position when pumped. As this e𝕧 length of the pump increases then the -𝕀D inertial torque inside from molecules colliding with each other decreases as a square. That causes the gas to generate less random heat. Using this change of e𝕧 length a wave of randomness can be directed in a Carnot engine.

Inverted exponentials

These two exponentials, the normal curve with work as an integral, and the exponential curve as a changing derivative slope, occur where there are forces. Friction in a car tire can cause random -𝕀D inertial probabilities to degrade a forward motion exponentially. If the car skids then the loss of traction can increase exponential with a larger displacement between the tire and the road.

The **damping constant** b depends in a complicated way on the shape of the object *and* on the viscosity of the air or other medium in which the particle moves. The damping constant plays the same role in our model of drag that the coefficient of friction does in our model of friction.

The units of b need to be such that they will give units of force when multiplied by units of velocity. As you can confirm, these units are kg/s. A value $b = 0$ kg/s corresponds to the limiting case of no resistance, in which case the mechanical energy is conserved. A typical value of b for a spring or a pendulum in air is ≤ 0.10 kg/s. Objects moving in a liquid can have significantly larger values of b.

FIGURE 15.21 shows a mass oscillating on a spring in the presence of a drag force. With the drag included, Newton's second law is

$$(F_{net})_x = (F_{Sp})_x + (F_{drag})_x = -kx - bv_x = ma_x \qquad (15.53)$$

Using $v_x = dx/dt$ and $a_x = d^2x/dt^2$, we can write Equation 15.53 as

$$\frac{d^2x}{dt^2} + \frac{b}{m}\frac{dx}{dt} + \frac{k}{m}x = 0 \qquad (15.54)$$

Equation 15.54 is the equation of motion of a damped oscillator. If you compare it to Equation 15.32, the equation of motion for a block on a frictionless surface, you'll see that it differs by the inclusion of the term involving dx/dt.

Equation 15.54 is another second-order differential equation. We will simply assert (and, as a homework problem, you can confirm) that the solution is

$$x(t) = Ae^{-bt/2m}\cos(\omega t + \phi_0) \qquad \text{(damped oscillator)} \qquad (15.55)$$

where the angular frequency is given by

$$\omega = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}} = \sqrt{\omega_0^{\,2} - \frac{b^2}{4m^2}} \qquad (15.56)$$

Here $\omega_0 = \sqrt{k/m}$ is the angular frequency of an undamped oscillator ($b = 0$). The constant e is the base of natural logarithms, so $e^{-bt/2m}$ is an *exponential function*. Because $e^0 = 1$, Equation 15.55 reduces to our previous $x(t) = A\cos(\omega t + \phi_0)$ when $b = 0$. This makes sense and gives us confidence in Equation 15.55.

Obscure and Intangible numbers

In this model the exponent can have the two Pythagorean Triangle sides, this is like a complex number. Here e$^{\text{e𝕪-𝕠d}}$ and e$^{\text{e𝕒+𝕠d}}$ are called Obscure numbers, this is because it starts with O and is similar to imaginary numbers as a memory aid. e$^{\text{e𝕧-𝕚d}}$ and e$^{\text{e𝕙+𝕚d}}$ are called Intangible numbers, to start with I and be different from imaginary numbers.

Radius as the straight Pythagorean Triangle side

These work in a similar way to complex numbers, however the hypotenuse of the Pythagorean Triangle is not used. It is not then the radius of a circle like with the Euler equation. Instead the Pythagorean Triangles can be inscribed in a cone, the +𝕠d and e𝕒 Pythagorean Triangle as the proton would have e𝕒 as this radius, then the +𝕠d spin Pythagorean Triangle side points clockwise or counterclockwise at the opposite end to the origin.

Exponential decay and electrons

This indicates the value of the +𝕠d potential magnetic field at a particular e𝕒 altitude, that might be where an electron is for example. This allows the electron to decay exponentially when it is in a higher orbital, the dampened oscillator also works this way. The +𝕆D×e𝕒 potential work is where this -𝕠d and e𝕪 Pythagorean Triangle is inscribed in the circle, +𝕆D is the potential probability so this increases as a square when the e𝕒 altitude decreases linearly.

Normal curves and negative exponentials

That would appear as e$^{\text{e𝕒+𝕆D}}$ in the exponent, because +𝕆D is a negative square in this model the different D values give a normal curve integral. It is a negative square because +𝕠d is the positive square root of -1.

Probability of emitting a photon

Inverse to this is the $e^{e𝕪\text{-}𝕆D}$ -𝕆D×e𝕪 kinetic work, here the -𝕆D kinetic probability is larger in a higher orbital, that has a stronger -𝕆D kinetic torque while the +𝕆D potential probability is inversely lower for this. An electron then can move to a higher orbital with this kinetic torque, it is less likely unless it absorbs a e𝕪×-𝕘d photon doing -𝔾D×e𝕪 light work. The potential probability +𝕆D means that it is more likely the e𝕪×-𝕘d photon will be emitted and the electron drop to a lower orbital again.

Euler equation and Pythagorean Triangles

In Biv space-time there is +𝕀D×e𝕙 gravitational work as $e^{e𝕙+𝕀D}$ where +𝕀D is the gravitational probability. This is also inscribed in a circle and is convertible into the Euler equation. The e𝕙 height is the radius and the +𝕚d gravitational field is at the outer end of e𝕙, that gives the strength of +𝕚d at that e𝕙 height.

Gravitational probability

With +𝕀D×e𝕙 gravitational work a satellite would be more gravitationally probable to move to a lower e𝕙 height. This is like falling directly down to a lower gravitational energy level. When in orbit this is balanced by -𝕀D×e𝕧 inertial work as $e^{e𝕧\text{-}𝕀D}$ where for a given e𝕙 height the +𝕀D gravitational probability and the -𝕀D inertial probability are equal.

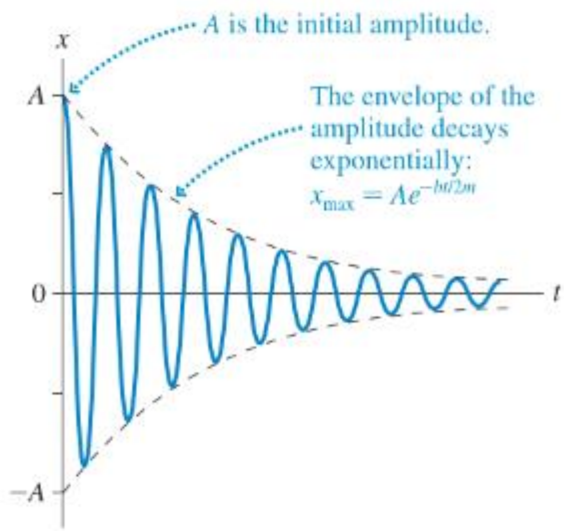
Quantized rings

This gives a gravitational exponential, for example a dampened oscillation would be where a satellite falls into a lower orbit with atmospheric friction. This can also happen with many particles in orbit, as they collide randomly they spread out their inertial velocities according to an inertial Boltzmann constant e𝕧/-𝕀D × -𝕚d. Because the inertial probability -𝕀D is a negative square in the exponent, this also gives a normal curve. The particles would tend to form a quantized orbit like a ring around Saturn.

Resonations and rings

There can be other rings above and below this one, the quantization effect from +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work means they cannot move chaotically. The planets and moons tend to form resonations with their orbits in whole numbers, these come from +𝕀D and -𝕀D as time periods squared. The resonations also form these rings with Saturn's moon with whole number periods. The asteroid belt has a single orbital ring as +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work because there are no other moons to create more resonations.

FIGURE 15.22 Position-versus-time graph for a lightly damped oscillator.



Mechanical and magnetic oscillations

In this model mechanical vibrations occur with work, the regular oscillations are like a quantization. With an electric circuit this oscillation happens from the -𝕠d kinetic magnetic field and the +𝕠d potential magnetic field. With both these cases the oscillation decreases in amplitude as a e𝕧 length. That occurs because of the random motion of the oscillator in different degrees of freedom not just back and forward like in impulse.

Radioactivity is not an oscillation

In radioactivity this is not an oscillation, instead the decays are unpredictable and chaotic. That would come from E𝕐/-𝕠d kinetic impulse, the exponential decay occurs over time. This allows for an exponential chain reaction with a E𝕐/-𝕠d kinetic impulse, the radioactive decay can cause other radioactive atoms to decay in a nuclear reactor. The -𝕠d kinetic time is increasing, so the E𝕐 kinetic displacement force decreases as a square making an exponential curve. Because this is chaotic it need not settle around a normal level, it could also explode chaotically as a nuclear bomb.

Electron orbital decay

An electron acts as a kinetic oscillator, the frequency of the oscillation changes with the linear spacing of orbitals in an atom. An electron might begin at a higher orbital where the -𝕆D kinetic torque is higher. The electron has a lower e𝕧/-𝕚d inertial velocity, then e𝕧 is small and -𝕚d as inertial time is larger. This is proportional to a larger -𝕀D inertial probability as a square when the -𝕀D×e𝕧 inertial work is being measured.

Dropping to lower orbitals

If the electron drops a quantized amount of this oscillation to a lower orbital, the e𝕧/-𝕚d inertial velocity increases because e𝕧 is increasing and -𝕚d is decreasing. That means the -𝕆D kinetic torque decreases as a whole number D making it quantized. With -𝕠d the d value is a square root, when this is squared it gives a quantized integer, according to this model. If the electron acts as a damped oscillator, the decrease of the -𝕀D inertial torque of the electron would occur from a dampening process, such as random friction from other atoms doing -𝕀D×e𝕧 inertial work. That comes from the Boltzmann constant, where air molecules tend to distribute their inertial velocities on a normal curve. This is similar to the drag from air on a mechanical oscillator.

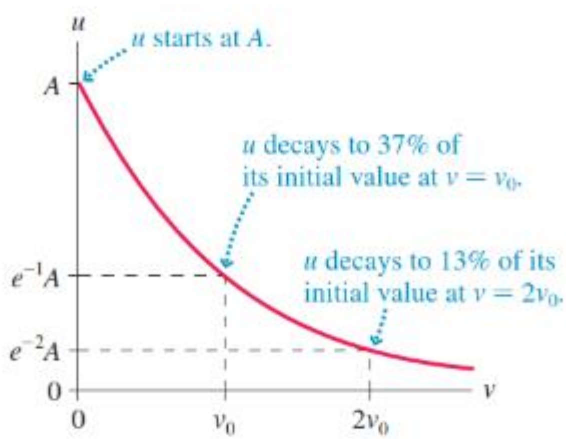
Exponential decay

Exponential decay occurs in a vast number of physical systems of importance in science and engineering. Mechanical vibrations, electric circuits, and nuclear radioactivity all exhibit exponential decay.

The mathematical analysis of physical systems frequently leads to solutions of the form

$$u = Ae^{-v/v_0} = A\exp(-v/v_0)$$

where exp is the *exponential function*. The number $e = 2.71828...$ is the base of natural logarithms in the same way that 10 is the base of ordinary logarithms.



The damped oscillation is not conserved

A damped oscillator occurs from the random drag of air, itself connected to the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work from moving through the air molecules. This is not conserved because the -𝕠d and e𝕪 Pythagorean Triangles of the air are not connected to the Pythagorean Triangles of the oscillator. It is still exponential decay because in both cases there is -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, the increase in -𝕆D kinetic probability and -𝕀D inertial probability continues as a square.

Exponential decay as impulse

In (15.58) this is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy on the left-hand side, the changes on the right-hand side occur from exponential decay. The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is a combination of the E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work, this can be used as an approximation with the damped oscillator doing work.

The time constant and a distance constant

The time constant here comes from the E𝕐/-𝕠d kinetic impulse, this would be an exponential curve from radioactive decay but not with a damped oscillator which would be -𝕆D×e𝕪 kinetic work. Because the -𝕚d inertial time here is a time constant, that is the inverse of a e𝕧 length as a distance constant in work. The two can then be converted into each other as an approximation. When the damped oscillation decreases in amplitude this would give a linear decrease in this e𝕧 length. The time constant comes from the -𝕀D inertial probability being quantized.

The mechanical energy of a damped oscillator is *not* conserved because of the drag force. We previously found the energy of an undamped oscillator to be $E = \frac{1}{2}kA^2$. This is still valid for a lightly damped oscillator if we replace A with the slowly decaying amplitude x_{max}. Thus

$$E(t) = \tfrac{1}{2}k(x_{max})^2 = \tfrac{1}{2}k(Ae^{-bt/2m})^2 = \tfrac{1}{2}kA^2e^{-bt/m} \qquad (15.58)$$

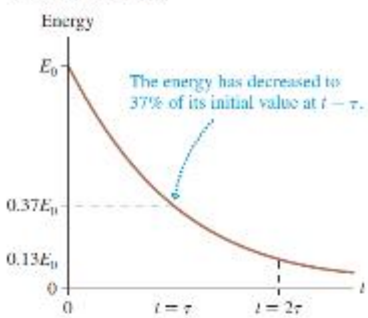
Here A is the initial amplitude, so $\frac{1}{2}kA^2$ is the initial energy, which we call E_0. Let's define the **time constant** τ (also called the *decay constant* or the *decay time*) to be

$$\tau = \frac{m}{b} \qquad (15.59)$$

Two kinds of exponential

There are two exponential curves here, work gives an exponential oscillation. Impulse gives an exponential distribution with chaotic observations such as in radioactive decay. The normal curve comes from an inverse exponential, there the negative squared exponents come from the spin Pythagorean Triangle sides. The impulse exponential in this model comes from squaring the straight Pythagorean Triangle sides, they are square roots so squaring them gives integers with this exponential curve.

FIGURE 15.24 Energy decay of a lightly damped oscillator.



Because b has units of kg/s, τ has units of seconds. With this, we can write the energy decay as

$$E(t) = E_0e^{-t/\tau} \qquad (15.60)$$

In other words, **a lightly damped oscillator's mechanical energy decays exponentially with time constant τ.**

As **FIGURE 15.24** shows, the time constant is the amount of time needed for the energy to decay to e^{-1}, or 37%, of its initial value. We say that the time constant τ measures the "characteristic time" during which the energy of the oscillation is dissipated. Roughly two-thirds of the initial energy is gone after one time constant has elapsed, and nearly 90% has dissipated after two time constants have gone by.

For practical purposes, we can speak of the time constant as the *lifetime* of the oscillation—about how long it lasts. Mathematically, there is never a time when the oscillation is "over." The decay approaches zero asymptotically, but it never gets there in any finite time. The best we can do is define a characteristic time when the motion is "almost over," and that is what the time constant τ does.

The spring constant and work

Here the 1/-𝕚d inertial time is the natural frequency, this is proportional to square root of the -𝕚d inertial mass. Squaring both sides, the 1/-𝕀D inertial torque is proportional to the -𝕚d inertial mass.

Because e𝕧 is the inverse of -𝕚d this also means 1/-𝕀D is proportional to 1/e𝕧. Multiplying both sides by e𝕧 gives e𝕧/-𝕀D in meters/second² as a constant. If the e𝕧 length is doubled then the 1/-𝕀D increases as a square, this gives an exponential curve. It also means e𝕧/-𝕀D is a constant, if the -𝕚d inertial mass of a spring is doubled this is the same as the e𝕧 length doubling.

The spring constant and impulse

This can also be converted to an E𝕍/-𝕚d inertial impulse, the square of the frequency as 1/-𝕀D is approximately E𝕍, this is proportional to the -𝕚d inertial mass. If this inertial mass doubled then the E𝕍 inertial displacement increases 4 times as a square. This is the same as -𝕚d as the inertial mass ∝ 1/-𝕀D as the inertial time squared.

The spring constant and F=ma

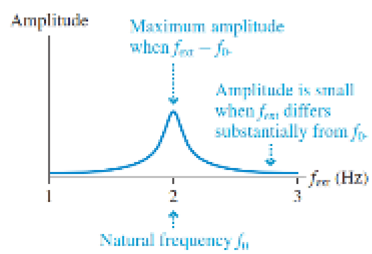
The equation F=ma can also be used with a constant force. F equals -𝕚d×e𝕧/-𝕀D so F×e𝕧=-𝕚d/-𝕀D, with a constant spring e𝕧 length if the -𝕚d inertial mass doubles the 1/-𝕀D inertial probability as time squared goes up 4 times. This means if the inertial mass doubles the frequency increases by 4 times.

Consider an oscillating system that, when left to itself, oscillates at a frequency f_0. We will call this the **natural frequency** of the oscillator. The natural frequency for a mass on a spring is $\sqrt{k/m}/2\pi$, but it might be given by some other expression for another type of oscillator. Regardless of the expression, f_0 is simply the frequency of the system if it is displaced from equilibrium and released.

Suppose that this system is subjected to a *periodic* external force of frequency f_{ext}. This frequency, which is called the **driving frequency,** is completely independent of the oscillator's natural frequency f_0. Somebody or something in the environment selects the frequency f_{ext} of the external force, causing the force to push on the system f_{ext} times every second.

Although it is possible to solve Newton's second law with an external driving force, we will be content to look at a graphical representation of the solution. The most important result is that the oscillation amplitude depends very sensitively on the frequency f_{ext} of the driving force. The response to the driving frequency is shown in FIGURE 15.25 for a system with $m = 1.0$ kg, a natural frequency $f_0 = 2.0$ Hz, and a damping constant $b = 0.20$ kg/s. This graph of amplitude versus driving frequency, called the **response curve,** occurs in many different applications.

FIGURE 15.25 The response curve of a driven oscillator at frequencies near its natural frequency of 2.0 Hz.



Transverse waves

In this model a transverse wave comes from work, the rolling wheel gives an up and down motion. These waves can interfere with each other constructively and destructively, with different waves on the same rope they can pass through each other. This up and down value is the e𝕧 Pythagorean Triangle side with -𝕀D×e𝕧 inertial work, when pointing up it gives the crest of the wave.

Constructive and destructive interference

With other waves passing through it the interference adds up to change the e𝕧 length linearly. When there is a sinusoidal wave the e𝕧 wavelength in between the crests is doubled. This is because the e𝕧 radius or spoke of the rolling wheel can point up as well as down in between the crests.

Longitudinal impulse

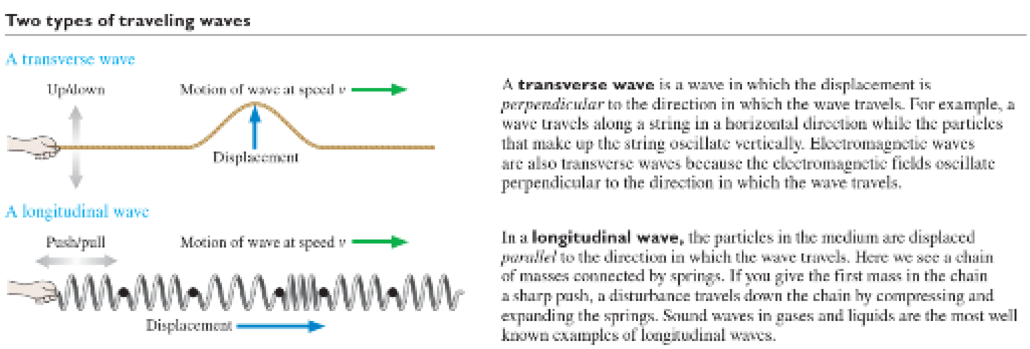
A longitudinal wave in this model is not a wave, it comes from impulse. When this hits a target it delivers a longitudinal impulse force, this is like a tennis ball hitting a racket as the strings deform then rebound. It represents according to this model the particle nature of the force, the transverse wave is orthogonal to this like the straight and spin Pythagorean Triangle sides are orthogonal to each other.

Ocean waves changing to ocean impulse

With ocean wave near a beach, they can change from -𝕀D×e𝕧 inertial work to an E𝕍/-𝕚d inertial impulse. Offshore the waves can cross each other with constructive and destructive interference, the wave does -𝕆D×e𝕪 kinetic work as it moves and is pulled downwards by +𝕀D×e𝕙 gravitational work. It moves forward with -𝕀D×e𝕧 inertial work and the protons in the water molecules oscillate with +𝕆D×e𝕒 potential work.

The beach creates impulse

When the ocean wave nears the beach the shallow water gives an upward kinetic displacement force as E𝕍 against the Eℍ gravitational displacement force pulling the water downwards. This acceleration of the water molecules is in a straight direction, unlike the oscillations with work. That causes the wave to act more like a particle with impulse, it can then exert a force on bathers pushing them backwards towards the beach. That can lead to a rip with the E𝕍/-𝕚d inertial impulse of the water can also pull a bather out from the beach. There can also be a -𝕀D inertial torque where the wave causes a bather to spin, this can also happen with a surfer in a tube.



Mechanical waves

In this model mechanical waves move in Roy electromagnetism and Biv space-time. The atoms can oscillate with +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, also with +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work. Mechanical would refer to Biv space-time with +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, this allows for kinematics where iotas can move under gravity and inertia with oscillations. The oscillations occur with active gravity waves as +𝔾D×e𝕓 gravis work, the reactions against this comes from -𝔾D×e𝕧 iners work.

Electromagnetic waves

Electromagnetic waves occur in Roy electromagnetism with +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, here these would include the wave like nature of the electron in an orbital. When there are changes in this -𝕆D×e𝕪 kinetic work there can be e𝕪×-𝕘d photons being emitted and absorbed with -𝔾D×e𝕪 light work. There is also +𝕘d×e𝕒 virtual photon that reacts against the e𝕪×-𝕘d photon. This does +𝔾D×e𝕒 virtual photon work.

Roy electromagnetic medium

In this model mediums for waves are Roy electromagnetism and Biv space-time. Inside the atom, below the ionization boundary, electrons do -𝕆D×e𝕪 kinetic work which is reacted against by

+𝕆D×e𝕒 potential work by the proton. This acts as a medium because all changes in the proton and electron are measured by the e𝕒 altitude above the proton and the e𝕪 kinetic electric charge as a distance along which the electron moves.

Biv space-time medium

Outside this Biv space-time also acts as a medium for waves, this extends to the maximum e𝕙 height of the +𝕚d and e𝕙 Pythagorean Triangle as gravity. This would be past the CMB to where gravitons would appear with a Eℍ/+𝕚d gravitational impulse. This medium is defined by the e𝕙 height above a gravitational source and a e𝕧 length along with iotas can move. Because e𝕪×-𝕘d photons can be measured in terms of the e𝕙 height and e𝕧 length this acts as a medium.

Disturbance of a medium

This can be disturbed with two different forces, that of work or impulse. When the water molecules move with a rotary motion this is from -𝕀D×e𝕧 inertial work. An example would be a water buoy that moves up and down, back and forward, as a wave passes. When they move more with an E𝕍/-𝕚d inertial impulse, such as from an underwater explosion or tsunami, then the pulse is chaotic. This water impulse can move far inland, a water wave oscillates on a beach going in and out.

Sonic booms

In this model a sonic boom occurs from E𝕍/-𝕚d inertial impulse, the increased e𝕧/-𝕚d inertial velocity has a greater E𝕍/-𝕚d inertial impulse because as e𝕧 grows so does E𝕍 as a squared inertial displacement force. This has a shearing effect on the sound waves from -𝕀D×e𝕧 inertial work, the oscillations are overcome and the jet can create a sonic boom as a longitudinal impulse.

We can also classify waves on the basis of what is "waving":

1. **Mechanical waves** travel only within a material *medium*, such as air or water. Two familiar mechanical waves are sound waves and water waves.
2. **Electromagnetic waves,** from radio waves to visible light to x rays, are a self-sustaining oscillation of the *electromagnetic field*. Electromagnetic waves require no material medium and can travel through a vacuum.

The **medium** of a mechanical wave is the substance through or along which the wave moves. For example, the medium of a water wave is the water, the medium of a sound wave is the air, and the medium of a wave on a stretched string is the string. A medium must be *elastic*. That is, a restoring force of some sort brings the medium back to equilibrium after it has been displaced or disturbed. The tension in a stretched string pulls the string back straight after you pluck it. Gravity restores the level surface of a lake after the wave generated by a boat has passed by.

As a wave passes through a medium, the atoms of the medium—we'll simply call them the particles of the medium—are displaced from equilibrium. This is a **disturbance** of the medium. The water ripples of **FIGURE 16.1** are a disturbance of the water's surface. A pulse traveling down a string is a disturbance, as are the wake of a boat and the sonic boom created by a jet traveling faster than the speed of sound. **The disturbance of a wave is an *organized* motion of the particles in the medium,** in contrast to the *random* molecular motions of thermal energy.

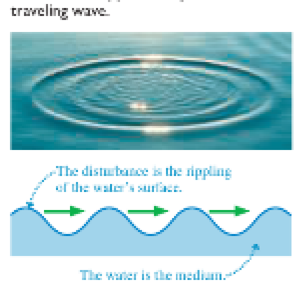


FIGURE 16.1 Ripples on a pond are a traveling wave.

A vacuum is measured with straight Pythagorean Triangle sides

In this model a vacuum is composed of straight and spin Pythagorean Triangle sides, when measuring waves this uses e𝕙 height and e𝕧 length in Biv space-time. The medium in Roy electromagnetism is e𝕒 altitude or potential electric charge from the proton and the e𝕪 kinetic electric charge from the electron. These also act like dimensions, proportionally of height and length. The electric charge then defines the medium in which waves move.

Permittivity and permeability

The speed of c comes from the permittivity and permeability of free space, these are derived from the e𝕒 and e𝕪 electric charges for permittivity, also the +𝕠d and -𝕠d magnetic fields for permeability. The e𝕧/-𝕚d inertial velocity of light is also fixed by the value of α as ≈ 1/137 of c. Because this is equivalent to $e^{-\mathbb{O}D}$ as an exponent of 1, this also fixes c. The permittivity and permeability are also changing ratios in the atom as e𝕪 and -𝕠d change for the electron. Also inversely to this they change for e𝕒 and +𝕚d as the proton. The ground state for example has a ratio of the permittivity and permeability proportional to e𝕧/-𝕚d as the electron velocity there. This means that the permittivity:permeability ratio for c is also a fixed value derived from its ratio at α in the ground state.

A change in the permittivity:permeability ratio

In matter this permittivity:permeability ratio changes from a vacuum, closer to an atom the electron slows down with its inertial velocity. The highest orbital of an atom has a fixed permittivity:permeability ratio proportional to a slow inertial velocity. This is much faster in lower orbitals going to the ground state.

Averaging out different ratios

A medium such as a string has many different permittivity:permeability ratios that average out. A wave going through the string encounters the faster and slower areas, this slows the diffusion of the wave as a faster segment might encounter a slower part of the rope. These segment velocities are random so the wave, based on randomness itself maintains this coherence around an average or middle of a normal curve.

A transparent medium

A similar process happens with e𝕪×-𝕘d photons going through a transparent medium such as glass. The -𝔾D×e𝕪 light work done has constructive and destructive interference, these cancel as the wave continues so that is diffuses more slowly. That corresponds to a slower e𝕧/-𝕚d inertial velocity of light because the photons are bending more around the atoms, also because this permittivity:permeability ratio changes closer to atoms. A wave in a string is also bending and interfering, as different segments have a different tension or μ density.

Tension and the permittivity:permeability ratio

When a string has a higher tension it is more spread out, the string becomes thinner with less -𝕚d inertial mass in a given e𝕧 length. That corresponds to a higher e𝕧:-𝕚d or permittivity:permeability ratio and so the inertial velocity of the wave is faster. The square root of T as the tension is used, this would be -𝕆D×e𝕪 kinetic work done on one end of the string to increase its e𝕧 length. That is because work is measured over a change in e𝕧 length.

Linear density as μ

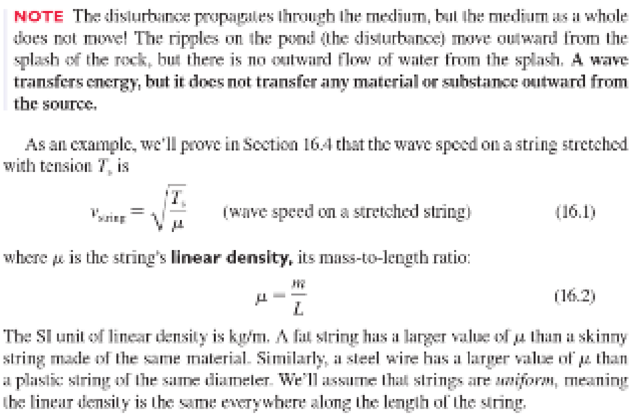
The linear density of the string is μ, this is its mass to length ratio of -𝕚d/e𝕧. Another way to write (16.1) is by squaring both sides, this becomes E𝕍/-𝕀D = T/(-𝕚d/e𝕧). Rearranging this gives E𝕍/-𝕀D × -𝕚d/e𝕧 or e𝕧/-𝕚d. The tension has no actual force because the rope's length is not changing. If the string is tightened, then its μ density decreases because its -𝕚d inertial mass is spread out over a longer e𝕧 length. That corresponds to 1/μ on the left-hand side as $e\mathbb{v}_{\mu}/-\mathbb{i}d_{\mu}$ so the overall wave velocity increases.

A rolling wheel wave and frequency changes

A wave moves like a rolling wheel in a vacuum with e𝕪×-𝕘d photons, it also moves this way in a string because the electrons also move as rolling wheels in this model. Because of this, the wave moves at the same e𝕧/-𝕚d inertial velocity as the frequency changes. This also happens with sound waves and with e𝕪×-𝕘d photons.

The rolling wheel changes its radius

That is because the wheel changes its e𝕧 radius as the frequency changes. When the frequency doubles the -𝕚d inertial time also doubles as 1/-𝕚d, this makes the e𝕧 radius of the wheel spoke halve to maintain a constant Pythagorean Triangle area. The wheel then rotates twice as faster but has half the radius, it moves at the same e𝕧/-𝕚d inertial velocity.



NOTE The disturbance propagates through the medium, but the medium as a whole does not move! The ripples on the pond (the disturbance) move outward from the splash of the rock, but there is no outward flow of water from the splash. **A wave transfers energy, but it does not transfer any material or substance outward from the source.**

As an example, we'll prove in Section 16.4 that the wave speed on a string stretched with tension T_s is

$$v_{string} = \sqrt{\frac{T_s}{\mu}} \quad \text{(wave speed on a stretched string)} \qquad (16.1)$$

where μ is the string's **linear density,** its mass-to-length ratio:

$$\mu = \frac{m}{L} \qquad (16.2)$$

The SI unit of linear density is kg/m. A fat string has a larger value of μ than a skinny string made of the same material. Similarly, a steel wire has a larger value of μ than a plastic string of the same diameter. We'll assume that strings are *uniform*, meaning the linear density is the same everywhere along the length of the string.

One dimensional waves

In this model all waves are one dimensional, they have a straight Pythagorean Triangle side to measure the spin Pythagorean Triangle side squared as a torque or probability. Many of these waves can go together with constructive and destructive interference, that can appear as a large wave.

Waves are not measured in time

The motion of the wave would not be measured with respect to a time t, that would be for impulse where the wave acts like a particle. Instead, the wave is measured according to the distance it travels relative to its spin force. A position in space, such as e𝕧 is used to measure the wave. It does not have a time as an instant, so its position as e𝕧 and time as -𝕚d can be known exactly. This is also from the uncertainty principle, there can only be an approximate snapshot of the wave.

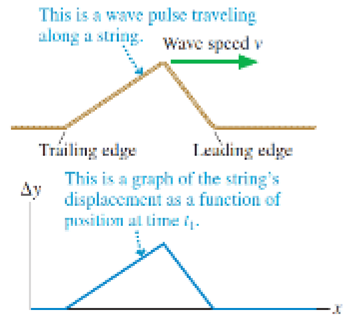
Measured or observed

The iota can be measured or observed as a wave or a particle. When measured as a wave the spin Pythagorean Triangle side is squared, this gives a probability referring to part of the time, rather than an instant of time. This is a duration, like a minute is a duration between a starting instant and a final instant. If the time is to be observed as an instant, then the straight Pythagorean Triangle side as a distance must be squared as a displacement from a starting to a final position.

To understand waves we must deal with functions of *two* variables. Until now, we have been concerned with quantities that depend only on time, such as $x(t)$ or $v(t)$. Functions of the one variable t are appropriate for a particle because a particle is only in one place at a time, but a wave is not localized. It is spread out through space at each instant of time. To describe a wave mathematically requires a function that specifies not only an instant of time (when) but also a point in space (where).

Rather than leaping into mathematics, we will start by thinking about waves graphically. Consider the wave pulse shown moving along a stretched string in FIGURE 16.3. (We will consider somewhat artificial triangular and square-shaped pulses in this section to make clear where the edges of the pulse are.) The graph shows the string's displacement Δy at a particular instant of time t_1 as a function of position x along the string. This is a "snapshot" of the wave, much like what you might make with a camera whose shutter is opened briefly at t_1. A graph that shows the wave's displacement as a function of position at a single instant of time is called a **snapshot graph.** For a wave on a string, a snapshot graph is literally a picture of the wave at this instant.

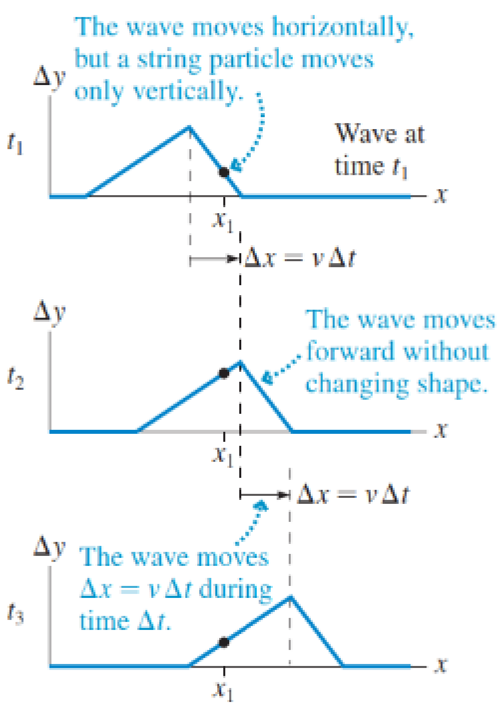
FIGURE 16.3 A snapshot graph of a wave pulse on a string.



The wave moves with a change of position not time

In this model the wave moves with a change in amplitude, this would be e𝕧 as a vertical length in -𝕀D×e𝕧 inertial work. The wave tends to not change shape because it is based on a normal curve, also the rolling wheel spins rather than changes shape. An ocean wave becomes more of an ellipse than a circle from the flattening effect of gravity. This would be measured over a change in e𝕧 position below rather than with a change in -𝕚d inertial time. With vt this is e𝕧/-𝕚d × -𝕚d which gives the change in the e𝕧 position.

FIGURE 16.4 A sequence of snapshot graphs shows the wave in motion.



History graphs

In this model a history graph would refer to the +𝕠d and e𝕒 Pythagorean Triangle as the proton, and the +𝕚d and e𝕙 Pythagorean Triangle as gravity. These have +𝕠d potential time and +𝕚d gravitational time which travel back into the past. The -𝕠d and e𝕪 Pythagorean Triangle as the electron, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia, travel forwards in time into the future.

Redshifts back in time

Looking backwards in time, the +𝕚d and e𝕙 Pythagorean Triangle as gravity gives redshifts from the different e𝕙 heights back to its maximum height. It appears like an explosion as Eℍ/+𝕚d gravitational impulse, this would be a chaotic height displacement force. Along with this straight Pythagorean Triangle side there is the +𝕚d gravitational time or field giving quantized levels with +𝕀D×e𝕙 gravitational work back to this maximum height. A kind of ground state is reached at the CMB where no more e𝕪×-𝕘d photons can be detected past it.

Proton moving backwards in time

The proton in this model moves backwards in time with +𝕠d as potential time, the electron moves forward in time with -𝕠d. When these join together they become a neutron with a balance of time moving forward and backward. The proton reacts against the electron's forward time motion, this is because of its moving backwards in time. The active gravitational field or time +𝕚d moves back in time, this is reacted against by the -𝕚d inertial mass or time moving forward. There are then action/reaction pairs in time.

FIGURE 16.5 A history graph for the dot on the string in Figure 16.4.

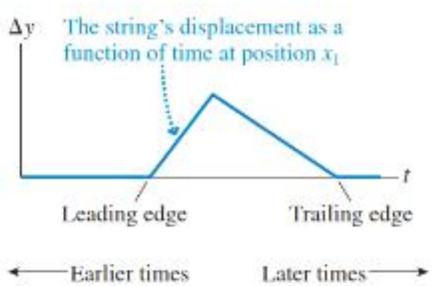
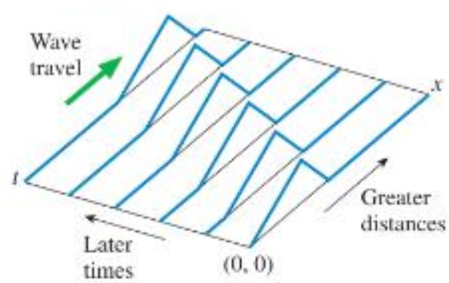


FIGURE 16.6 An alternative look at a traveling wave.



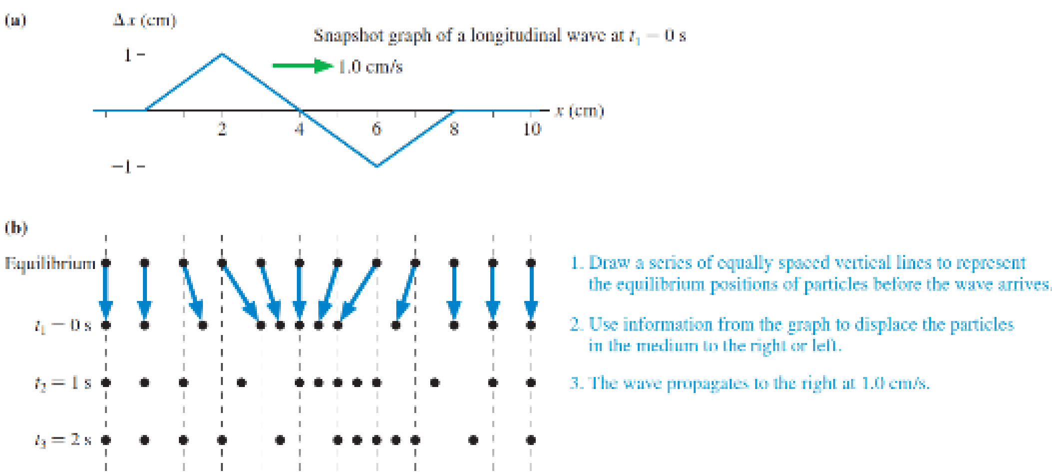
Longitudinal waves

In this model it would be a longitudinal impulse not a wave, the motion would not be a perfect oscillation. The compression and expansion occurs in a straight-line, this would be the displacement force from a starting to a final position. A snapshot in time would be an instant, for example of -𝕚d^{0} inertial time. The impulse can be observed this way because it does not use a duration from a starting to a final instant. A wave of work can be measured at a position, this would be an infinitesimal such as e𝕧^{0}.

Observations and measurements

There cannot be a measurement and observation in the same position and time, that would mean there were no squared Pythagorean Triangle sides of duration and displacement. If so then there are no forces, with no measurement or observation.

FIGURE 16.9 Visualizing a longitudinal wave.



Displacement and impulse

When there is a displacement there is impulse, it is from a starting to a final position. A sound wave moves with more of an oscillation of -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. There is a different -𝕀D inertial probability or density of air molecules at various positions. This is because when the -𝕀D inertial density is higher then air molecules are more likely to be found there.

Changing reference frames from impulse to work

D would not be an electromagnetic field strength because it is a displacement, instead it would be an electric displacement force. Orthogonal to this is the squared spin Pythagorean Triangle side as a magnetic field force, the two in this model are not directly convertible into each other according to the reference frame used. When the magnetic field force is measured in one direction this is the -𝕆D×e𝕪 kinetic work for example. Orthogonal to this is the E𝕐/-𝕠d kinetic impulse with an E𝕐 kinetic displacement force from the e𝕪 kinetic electric charge. Changing the reference frame then changes it from an observation to a measurement, from impulse to work.

For a string, where the atoms stay fixed relative to each other, you can think of either the atoms themselves or very small segments of the string as being the particles of the medium. D is then the perpendicular displacement Δy of a point on the string. For a sound wave, D is the longitudinal displacement Δx of a small volume of fluid. For any other mechanical wave, D is the appropriate displacement. Even electromagnetic waves can be described within the same mathematical representation if D is interpreted as a yet-undefined *electromagnetic field strength*, a "displacement" in a more abstract sense as an electromagnetic wave passes through a region of space.

A loudspeaker cone and work

In this model an oscillation forms a sinusoidal wave, the example of a loudspeaker cone would be a cosine impulse not a sine wave. This is because the magnet moves forwards and backwards with a displacement force. In the macro world impulse and work approximately coexist, so the change in position with the speaker magnet can also do work. When a magnet is used for a force this is using -

𝕆D×e𝕪 kinetic work, the -𝕆D kinetic probability comes from the -𝕠d kinetic magnetic field. If the sound waves are created more by the magnet moving the cone to different positions, then this would be more work than impulse.

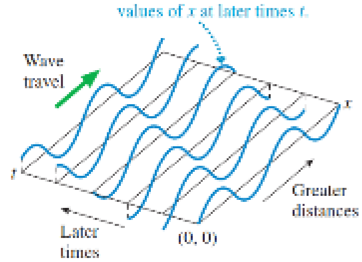
The rolling wheel has no forces

The amplitude of the wave comes from the straight Pythagorean Triangle side, the frequency of the wave is 1/-𝕚d with inertial time. This would be where the wave is not being measured, but its motion through a medium is itself a measurement because there are torque forces. The rolling wheel itself has no forces, so it can have the amplitude as the e𝕧 spoke and the frequency as 1/-𝕚d in inertial time.

Photons and electrons with no forces

In this model a e𝕪×-𝕘d photon has no forces, also an electron can be in an orbital with no forces. This is because they are not being measured or observed, the photon cannot have any forces because this would change it in a collision or absorb it into an atom. The electron can form a standing wave around an orbital that is not changing, it is equivalent to this rolling wheel moving around the orbital without the straight spoke or spin axle changing its values.

FIGURE 16.10 A sinusoidal wave moving along the x-axis.



A wave source that oscillates with simple harmonic motion (SHM) generates a **sinusoidal wave.** For example, a loudspeaker cone that oscillates in SHM radiates a sinusoidal sound wave. The sinusoidal electromagnetic waves broadcast by television and FM radio stations are generated by electrons oscillating back and forth in the antenna wire with SHM. **The frequency f of the wave is the frequency of the oscillating source.**

FIGURE 16.10 shows a sinusoidal wave moving through a medium. To understand how this wave propagates, let's look at history and snapshot graphs. **FIGURE 16.11a** is a history graph, showing the displacement of the medium at one point in space. Each particle in the medium undergoes simple harmonic motion with frequency f, so this graph of SHM is identical to the graphs you learned to work with in Chapter 15. The *period* of the wave, shown on the graph, is the time interval for one cycle of the motion. The period is related to the wave frequency f by

$$T = \frac{1}{f} \qquad (16.3)$$

exactly as in simple harmonic motion. The **amplitude** A of the wave is the maximum value of the displacement. The crests of the wave have displacement $D_{crest} = A$ and the troughs have displacement $D_{trough} = -A$.

A photon with no forces

The diagram could represent a photon moving through Biv space-time. This is not being measured or observed, the rolling wheel would then have a e𝕧^0 scale of positions and a -𝕚d^0 clock gauge of instants or fluxions. This could also be a macro sized wheel moving along a surface, a spot on the end of a spoke could be measured to move up and down in a sinusoidal wave.

A rolling wheel with vertical or horizontal motion

When this is observed only in a forward and backwards motion then the up and down motion is ignored. It then appears to move like a piston, the dot would appear to make an impact onto a target if the wheel came up against a wall. This would not be a wave, instead it would be from impulse as a particle. For example, it would resemble a tennis ball bouncing off a racket with its acceleration and deceleration as E𝕍.

Freezing a wave or a particle

When a wave is periodic it comes from measuring work, then there is a e𝕧 wavelength as the sum of two radii of the rolling wheel. A frozen wave can refer to a given position, a frozen impulse particle can refer to time. This makes a Pythagorean Triangle side small with a frozen measurement or observation, the opposing Pythagorean Triangle side would then become larger as a square.

The uncertainty principle

This gives the uncertainty principle, when the position is small with a frozen snapshot then the spin Pythagorean Triangle side increases as a squared probability. This makes a given position of the snapshot more improbable because the probability density spreads out as a normal curve. When the snapshot is frozen in time then the straight Pythagorean Triangle side grows as a square. This causes it to become unpredictable with a displacement force, as a particle it seems to have an innate energy resisting it stopping like this.

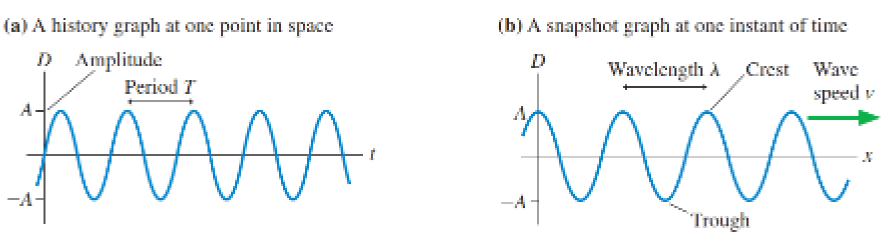
Low temperature motion

That can appear as a minimum temperature above absolute zero where the motion cannot be completely stopped. With a minimum position at a low temperature then iotas such as the electron act more wave like, they can flow with no resistance in a superconductive circuit. This is because the positions of the electrons are being measured by flowing around a circuit. It can also tunnel through a barrier because its position is being measured with a probability as a wave.

High temperature motion

When a particle has a high inertial velocity e𝕧/-𝕚d this can have a small -𝕚d inertial time value. This is like it being frozen in time as a snapshot. Because the Pythagorean Triangle has a constant area this can only happen with a high velocity, it is observed more as a particle such as with an E𝕍/-𝕚d inertial impulse. The converse is that trying to observe a particle frozen in -𝕚d inertial time means this higher e𝕧/-𝕚d inertial velocity must occur.

FIGURE 16.11 History and snapshot graphs for a sinusoidal wave.



Displacement versus time is only half the story. **FIGURE 16.11b** shows a snapshot graph for the same wave at one instant in time. Here we see the wave stretched out in space, moving to the right with speed v. An important characteristic of a sinusoidal wave is that it is *periodic in space* as well as in time. As you move from left to right along the "frozen" wave in the snapshot graph, the disturbance repeats itself over and over. The distance spanned by one cycle of the motion is called the **wavelength** of the wave. Wavelength is symbolized by λ (lowercase Greek lambda) and, because it is a length, it is measured in units of meters. The wavelength is shown in Figure 16.11b as the distance between two crests, but it could equally well be the distance between two troughs.

The fundamental relationship for sinusoidal waves

In this model there is a difference between a sinusoidal wave moving with a frequency 1/-𝕚d, and it being observed at a 1/-𝕚d inertial time. A wave then might be moving as a rolling wheel, but then it is an iota not a wave or a particle. This is similar to the thought experiment of Schrodinger's Cat, the iota is different when it is not being observed or measured like the cat was.

A medium

The inertial velocity e𝕧/-𝕚d through a medium is defined by λ/T or e𝕧/-𝕚d. If the iota is measured as a wave, then there is a wavelength e𝕧 with various e𝕧 positions and their associated -𝕀D inertial probability densities. This e𝕧 gives part of the medium because there is now a conserved e𝕧 length for the one-dimensional wave. When the E𝕍/-𝕚d inertial impulse is observed this gives a -𝕚d inertial time passing, as part of defining a particle as a Pythagorean Triangle slope. Together they give a medium which is separately observed and measured to give space and time.

Two dimensional ocean waves

If this was an ocean wave then e𝕙 would give two dimensions, enough in this model to give Biv space-time. Width is not needed because e𝕙 height is in circular geometry with gravity and e𝕧 is in hyperbolic geometry with inertia. Together they give all the possible curves in a cone.

A third dimension of width

A third dimension of width does not interact with them, here it is associated with the neutrino. That is because there are three direction of spin, +𝕠d as the potential magnetic field is like a planet rotating. An electron moves like a rolling wheel as -𝕠d around the planet, so its spin is orthogonal. The third direction can act as a precession, here when the proton and electron combine to form a neutron this third direction of spin rejoins them as a neutrino.

𝕚d neutrino mass and 𝕨 width

In Biv space-time there is a 𝕚d neutrino mass which cannot interact with the +𝕚d gravitational mass and the -𝕚d inertial mass. Associated with this is the 𝕨 width from the 𝕚d and 𝕨 Pythagorean Triangle, 𝕚d has no sign because it is in neither the positive nor negative spin direction.

There is an important relationship between the wavelength and the period of a wave. FIGURE 16.12 shows this relationship through five snapshot graphs of a sinusoidal wave at time increments of one-quarter of the period T. One full period has elapsed between the first graph and the last, which you can see by observing the motion at a fixed point on the x-axis. Each point in the medium has undergone exactly one complete oscillation.

The critical observation is that the wave crest marked by an arrow has moved one full wavelength between the first graph and the last. That is, **during a time interval of exactly one period T, each crest of a sinusoidal wave travels forward a distance of exactly one wavelength λ.** Because speed is distance divided by time, the wave speed must be

$$v = \frac{\text{distance}}{\text{time}} = \frac{\lambda}{T} \qquad (16.4)$$

Because $f = 1/T$, it is customary to write Equation 16.4 in the form

$$v = \lambda f \qquad (16.5)$$

Although Equation 16.5 has no special name, it is *the* fundamental relationship for periodic waves. When using it, keep in mind the *physical* meaning that a wave moves forward a distance of one wavelength during a time interval of one period.

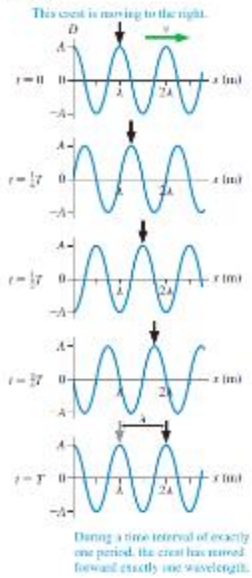
NOTE Wavelength and period are defined only for *periodic* waves, so Equations 16.4 and 16.5 apply only to periodic waves. A wave pulse has a wave speed, but it doesn't have a wavelength or a period. Hence Equations 16.4 and 16.5 cannot be applied to wave pulses.

Because the wave speed is a property of the medium while the wave frequency is a property of the oscillating source, it is often useful to write Equation 16.5 as

$$\lambda = \frac{v}{f} = \frac{\text{property of the medium}}{\text{property of the source}} \qquad (16.6)$$

The wavelength is a *consequence* of a wave of frequency f traveling through a medium in which the wave speed is v.

FIGURE 16.12 A series of snapshot graphs at time increments of one-quarter of the period T.



The mathematics of sinusoidal waves

Here the sinθ angle of the -𝕚d and e𝕧 Pythagorean Triangle allows it to rotate while the angle does not change. This is like the rolling wheel, the axle as -𝕚d does not change, neither does the e𝕧 spoke or radius of the wheel. When this Pythagorean Triangle spin there is a changing angle a between the spoke e𝕧 and a surface, adding 2π to this angle does not change it because that would be a complete revolution.

The tine width and a revolution

The value 2π is also related to the √(2π) which comes from β as the tine width in chaos. If this is taken as a quantized spin value then squaring this, such as in -𝕆D×e𝕪 kinetic work, would give $[\sqrt{(2\pi)}]^2$ or 2π as a complete rotation. This can become a quantized value, if this was a ground state then a second orbital might rotate more slowly as a fraction of this, and so on up to the ionization boundary of an atom.

Spin exponential as a normal curve

Because this is quantized the radius as e𝕒 in an atom would be increasing linearly, then with the +𝕆D×e𝕒 potential work this single rotation, as the square of √(2π), would have to change as a spin square to give a normal curve spin exponential. It is a spin exponential because the exponents of e, when they are negative squares of the square roots such as +𝕠d, give the normal curve integral.

A gap from β to √(2π)

This then connects the β tine as close to √(2π), there is a gap between them to make a jump between chaos and randomness. When this does not reach 2π then the motion is not random, in this model it would be E𝕍/-𝕚d inertial impulse and not an exact oscillation.

Two chaos constants and α

In this model δ is the first Fiegenbaum constant, this is close to α in combination with 2π. That makes α as $e^{-𝕠d}$ as the ground state. Its orbital has a rotation of 2π, or conversely it has a circumference of 1 and a radian value of 1/2π. The tine value would be 1/√(2π) equivalent to the e𝕒 altitude of the proton. The two chaos constants, δ and β, then can jump to α and 2π to give probabilistic work and quantization.

Angular frequency

Because this uses the +𝕠d and e𝕒 Pythagorean Triangle as the proton, the +𝕠d potential spin in this ground state rotation is an angular frequency. When the -𝕠d and e𝕪 Pythagorean Triangle is used as the electron, that is the inverse which gives the e𝕪 kinetic electric charge in relation to δ and β. (16.10) is 2π/T, because 2π is a unit of potential torque with this rotation that represents the +𝕆D×e𝕒 potential work. Here e𝕒=1/+𝕠d so this is approximately 2π/T. With this model work would not be written with respect to time as T, however it can be approximated with using the inverse of e𝕒.

The function of Equation 16.7 is periodic with period λ. We can see this by writing

$$D(x+\lambda) = A\sin\left(2\pi\frac{(x+\lambda)}{\lambda} + \phi_0\right) = A\sin\left(2\pi\frac{x}{\lambda} + \phi_0 + 2\pi \text{ rad}\right)$$

$$= A\sin\left(2\pi\frac{x}{\lambda} + \phi_0\right) = D(x)$$

where we used the fact that $\sin(a + 2\pi \text{ rad}) = \sin a$. In other words, the disturbance created by the wave at $x + \lambda$ is exactly the same as the disturbance at x.

The next step is to set the wave in motion. We can do this by replacing x in Equation 16.7 with $x - vt$. To see why this works, recall that the wave moves distance vt during time t. In other words, whatever displacement the wave has at position x at time t, the wave must have had that same displacement at position $x - vt$ at the earlier time $t = 0$. Mathematically, this idea can be captured by writing

$$D(x, t) = D(x - vt, t = 0) \qquad (16.8)$$

Make sure you understand how this statement describes a wave moving in the positive x-direction at speed v.

This is what we were looking for. $D(x, t)$ is the general function describing the traveling wave. It's found by taking the function that describes the wave at $t = 0$—the function of Equation 16.7—and replacing x with $x - vt$. Thus the displacement equation of a sinusoidal wave traveling in the positive x-direction at speed v is

$$D(x, t) = A\sin\left(2\pi\frac{x - vt}{\lambda} + \phi_0\right) = A\sin\left(2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right) + \phi_0\right) \qquad (16.9)$$

In the last step we used $v = \lambda f = \lambda/T$ to write $v/\lambda = 1/T$. The function of Equation 16.9 is not only periodic in space with period λ, it is also periodic in time with period T. That is, $D(x, t + T) = D(x, t)$.

It will be useful to introduce two new quantities. First, recall from simple harmonic motion the *angular frequency*

$$\omega = 2\pi f = \frac{2\pi}{T} \qquad (16.10)$$

Wave number k

Here the wave number is a rotation, when 2π is the +𝕆D potential torque then this is divided by e𝕒 as the potential wavelength. The kinetic wave number would use the same ground state as -𝕆D, then this is divided by the e𝕧 wavelength. That can be used with the electron as a rolling wheel, it would rotate an integer number of times for example 4 before it rejoined the original rotation, the wheel would be rolling around the orbital as a standing wave.

ω/k=e𝕧/-ⅈd

Here 1/k is e𝕧 and ω is 1/-ⅈd to give ω/k as the e𝕧/-ⅈd inertial velocity. Using 2π as a tine then it is a complete rotation, when 2π/k is used that is equivalent to -𝕀D×e𝕧 inertial work with -𝕀D as an inertial torque around a complete circle.

The units of ω are rad/s, although many textbooks use simply s^{-1}.

You can see that ω is 2π times the reciprocal of the period in time. This suggests that we define an analogous quantity, called the **wave number** k, that is 2π times the reciprocal of the period in space:

$$k = \frac{2\pi}{\lambda} \qquad (16.11)$$

The units of k are rad/m, although many textbooks use simply m^{-1}.

> **NOTE** The wave number k is *not* a spring constant, even though it uses the same symbol. This is a most unfortunate use of symbols, but every major textbook and professional tradition uses the same symbol k for these two very different meanings, so we have little choice but to follow along.

We can use the fundamental relationship $v = \lambda f$ to find an analogous relationship between ω and k:

$$v = \lambda f = \frac{2\pi}{k}\frac{\omega}{2\pi} = \frac{\omega}{k} \qquad (16.12)$$

Sinusoidal traveling wave

Here the sinusoidal wave is a sine, that is the -ⅈd spin Pythagorean Triangle side divided by the hypotenuse ζ. In the brackets is kx which is e𝕧, minus ωt which is -ⅈd, plus a phase constant ϕ. This would be the beginning of the wave at a position e𝕧 and at an inertial time -ⅈd. In this model a wave could not begin without work being done, initially that might be -𝕆D×e𝕪 kinetic work and reacting against this is -𝕀D×e𝕧 inertial work.

Increasing e𝕧 and -ⅈd

The wave would move with an increase in x and t linearly, this is the same as increasing e in e𝕧 and d in -ⅈd linearly. This is like a rolling wheel where the e𝕧 length traveled follows the axle, the time is the number of rotations of this axle. To make a sinusoidal wave, a point on the end of the spoke is traced out.

which is usually written

$$\omega = vk \qquad (16.13)$$

Equation 16.13 contains no new information. It is a variation of Equation 16.5, but one that is convenient when working with k and ω.

If we use the definitions of Equations 16.10 and 16.11, Equation 16.9 for the displacement can be written

$$D(x, t) = A\sin(kx - \omega t + \phi_0) \qquad (16.14)$$

(sinusoidal wave traveling in the positive x-direction)

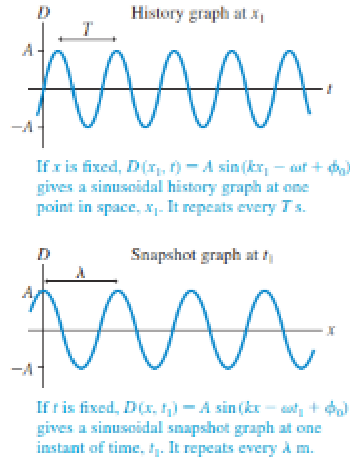
A sinusoidal wave traveling in the negative x-direction is $A\sin(kx + \omega t + \phi_0)$. Equation 16.14 is graphed versus x and t in FIGURE 16.14.

You learned in « Section 15.2 that the initial conditions of an oscillator can be characterized by a phase constant. The same is true for a sinusoidal wave. At $(x, t) = (0\text{ m}, 0\text{ s})$ Equation 16.14 becomes

$$D(0\text{ m}, 0\text{ s}) = A\sin\phi_0 \qquad (16.15)$$

Different values of ϕ_0 describe different initial conditions for the wave.

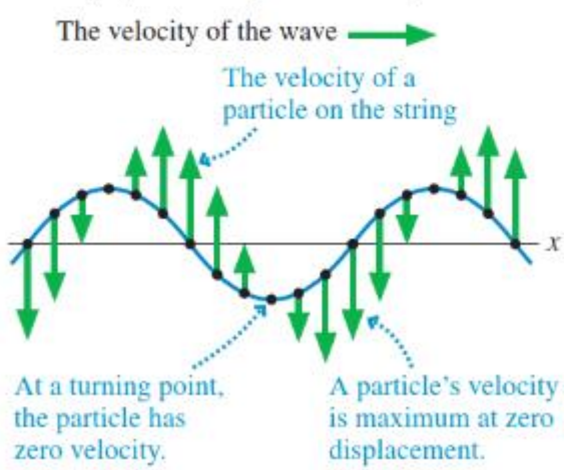
FIGURE 16.14 Interpreting the equation of a sinusoidal traveling wave.



Vertical and horizontal acceleration

As the rolling wheel rotates, this traces out an acceleration vertically with -𝕀D×e𝕧 inertial work and horizontally with the E𝕍/-𝕚d inertial impulse. The -𝕀D×e𝕧 inertial work can be measured when the e𝕧 spoke is pointing up to pointing down, this would be a half rotation of the wheel. That would not be a particle because, as a point or position e𝕧 on the spoke, the size of the spoke has not changed. It is not a force, instead it is measuring the work on a series of e𝕧 points.

FIGURE 16.16 A snapshot graph of a wave on a string with vectors showing the velocity *of the string* at various points.



Longitudinal impulse

The longitudinal impulse moves with an E𝕍/-𝕚d inertial impulse, this has an inertial velocity e𝕧/-𝕚d according to the medium. Because this is the inverse of the -𝕀D×e𝕧 inertial work as a wave, the two must remain connected to each other. Increasing the amplitude of the -𝕀D×e𝕧 inertial work wave does not increase this inertial velocity, that is because the amplitude e𝕧 only affects the -𝕀D inertial torque not the E𝕍/-𝕚d inertial impulse.

Amplitude of the rolling wheel

The wave moves like a rolling wheel, when the amplitude as the e𝕧 spoke of the wheel increases then the -𝕚d frequency decreases inversely. That means the wheel is larger but rotates more slowly, the inertial velocity remains the same.

Changing the frequency does not change the velocity

In this model that is the same with sound waves, a lower frequency wave moves at the same inertial velocity. E𝕪×-𝕘d photons also move like a rolling wheel, this is because they transmit the differences between electrons in atoms. If they operated differently then these changes would not be conserved.

Velocity from a derivative and impulse

The E𝕍/-𝕚d inertial impulse along the rope gives its inertial velocity, this is because e𝕧/-𝕚d is a derivative. The -𝕚d×e𝕧 integral is a field not a slope, when one changes such as -𝕚d halving then e𝕧 doubles. That has the same field value, like the rolling wheel it has the same inertial velocity. The -𝕀D inertial torque of the wheel would be lower, the wheel could do less work such as in climbing a hill.

Redshifted photons

This is like redshifted e𝕪×-𝕘d photons with a longer e𝕧 wavelength, they can do less -𝔾D×e𝕪 light work such as in liberating electrons with the photoelectric effect. Conversely, they can have a larger e𝕐/-𝕘d light impulse, these particle-like photons can collide more with electrons with the Compton effect.

A piston and impulse

When the rolling wheel is connected to a piston, moving back and forth in the horizontal plane, then the E𝕍/-𝕚d inertial impulse is inversely larger to the -𝕀D×e𝕧 inertial work. The piston on striking a target would exert this greater impulse.

Gearing ratios in cars

The difference is why cars have gears, in a lower gear the engine exerts more -𝕆D kinetic torque from -𝕆D×e𝕪 kinetic work. It can then climb hills better. For longer distances a higher gear has a larger E𝕍/-𝕚d inertial impulse, this allows the car to have a higher e𝕧/-𝕚d inertial velocity. The difference is that the cogs in the gearbox are rolling wheels, when they have a larger e𝕧 radius then this is a higher gear with lower torque in work and a higher impulse. When the e𝕧 radius or spoke is smaller, then it has a larger torque in work and a smaller impulse.

At time t, the displacement of the medium at position x is

$$D(x, t) = A\sin(kx - \omega t + \phi_0) \tag{16.16}$$

The velocity of the medium—**which is not the same as the velocity of the wave along the string**—is the time derivative of Equation 16.16:

$$v = \frac{dD}{dt} = -\omega A\cos(kx - \omega t + \phi_0) \tag{16.17}$$

Thus the maximum speed of particles in the medium is $v_{max} = \omega A$. This is the same result we found for simple harmonic motion because the motion of the medium *is* simple harmonic motion. **FIGURE 16.16** shows velocity vectors *of the particles* at different points along a string as a sinusoidal wave moves from left to right.

NOTE Creating a wave of larger amplitude increases the speed of particles in the medium, but it does *not* change the speed of the wave *through* the medium.

F=ma as a wave equation

In (16.20) the left-hand side is F=ma, this is -𝕚d×e𝕧/-𝕀D according to the model. Because -𝕀D is the force this is work, on the right-hand side there is a wave equation.

$$ma_y = \mu\,\Delta x\frac{\partial^2 D}{\partial t^2} \tag{16.20}$$

A calculus Pythagorean Triangle with an infinitesimal and a fluxion

In (16.21) the small piece of string is made into a calculus Pythagorean Triangle with infinitesimal sides, initially this has no forces. In this model there is a straight Pythagorean Triangle side as e𝕧^0 and a spin or time Pythagorean Triangle side as -𝕚d^0, these are an infinitesimal and a fluxion respectively. With tension this would by measured over a length e𝕧, that would be -𝕀D×e𝕧 inertial work.

A combination of a derivative and an integral

To calculate this infinitesimal the Pascal's Triangle calculus is used. This is where each cell in Pascal's Triangle is a combination of a derivative and an integral. When the integral is used as work that is measured over a e𝕧 length. In the text below this is referred to as a derivative, in this model work is an integral.

The cells of the Pascal's Triangle calculus

The first row of the Pascal's Triangle calculus would be (e𝕧^0-𝕚d^0)^0, this allows for the exponent to become 1 for whole numbers or -1 for fractions. For an exponent of 2 there is E𝕍 2×-𝕚d×e𝕧-𝕀D. This combines a derivative and an integral, E𝕍 is e𝕧^2 so the derivative is 2×e𝕧. The -𝕀D term is -𝕚d^2 so the total integral is ½×-𝕚d^2. Taking the derivative of this moves it one to the left, that gives -𝕚d. When multiplied by 2×e𝕧 this gives the central term 2×-𝕚d×e𝕧. Each term is a cell in the Pascal's Triangle calculus.

Moving a cell to the left or right

When this term overall is moved to the left this gives E𝕍 or e𝕧^2, the integral becomes -𝕚d^0 as a fluxion. When this term is moved to the right the integral again becomes 1/2 ×-𝕚d^2 and the 2×e𝕧 term becomes 2×e𝕧^0 to give -𝕚d^2×e𝕧^0 as the -𝕀D×e𝕧^0 inertial work. In conventional calculus the infinitesimal and fluxion would become 1 from a 0 exponent or disappear. Here they are conserved and remain as part of the Pythagorean Triangles for physics.

An infinitesimal amount of work

The tension here is also -𝕀D×e𝕧 inertial work, the value for e𝕧^0 is the infinitesimal. This tension would not be moving, the work would then be a balance of -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work as a reaction. An additional amount of -𝕀D×e𝕧 inertial work, or -𝕆D×e𝕪 kinetic work would have an infinitesimal of e𝕧^0 or e𝕪^0 as the kinetic electric charge. This amount in the e𝕪×-𝕘d photon would go together with -𝕘d^0 as a fluxion or instant. This allows for calculus to have the formula for a derivative or an integral to be separated from each other.

Defining the infinitesimal and fluxion

It also gives a definition for the infinitesimal and a fluxion, as long as the 0 exponent is used the values of d an e are conserved. That allows for the Pythagorean Triangle to observed with an E𝕍/-𝕚d^0 inertial impulse or measured with -𝕀D×e𝕧^0 inertial work, the 0 exponent can become 1 where e𝕧 acts as a ruler and -𝕚d as a clock gauge. When this impulse or work is observed or measured, these are no longer infinitesimals and fluxions but linear values.

First row

The first row in the Pascal's Triangle calculus would be (e𝕧^0-𝕚d^0)^0, this is where the values are at their minimum. It can also be written as (e𝕧-𝕚d)^0 because the 0 exponents are only used when the derivatives and integrals are separated. The same calculus rules would work when the exponents are negative as fractions.

Intangible and obscure numbers

The Pythagorean Triangles are all kinds of complex numbers, e𝕧-𝕚d is an intangible number as is e𝕙+𝕚d. Here e𝕪-𝕠d and e𝕒+𝕠d as obscure numbers, this is to separate complex numbers into two types with friendly names of intangible and obscure.

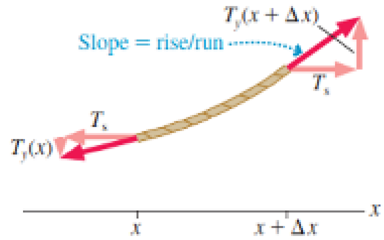
e and π

Together the derivatives and integrals give other rates of growth, the cells of the Pascal's Triangle calculus are also combinations and permutations as with the standard Pascal's Triangle. Vertical columns are exponentials, when the logs are taken of these they are straight lines. The rows approach a normal curve, in this model then the vertical columns relate to e and the horizontal rows to π.

The net force on this little piece of string in the transverse direction (the y-direction) is

$$F_{\text{net } y} = T_y(x + \Delta x) + T_y(x) \qquad (16.21)$$

FIGURE 16.18 Finding the net force on the string.



Separating work and impulse

The slope of the Pythagorean Triangle is an infinitesimal/fluxion, or e𝕧^0/-𝕚d^0. In this model the infinitesimal and instant or fluxion allow for work and impulse to be separated, but the Pythagorean Triangles are in a superposition of a derivative and an integral. When this is a derivative slope it can only be observed as impulse, when an integral field it can only be measured as work.

A superposition or duality

The Pythagorean Triangle is a kind of superposition because it contains both a slope and an area or integral field. This does not mean it fluctuates from one to the other, but that a Pythagorean Triangle has a duality of these attributes.

Partial derivatives and integrals

In this model one Pythagorean Triangle side is held constant while the other has its exponent changed. With an E𝕍/-𝕚d inertial impulse the e𝕧 position is squared as a displacement. The other Pythagorean Triangle side acts as a clock gauge of time, it is a constant because there is no force. With a partial integral -𝕀D×e𝕧 inertial work keeps the e𝕧 position constant on a ruler, it does not change because it is a position where the measurement is taken.

Other calculus operations

The chain rule can be derived from the derivatives in the Pascal's Triangle calculus, it is a combination of two derivatives. Likewise this can be done with two integrals chained together. The product rule can be derived from the two cells above a cell in the Pascal's Triangle calculus. For example in the third row there is e𝕧^3 3×-𝕚d×e𝕧^2 3×e𝕧×-𝕚d^3 -𝕚d^3. The 3×-𝕚d×e𝕧^2 cell can be regarded as a product of two different variables d and e.

The product rule

Above this is e𝕧^2 and 2×e𝕧×-𝕚d. The product rule of ∂d×∂e as d∂e+e∂d, the two cells above would then be 2×e𝕧×-𝕚d as d∂e and e𝕧^2×1×-𝕚d^0 as e𝕧^2. The factor 3 disappears because it would be d in -𝕚d, that becomes a fluxion with no size. This regards the derivative and the integral in a cell as two derivatives, it depends on whether the movement is to the left or right as to whether the derivative or integral process changes the cell. This means as in Pascal’s Triangle a cell is the sum of the two above it, when this is done with derivatives it gives the product rule. If not then the exponents and coefficients of each cell would not change consistently.

A changing slope of a wave

The slope of the string would be the E𝕍/-𝕚d inertial impulse at a -𝕚d inertial time. This is like the -𝕚d and e𝕧 Pythagorean Triangle having its slope change as the wave passes. The -𝕀D×e𝕧 inertial work is where the -𝕀D inertial torque causes the angle θ to change as it passes. At a given instant or fluxion as -𝕚d inertial time, this wave can be regarded as a spring moving forward and backwards along the string. For example a buoy moored in the ocean can move forwards and backwards as the wave passes, this would be the E𝕍/-𝕚d inertial impulse.

You can see, from the force triangle in Figure 16.18, that the ratio $T_y(x + \Delta x)/T_s$—rise over run—is the *slope of the string* at position $x + \Delta x$. This is a key part of the analysis, so make sure you understand it. The slope is the derivative of the string's displacement with respect to *x at this specific instant of time*. We're holding *t* constant while looking at the spatial variation of the string, so this is another partial derivative:

$$\text{string slope} = \frac{\partial D}{\partial x} \qquad (16.22)$$

Wave equation for a string

The wave equation for a string in (16.28) can be written as 1/-𝕀D=1/E𝕍×e𝕧/-𝕚d×e𝕧/-𝕚d, or E𝕍/-𝕀D=e𝕧/-𝕚d × e𝕧/-𝕚d. Here 1/μ is e𝕧/-𝕚d and the tension T is also e𝕧/-𝕚d because increasing it stretches the string with a longer e𝕧 length. That would decrease the -𝕚d inertial mass per unit length inversely.

$$\frac{\partial^2 D}{\partial t^2} = \frac{T_s}{\mu}\frac{\partial^2 D}{\partial x^2} \quad \text{(wave equation for a string)} \qquad (16.28)$$

Equation 16.28 is the *wave equation for a string*. It's really Newton's second law in disguise, but written for a continuous object where the displacement is a function of both position and time. Just like Newton's second law for a particle, it governs the dynamics of motion on a string.

The general wave equation

V^2 here is T_s/μ or e𝕧/-𝕚d × e𝕧/-𝕚d where the first is a tension and the second is inverted μ.

With Equation 16.9 in hand, we can write Equation 16.28 as

$$\frac{\partial^2 D}{\partial t^2} = v^2\frac{\partial^2 D}{\partial x^2} \quad \text{(the general wave equation)} \qquad (16.35)$$

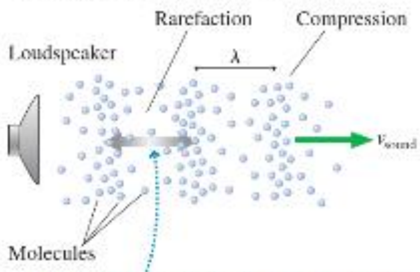
Compressions and rarefactions

In this model sound can move with -𝕀D×e𝕧 inertial work as waves, also with an E𝕍/-𝕚d inertial impulse as particles. These are referred to as phonons. The motion backwards and forwards is like the piston example from the rolling wheel model as the E𝕍/-𝕚d inertial impulse. The rolling wheel can be regarded as driving this E𝕍/-𝕚d inertial impulse with -𝕀D×e𝕧 inertial work, or the impulse drives the work. In this model the Pythagorean Triangles have no forces until -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse create the sound, then there is a reaction to this as -𝕀D×e𝕧 inertial work and the E𝕍/-𝕚d inertial impulse.

Pressure from impulse

Here pressure comes from impulse which is not a wave, instead particles might collide inside a container creating pressure on the walls. These molecules can also bounce off each other with a kinetic and inertial torque, this is work that randomizes according to the Boltzmann constant.

FIGURE 16.19 A sound wave is a sequence of compressions and rarefactions.



Interfering waves and a slower inertial velocity

In this model the e𝕪 and -𝕘d Pythagorean Triangle as the photon changes when passing through the medium. This is like photons passing near a gravitational field around a planet. They bend towards the atoms in the medium, with -𝔾D×e𝕪 light work this can be represented as waves interfering with each other. That bending decreases its e𝕧/-𝕚d inertial velocity to lower than c.

Muons with a contracted path and slower time

Also the e𝕪×-𝕘d photons have a E𝕍 inertial displacement history and a -𝕀D inertial temporal history, this is because they have moved closer to a +𝕚d gravitational field. As E𝕍 increases then -𝕚d associated with E𝕍/-𝕚d inertial impulse slows, as -𝕀D increases then e𝕧 associated with -𝕀D×e𝕧 inertial work also contracts. This makes e𝕧/-𝕚d slower for the photons, the e𝕧 length covered is contracted like a muon would have its path contracted. Also its -𝕚d inertial mass is slowed, like the muon has its inertial time slowed so its decay time is reduced.

A smaller rolling wheel

The e𝕪×-𝕘d photons must maintain a constant Pythagorean Triangle area in this model, they do this by e𝕪 contracting from the -𝔾D light temporal history and -𝕘d slowing from the E𝕐 light displacement history. The contracting of e𝕪 and proportionally e𝕧 makes the wavelength decrease. The frequency appears to be the same because the e𝕪×-𝕘d rolling wheel is rotating more slowly while its e𝕪 spoke also contracts. If this rolling wheel is compared to one in a vacuum, both would be rotating at the same frequency but the one in the medium would be going more slowly.

Smaller wavelength in a vacuum

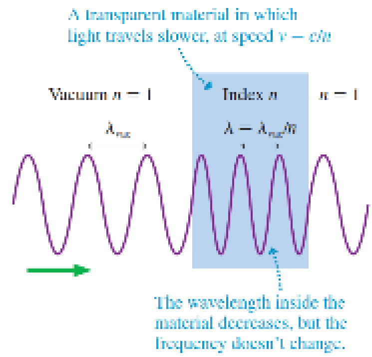
This is different from a change in e𝕧 wavelength in a vacuum, as e𝕧 contracts then the -𝕚d inertial time of the photon would increase inversely. That is proportional to the -𝕘d rotational frequency of the photon also increasing. The rolling wheel of the photon would then have a smaller radius or e𝕧 spoke, to maintain the same e𝕧/-𝕚d inertial velocity the rotational frequency increases inversely to it.

FIGURE 16.21 shows a light wave passing through a transparent material with index of refraction n. As the wave travels through vacuum it has wavelength λ_{vac} and frequency f_{vac} such that $\lambda_{vac} f_{vac} = c$. In the material, $\lambda_{mat} f_{mat} = v = c/n$. The frequency does not change as the wave enters ($f_{mat} = f_{vac}$), so the wavelength must. The wavelength in the material is

$$\lambda_{mat} = \frac{v}{f_{mat}} = \frac{c}{nf_{mat}} = \frac{c}{nf_{vac}} = \frac{\lambda_{vac}}{n} \qquad (16.38)$$

The wavelength in the transparent material is less than the wavelength in vacuum. This makes sense. Suppose a marching band is marching at one step per second at a speed of 1 m/s. Suddenly they slow their speed to $\frac{1}{2}$ m/s but maintain their march at one step per second. The only way to go slower while marching at the same pace is to take *smaller steps*. When a light wave enters a material, the only way it can go slower while oscillating at the same frequency is to have a *smaller wavelength*.

FIGURE 16.21 Light passing through a transparent material with index of refraction n.



Area not volume

In this model volume would not be used, instead it would be a side area of the volume. Pressure becomes then a squared force. This is related to Young's modulus, pressure can push down on electrons in their orbitals. An example of this would be in a star, the Eℍ/+𝕚d gravitational impulse causes the Eℍ height displacement to compress Hydrogen into Helium.

Compression of a star

When this is observed all around the star there can be a reduction in volume with circular geometry. The forces are not cubed, instead there are still squared forces of work and impulse. In an atom the compression of the Hydrogen atoms causes the E𝔸/+𝕠d potential impulse to react against the lowering of the electron orbitals.

Gas and hyperbolic geometry

A gas has more hyperbolic geometry, the molecules have a higher pressure from their E𝕍/-𝕚d inertial impulse. A solid is where the +𝕆D×e𝕒 potential work in between atoms is stronger, they can share electrons. When compressed they have a weaker E𝕐/-𝕠d kinetic impulse, as the electrons are pushed into lower orbitals e𝕪×-𝕘d photons can be released as heat.

Boltzmann's constant and work

The pressure change here uses an infinitesimal from calculus. With this model that comes from the Pascal's Triangle calculus, the gas molecules would move randomly with -𝕀D×e𝕧 inertial work. This would be in the rows of the Pascal's Triangle calculus where they approach a normal curve. This uses Boltzmann's constant as k or -𝕠d ×e𝕪/-𝕆d, the -𝕆D kinetic probabilities are measured by the e𝕧 length as the cylinder is compressed.

Impulse in compressing the cylinder

Because pressure is a straight-line force, the E𝕐/-𝕠d kinetic impulse in compressing the cylinder like a bike pump pushes the molecules in one direction. The strength of this impulse would be in the -𝕠d kinetic time taken in compressing the cylinder, or conversely in rarefaction. That makes the gas molecules move less randomly, they correspond more to the columns of the Pascal's Triangle calculus as exponentials.

Using h with impulse

In this model that uses a similar function to h as -𝕠d ×e𝕐/-𝕠d. The emission of e𝕪×-𝕘d photons from this compression is proportional to the overall -𝕠d ×e𝕐/-𝕠d value. This is observing the changes in the electron orbitals, as they are compressed lower more e𝕪×-𝕘d photons are emitted.

Using h with impulse and k with work

When the compression is removed the e𝕪×-𝕘d photons are absorbed as in a Carnot engine, this is where the atoms do more -𝕆D×e𝕪 kinetic work from the -𝔾D×e𝕪 light work of the photons. The gas becomes more random and k as -𝕠d ×e𝕪/-𝕆d becomes stronger inversely to h as -𝕠d ×e𝕐/-𝕠d.

Observing h with electrons as particles

This compression and rarefaction causes a change in the quantized orbitals of the molecules. The electrons make changes in their orbitals by emitting e𝕪×-𝕘d photons, when this is observed with h the electrons act as particles.

Separating the derivative and integral

When the derivative and integral pairs are separated from a cell in the Pascal's Triangle calculus, this leaves an infinitesimal e𝕪^0 that a derivative can change with. This can use a central cell in the Pascal's Triangle calculus where the integral and derivative have the same form. If there is an integral then there is a fluxion or time instant as -𝕠d^0.

A curve in between an exponential and inverse exponential

The cell acts like a function with an integral and derivative multiplied together, a curve can have a number of cells arranged as a sequence. That curve can be a combination of exponentials and inverse exponentials, the result would be in between these two. Each cell can also be regarded as a single derivative, then a change with an infinitesimal in calculus is the same process as in separating the derivative and integral.

Moving a cell as differentiation or integration

That curve can change as a combination of an exponential in columns and an inverse exponential or normal curve in rows. Each cell can also have its derivative and integral separated by making one of them use an infinitesimal or fluxion. Taking the remaining half of each cell as a term in a function there can be a derivative taken, this is like moving the cell to the left in each case. When the integral and derivative are separated, then the derivative rules can be in moving to another cell. The integral might later be expanded from a fluxion instant to further change the function.

16.6 ADVANCED TOPIC The Wave Equation in a Fluid

In Section 16.4 we used Newton's second law to show that traveling waves can propagate on a stretched string *and* to predict the wave speed in terms of properties of the string. Now we wish to do the same for sound waves—longitudinal waves propagating through a fluid.

A sound wave is a sequence of compressions and rarefactions in which the fluid is alternately compressed and expanded. A substance's compressibility is characterized by its *bulk modulus B*, which you met in « Section 14.6 when we looked at the elastic properties of materials. If excess pressure p is applied to an object of volume V, then the fractional change in volume—the fraction by which it's compressed—is

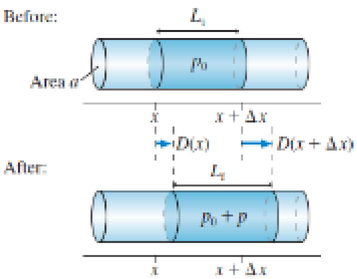
$$\frac{\Delta V}{V} = -\frac{p}{B} \tag{16.39}$$

The minus sign indicates that the volume *decreases* when pressure is applied. Gases are much more compressible than liquids, so gases have much smaller values of B than liquids.

Let's apply this to a fluid—either a liquid or a gas. FIGURE 16.22 shows a small cylindrical piece of fluid with equilibrium pressure p_0 located between positions x and $x + \Delta x$. The initial length and volume of this little piece of fluid are $L_i = \Delta x$ and $V_i = aL_i = a\,\Delta x$. Notice that we use a for area in this chapter so that there is no conflict with A for amplitude. Suppose the pressure changes to $p_0 + p$. The volume of this little piece of fluid will either decrease (compression) or increase (expansion), depending on whether p is positive or negative.

The volume changes only if the ends of the cylinder undergo *different* displacements. (Equal displacements would shift the cylinder but not change its volume.) In

FIGURE 16.22 An element of fluid changes volume as the pressure changes.



Creating an infinitesimal

In this model the displacement would come from the E𝕐/-𝕠d kinetic impulse used to create the pressure. There is also the E𝕍/-𝕚d inertial impulse in reaction to this. The volume has changed by an infinitesimal e𝕧^{0}, the E𝕍 inertial displacement can be written as e𝕧^{0}×e𝕧^{2} so that it becomes the same as e𝕧^{0}. This would be from the -𝕚d and e𝕧 Pythagorean Triangle as inertial, the additional e𝕧^{0} length has no impulse force and is not observable.

Conserving the function of an infinitesimal

To conserve Pythagorean Triangle side values this can remain as (𝕧^{2})𝕧^{0} where e= e𝕧^{2}. It can also be written as the E𝕍/-𝕚d inertial impulse plus an additional E𝕍/-𝕚d^{0} inertial impulse where the pressure occurs for an instant longer as a fluxion. For example the pressure might be overall 3×-𝕚d×e𝕧^{2} from the third row of the Pascal's Triangle calculus. This has a statistical value in the row approaching a normal curve, it also represents probabilities in the binomial theorem. From this can be taken combinations and permutations.

Combinations and permutations and a fluid

As the fluid molecules move they can be combining and have permutations in how they collide with each other. This can have probabilities like a row in the Pascal's Triangle calculus, approaching a normal curve distribution using Boltzmann's constant. They can also have exponential growth and decay in the columns of the Pascal's Triangle calculus, for example several collisions in a row like a chain reaction has an exponential force from the E𝕍/-𝕚d inertial impulse. This would dissipate with the randomizing -𝕀D×e𝕧 inertial work.

Connecting derivatives and integrals to other functions

One of the proposed aspects of the Pascal's Triangle calculus is that derivatives and integrals are part of other mathematical functions like combinations, permutations, exponentials, inverse exponentials as probabilities, complex numbers, and many others. This can include the definition of the derivatives and integrals, with 3×-𝕚d×e𝕧^2 as the E𝕍/-𝕚d inertial impulse this can be regarded as 3×-𝕚d^0×e𝕧^2 or E𝕍.

Separating and rejoining derivatives to other functions

Taking the derivative of E𝕍 that gives 2×e𝕧 or 2𝕧, this can come from the second row of the Pascal's Triangle calculus as 2e𝕧×-𝕀D as -𝕀D×e𝕧 inertial work. When -𝕚d^0 is substituted then the derivative rules remain in Pascal's Triangle. This can remain as a fluxion, but when -𝕚d^0 is expanded again into -𝕀D then the cell in the Pascal's Triangle calculus becomes part of the binomial theorem as a probability, an exponential, combination, and permutation.

Reducing a larger function

In (16.43) the change is -B∂1/∂e𝕧^0, this implies the second Pythagorean Triangle side as -B∂-𝕚d^0/e𝕧^0. This can also be a larger function that is reduced to a fluxion over an infinitesimal such as ∂(-𝕀D)-𝕚d^0/∂(e𝕧)e𝕧^0. For this infinitesimal length there is no force, for a greater length there would be -𝕀D×e𝕧 inertial work done. The motions in a fluid can then be reduced to only derivatives or integrals, their calculations are then impulse as particles or integrals as fields or waves.

Oblique normal and other curves

In the Pascal's Triangle calculus other curves can be constructed, for example an oblique line through Pascal's Triangle gives a Fibonacci number. As this grows it approaches a smoother curve like a normal curve. It looks then like a normal curve skewed to one side, also like a wave beginning to break. When this is regarded as derivatives then the curve can be in terms of the straight Pythagorean Triangle side only, such as e𝕧. Its rise and fall can be written as an exponential, when the derivatives are taken this would move out of a Pascal's Triangle calculus cell.

Each cell regarded as an integral

If it is regarded as an integral then all the terms are -𝕚d, when it is integrated that also moves it out of a cell. The columns can be regarded as being like integral columns that have a width as infinitesimals. When this curve is moved downwards in the Pascal's Triangle calculus then the width of the columns decreases to approach e𝕧^0 as this infinitesimal.

Intangible and Obscure numbers

When it is regarded as an Intangible number, in the form e𝕙+𝕚d or e𝕧-𝕚d, then the curve has a spin component as well as a straight-line direction. As an ocean wave then it can be regarded as having an E𝕍/-𝕚d inertial impulse upwards or a Eℍ/+𝕚d gravitational impulse downward. Moving to either side this can be regarded as +𝕀D×e𝕙 gravitational work or -𝕀D×e𝕧 inertial work, then this infinitesimal e𝕧 would be the length in between the columns in an integral. This can also be done for the Obscure numbers e𝕒+𝕠d and e𝕪-𝕠d.

Modeling in six Pascal's Triangles

To model an ocean wave in four of the Pascal's Triangle calculus there can be two with their vertices touching. Then e𝕙+𝕚d would have a curve of the changing Eℍ/+𝕚d gravitational impulse and +𝕀D×e𝕙 gravitational work. Inverse to this would be an inverted Pascal's Triangle above that, it would have an inertial curve of e𝕧-𝕚d. A second pair of Pascal's Triangles would have e𝕒+𝕠d protons as the triangle pointing upwards, above this pointing downwards would be the electrons as e𝕪-𝕠d.

Roy and Biv curves

This could then represent Roy electromagnetism in the ocean wave as well as Biv space-time. It can also be relativistic as the curve changes with stronger gravity or a faster inertial velocity. A third pair of Pasca's Triangles would represent e𝕓+𝕘d as gravis or gravitational waves, on top as an inverted triangle would be e𝕪-𝕘d as photons. The changing curve would show how photons were emitted and absorbed, also gravis or gravitational waves were emitted and absorbed.

Differentiating and integrating the curve

When done like this the curve can be differentiated or integrated. If instead the derivative and integral are separated, then differentiating can move the contents of a cell to the left. If the integral remains then integration moves it to the right. These cells would be approximately the same as a complete cell of a derivative times an integral, then comparing the two would give additional insights with exponentials, inverse exponentials or probabilities, combinations and permutations.

The curve as a skewed probability

The oblique normal curve as a Fibonacci number, or any other curve made of the cells, can also be regarded as a probability. For example in a survey there might be a skew to one side represented by a bias to one answer or another. This can be interpreted as an exponential increase towards one answer, then this would tend to be chaotic and prone to collapse like an avalanche.

Changing variance

A normal curve might also have a higher peak and a smaller variance, this can be regarded as an exponential bias towards the center. A wave function might have a higher E𝕐/-𝕠d kinetic impulse as an electron observation, then this column in the Pascal's Triangle calculus spreads out like a normal curve row as it becomes wavelike again. When the electron is represented by the Pascal's Triangles of e𝕪-𝕠d and e𝕧-𝕚d, then the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse give an observation. As the curve widens it is more like -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work such as in an orbital.

No displacement wave

In (16.46) there would not be a displacement wave, this comes from the E𝕍/-𝕚d inertial impulse where the fluid acts as particles not waves. Because of this the cosine would be used. The fluid molecules would move backwards and forwards colliding as particles in compression and rarefaction.

Pressure amplitude

The pressure amplitude in (16.46) would come from e𝕧 in the E𝕍/-𝕚d inertial impulse, this as a cosine can be converted into a sine when it becomes -𝕀D×e𝕧 inertial work. There would be a rolling wheel cycle associated with the frequency of the E𝕍/-𝕚d inertial impulse, this would give the wavelength e𝕧 from the wheel's -𝕀D×e𝕧 inertial work.

the bottom half of Figure 16.22 we see that the left end of the cylinder has undergone displacement $D(x, t)$ while the displacement at the right end is $D(x + \Delta x, t)$. Now the cylinder has length

$$L_f = L_i + (D(x + \Delta x, t) - D(x, t)) \qquad (16.40)$$

and consequently its volume has *changed* by

$$\Delta V = a(L_f - L_i) = a(D(x + \Delta x, t) - D(x, t)) \qquad (16.41)$$

Substituting both the initial volume and the volume change into Equation 16.39, we have

$$\frac{\Delta V}{V} = \frac{a(D(x + \Delta x, t) - D(x, t))}{a\,\Delta x} = -\frac{p}{B} \qquad (16.42)$$

After canceling the a, you can see that, just as in Section 16.4, we're left—in the limit $\Delta x \rightarrow 0$—with the definition of the derivative of D with respect to x. It is again a *partial* derivative because we're holding the variable t constant. Thus we find that the fluid pressure (or, to be exact, the pressure deviation from p_0) at position x is related to the displacement of the medium by

$$p(x, t) = -B\frac{\partial D}{\partial x} \qquad (16.43)$$

The pressure depends on how rapidly the fluid's displacement changes with position.

We anticipate that we'll discover sinusoidal sound waves later in this section, so a displacement wave of amplitude A,

$$D(x, t) = A\sin(kx - \omega t + \phi_0) \qquad (16.44)$$

is associated with a pressure wave

$$\begin{aligned} p(x, t) = -B\frac{\partial D}{\partial x} &= -kBA\cos(kx - \omega t + \phi_0) \\ &= -p_{max}\cos(kx - \omega t + \phi_0) \end{aligned} \qquad (16.45)$$

The *pressure amplitude*, or maximum pressure, is

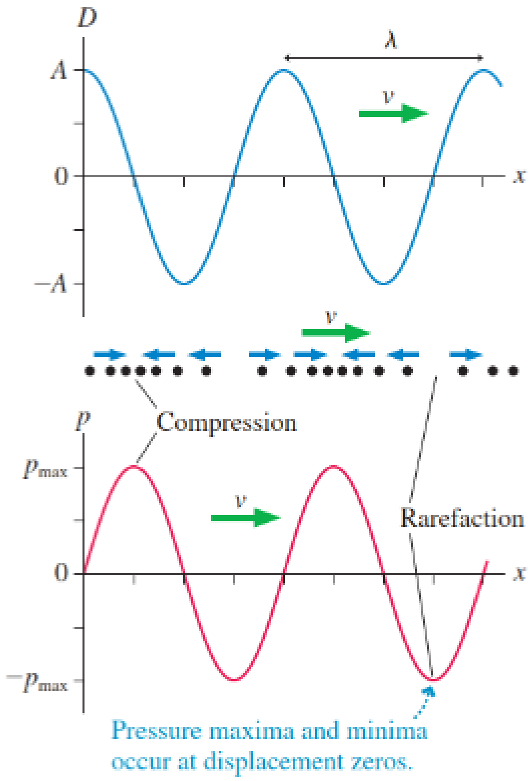
$$p_{max} = kBA = \frac{2\pi fBA}{v_{sound}} \qquad (16.46)$$

where we used $\omega = 2\pi f = vk$ (Equation 16.13) in the last step to write the result in terms of the wave's speed and frequency. In other words, a sound wave is not just a traveling wave of molecular displacement. **A sound wave is also a traveling pressure wave.**

Snapshot graph

Here the pressure from sound would again be E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, the rolling wheel would be doing -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. The impulse would not be an oscillation, the collisions between the particles would be chaotic but close to rhythmic. A snapshot in time would be from the E𝕍/-𝕚d inertial impulse, if this was a snapshot in positions e𝕧 then it would be measuring -𝕀D×e𝕧 inertial work.

FIGURE 16.23 Snapshot graphs of the sound displacement and pressure.



Compressibility and pressure

This is another wave equation, in this model (16.50) would be ∂1/-𝕀D=B/ρ × ∂1/E𝕍 or E𝕍/-𝕀D=B/ρ. This E𝕍/-𝕀D is found in the ½×e𝕍/-𝕀d ×-𝕚d linear inertia, there it is multiplied by -𝕚d as the inertial mass. In (16.51) the inertial velocity e𝕧/-𝕚d = √(B/ρ), B is the compressibility so a lighter gas is more compressible. The inverse of this is the pressure ρ, so a denser gas is less compressible and gives a greater pressure through its E𝕍/-𝕚d inertial impulse.

Temperature and compressibility

When the temperature of a gas as e𝕪 decreases the molecules are closer together, the compressibility decreases so sound moves slower through it. Conversely the ρ pressure of a colder gas increases. In this model the kinetic velocity of a gas is e𝕪/-𝕠d where e𝕪 is the temperature and -𝕠d is the kinetic time.

Transverse waves of work in solids

In a solid or liquid there are also transverse waves which come from the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. These move from side to side unlike the longitudinal impulse which moves forwards and backwards. A solid is dominated more by the wave nature of electrons because the solid molecules are bound together more in bonds. This is also referred to as a shear wave, it also comes from gas molecules escaping more from these molecular bonds.

Waves in molecules and shear waves

In this model the molecular bonds come from the -𝕆D×e𝕪 kinetic work of electrons, they act more like waves in the atom and in between them as molecules. The amplitude of this wave is orthogonal to the impulse, these are also slower because the -𝕀D×e𝕧 inertial work moves more to one side with spin rather than straight forward with a longitudinal impulse.

Photons in a denser medium

This is also like e𝕪×-𝕘d photons in a denser medium they do more -𝔾D×e𝕪 light work and so they are bonding around atoms more. Their waves interfere with each other giving an overall e𝕧/-𝕚d inertial velocity slower in water than a vacuum where there is more of a e𝕐/-𝕘d light impulse. There e𝕪/-𝕘d photons would collide more with free electrons, in water the e𝕪×-𝕘d photons would be absorbed more into the water molecules and emitted as well as bending around them.

$$\frac{\partial^2 D}{\partial t^2} = \frac{B}{\rho}\frac{\partial^2 D}{\partial x^2} \qquad (16.50)$$

Equation 16.50 is a wave equation! Just as in our analysis of a string, applying Newton's second law to a small piece of the medium has led to a wave equation. We've already shown that a sinusoidal traveling wave, Equation 16.44, is a solution, so we don't need to prove it again. Further, by comparing Equation 16.50 to the general wave equation, Equation 16.35, we can predict the speed of sound in a fluid:

$$v_{\text{sound}} = \sqrt{\frac{B}{\rho}} \qquad (16.51)$$

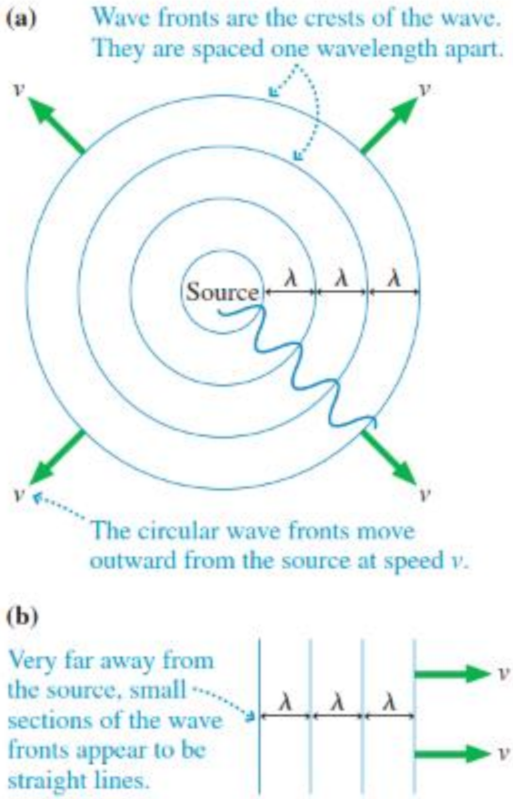
Waves in 2 and 3 dimensions

In this model a wave can be doing -𝕀D×e𝕧 inertial work, then the probability of what e𝕧 position the wave has can be spherical. This does not mean the wave is itself a volume, it only has an integral area as a square. Because this area can be at different angles overall it can make a sphere. Gravity for example can be regarded as a wave with an inverse square relationship as +𝕀D×e𝕙 gravitational work to the e𝕙 height above a planet.

Wave probabilities and quantization

A circular or spherical wave consists of different molecules doing -𝕀D×e𝕧 inertial work, then there are -𝕀D inertial probabilities that weaken or become less probable at larger e𝕙 heights. The equal wavelengths here also relate to quantization, the -𝕀D inertial probabilities would be decreasing as whole number squares of square roots of integers. These can also appear as an E𝕍/-𝕚d inertial impulse in a straight-line direction. For example, an earthquake can spread out with transverse or shear waves of work in all directions. When observing the longitudinal impulse this is in a straight-line.

FIGURE 16.25 The wave fronts of a circular or spherical wave.



Plane waves as impulse

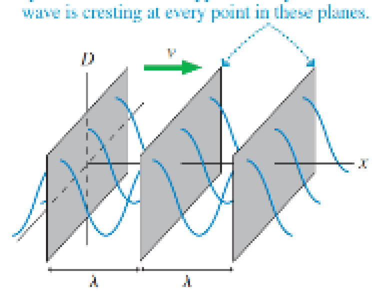
A plane wave in this model is from impulse, it is not actually a wave but collisions of particles.

To visualize a plane wave, imagine standing on the x-axis facing a sound wave as it comes toward you from a very distant loudspeaker. Sound is a longitudinal wave, so the particles of medium oscillate toward you and away from you. If you were to locate all of the particles that, at one instant of time, were at their maximum displacement toward you, they would all be located in a plane perpendicular to the travel direction. This is one of the wave fronts in Figure 16.26, and all the particles in this plane are doing exactly the same thing at that instant of time. This plane is moving toward you at speed v. There is another plane one wavelength behind it where the molecules are also at maximum displacement, yet another two wavelengths behind the first, and so on.

Because a plane wave's displacement depends on x but not on y or z, the displacement function $D(x, t)$ describes a plane wave just as readily as it does a one-dimensional wave. Once you specify a value for x, the displacement is the same at every point in the yz-plane that slices the x-axis at that value (i.e., one of the planes shown in Figure 16.26).

FIGURE 16.26 A plane wave.

Very far from the source, small segments of spherical wave fronts appear to be planes. The wave is cresting at every point in these planes.



Spreading out as a wave or particles

As a light wave spreads out, this changes its ability to do -𝔾D×e𝕪 light work. Because -𝔾D is no longer light time it is a light probability, the wave can then collapse in no time to a given -𝔾D light probability at a position e𝕧. When e𝕐/-𝕘d light impulse is observed the e𝕪/-𝕘d photons becomes sparser as its spreads out.

Two kinds of parabolas

This is associated with two kinds of parabolas, the -𝔾D×e𝕪 light work comes from the integral area under the parabola as the inverse square rule. The e𝕐/-𝕘d light impulse comes from the parabolic paths of photons colliding with electrons. It is also associated with δ as the first Feigenbaum number with cascading curves close to parabolas. When -𝔾D×e𝕪 light work is measured e𝕪 decreases proportionally to a e𝕧 length as an amplitude. The difference between measuring this as work or observing with impulse comes if the photons pass through a double slit experiment.

$$D(r, t) = A(r)\sin(kr - \omega t + \phi_0) \qquad (16.55)$$

Other than the change of x to r, the only difference is that the amplitude is now a function of r. A one-dimensional wave propagates with no change in the wave amplitude. But circular and spherical waves spread out to fill larger and larger volumes of space. To conserve energy, an issue we'll look at later in the chapter, the wave's amplitude has to decrease with increasing distance r. This is why sound and light decrease in intensity as you get farther from the source. We don't need to specify exactly how the amplitude decreases with distance, but you should be aware that it does.

The rolling wheel is not measured

In this model work is done by a rolling wheel, because the torque is probability the wheel is not observable as an actual disk. This is measured by the amplitude as the spin Pythagorean Triangle side axle turns, it would then oscillate according to the phase or angle between the spoke of the wheel and vertical on the transverse wave.

Polarization and the rolling wheel

It can also be regarded as horizontal or another angle being transverse, this also allows for the polarity or direction of the spoke to change. For example with e𝕪×-𝕘d photons the -𝔾D×e𝕪 light work can be measured at different angles, it can also be circular polarization where the wheel is spinning around the direction of travel.

Phase differences

The phase difference between two points can be measured from the e𝕧 wavelength, when radians are used this is connected to 1/√(2π) as ≈ β. When the plane impulse is observed, not as a wave, this is chaotic from the particle collisions and approached β as regular tine values or wavelengths. Because this is not a wave it does not become regular like the tines, that would be an oscillating wave.

Phase and Phase Difference

« Section 15.2 introduced the concept of *phase* for an oscillator in simple harmonic motion. Phase is also important for waves. The **phase** of a sinusoidal wave, denoted ϕ, is the quantity $(kx - \omega t + \phi_0)$. Phase will be an important concept in Chapter 17, where we will explore the consequences of adding various waves together. For now, we can note that the wave fronts seen in Figures 16.25 and 16.26 are "surfaces of constant phase." To see this, write the displacement as simply $D(x, t) = A \sin \phi$. Because each point on a wave front has the same displacement, the phase must be the same at every point.

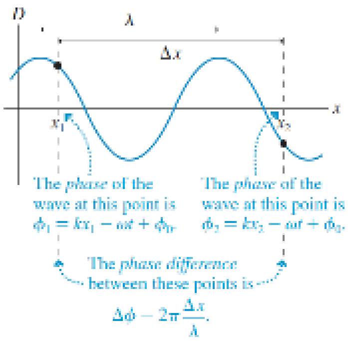
It will be useful to know the *phase difference* $\Delta\phi$ between two different points on a sinusoidal wave. FIGURE 16.27 shows two points on a sinusoidal wave at time t. The phase difference between these points is

$$\begin{aligned}\Delta\phi = \phi_2 - \phi_1 &= (kx_2 - \omega t + \phi_0) - (kx_1 - \omega t + \phi_0) \\ &= k(x_2 - x_1) = k\,\Delta x = 2\pi \frac{\Delta x}{\lambda}\end{aligned} \qquad (16.56)$$

That is, **the phase difference between two points on a wave depends on only the ratio of their separation Δx to the wavelength λ.** For example, two points on a wave separated by $\Delta x = \frac{1}{2}\lambda$ have a phase difference $\Delta\phi = \pi$ rad.

An important consequence of Equation 16.56 is that **the phase difference between two adjacent wave fronts is $\Delta\phi = 2\pi$ rad.** This follows from the fact that two adjacent wave fronts are separated by $\Delta x = \lambda$. This is an important idea. Moving from one crest of the wave to the next corresponds to changing the *distance* by λ and changing the *phase* by 2π rad.

FIGURE 16.27 The phase difference between two points on a wave.



Power, intensity and decibels

Watts are 1 joule/second, here joules would be the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. When this is divided by -𝕠d kinetic time it leaves E𝕐/-𝕆D leaving aside the ½ factor. When divided by square meters these are E𝕍 proportional to E𝕐, that leaves 1/-𝕆D as a kinetic probability. This would define intensity from -𝕆D×e𝕪 kinetic work, the inverse of this is the E𝕐/-𝕠d kinetic impulse.

FIGURE 16.28 shows a wave impinging on a surface of area a. The surface is perpendicular to the direction in which the wave is traveling. This might be a real, physical surface, such as your eardrum or a photovoltaic cell, but it could equally well be a mathematical surface in space that the wave passes right through. If the wave has power P, we define the **intensity** I of the wave to be

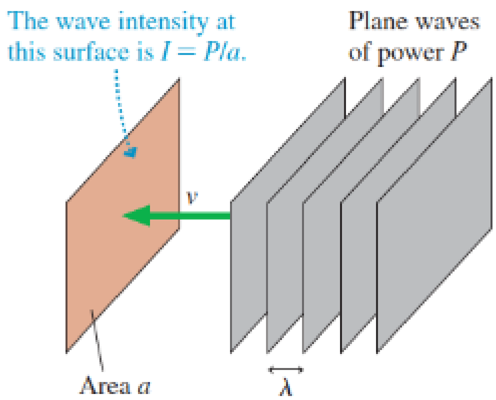
$$I = \frac{P}{a} = \text{power-to-area ratio} \qquad (16.57)$$

The SI units of intensity are W/m^2. Because intensity is a power-to-area ratio, a wave focused into a small area will have a larger intensity than a wave of equal power that is spread out over a large area.

Power and intensity

A plane wave in this model would be the E𝕐/-𝕠d kinetic impulse, the intensity comes from 1/-𝕆D as the kinetic probability and -𝕆D×e𝕪 kinetic work. The power P is the inverse of the intensity I, from I×P or 1/-𝕆D × E𝕐 = constant area. This would describe two different forces, 1/-𝕆D as intensity I would come from work and power P from impulse. The E𝕐/-𝕠d kinetic impulse then provides a straight-line power as it can push the target, the intensity gives the amount of the waves.

FIGURE 16.28 Plane waves of power P impinge on area a with intensity $I = P/a$.



Power on the wavefront

The power is spread over the surface of a sphere, this can be regarded as the ability of the plane impulse to impart a displacement.

If a source of spherical waves radiates uniformly in all directions, then, as **FIGURE 16.29** on the next page shows, the power at distance r is spread uniformly over the surface of a sphere of radius r. The surface area of a sphere is $a = 4\pi r^2$, so the intensity of a uniform spherical wave is

$$I = \frac{P_{\text{source}}}{4\pi r^2} \qquad \text{(intensity of a uniform spherical wave)} \qquad (16.58)$$

The inverse-square dependence of r is really just a statement of energy conservation. The source emits energy at the rate P joules per second. The energy is spread over a

Intensity ratio

The intensity ratio varies inversely with the radius which would be e𝕧, with -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work as E𝕍 increases then -𝕆D decreases inversely. That gives a ratio of -𝕆D$_2$/-𝕆D$_1$.

larger and larger area as the wave moves outward. Consequently, the energy *per unit area* must decrease in proportion to the surface area of a sphere.

If the intensity at distance r_1 is $I_1 = P_{source}/4\pi r_1^2$ and the intensity at r_2 is $I_2 = P_{source}/4\pi r_2^2$, then you can see that the intensity *ratio* is

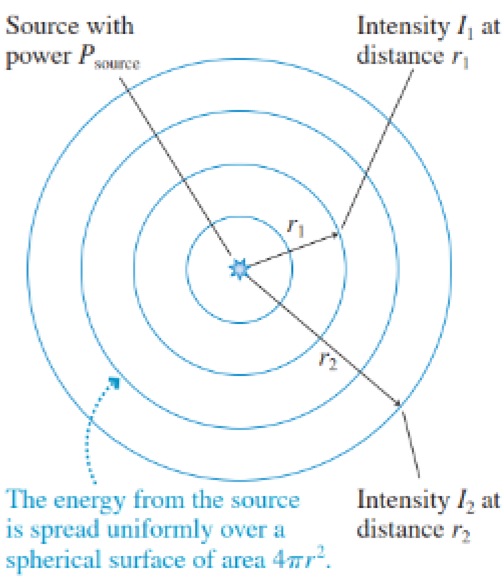
$$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2} \qquad (16.59)$$

You can use Equation 16.59 to compare the intensities at two distances from a source without needing to know the power of the source.

Work spread uniformly as a field

Here the source has a power from the E𝕐/-ⓞd kinetic impulse and E𝕍/-ⅈd inertial impulse, the energy spread uniformly over an area 4π×E𝕍 would be the -𝕀D×e𝕧 inertial work as a field. E𝕍 would not be a field here, instead it would be the power P which can cause a displacement on an observable target.

FIGURE 16.29 A source emitting uniform spherical waves.



Sound intensity level

This refers to the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, this is a logarithm set at base 10 by convention. The ratio of the I intensity is the change of e𝕪 distance proportional to a e𝕧 length in -𝕀D×e𝕧 inertial work.

Sound Intensity Level

Human hearing spans an extremely wide range of intensities, from the *threshold of hearing* at $\approx 1 \times 10^{-12}$ W/m^2 (at midrange frequencies) to the *threshold of pain* at ≈ 10 W/m^2. If we want to make a scale of loudness, it's convenient and logical to place the zero of our scale at the threshold of hearing. To do so, we define the **sound intensity level,** expressed in **decibels** (dB), as

$$\beta = (10\text{ dB})\log_{10}\left(\frac{I}{I_0}\right) \qquad (16.61)$$

where $I_0 = 1.0 \times 10^{-12}$ W/m^2. The symbol β is the Greek letter beta. Notice that β is computed as a base-10 logarithm, not a natural logarithm.

The decibel is named after Alexander Graham Bell, inventor of the telephone. Sound intensity level is actually dimensionless because it's formed from the ratio of two intensities, so decibels are just a *name* to remind us that we're dealing with an intensity *level* rather than a true intensity.

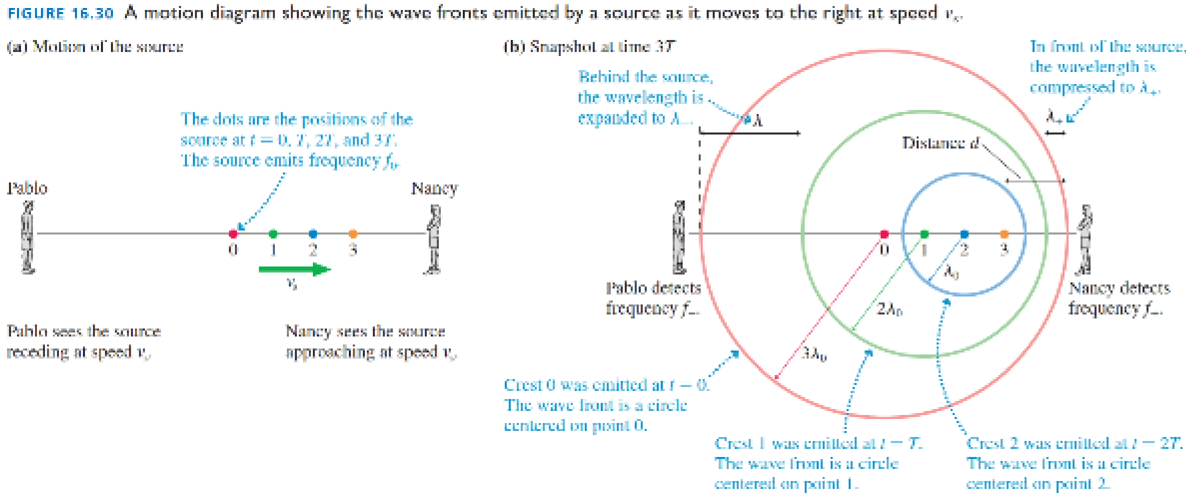
Right at the threshold of hearing, where $I = I_0$, the sound intensity level is

$$\beta = (10\text{ dB})\log_{10}\left(\frac{I_0}{I_0}\right) = (10\text{ dB})\log_{10}(1) = 0\text{ dB}$$

The Doppler Effect

The Doppler Effect here is where the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work are compressed towards Nancy, this is a stronger -𝕆D kinetic probability as a square and a smaller e𝕪 kinetic electric charge as a distance. Conversely Pablo measures a weaker intensity I as a square, the source moves as a kinetic velocity of e𝕪/-𝕠d and proportionally an inertial velocity of e𝕧/-𝕚d.

FIGURE 16.30 A motion diagram showing the wave fronts emitted by a source as it moves to the right at speed v_s.



Work and the Doppler Effect

The frequency of the source is 1/-𝕠d and 1/-𝕚d in kinetic and inertial time respectively. This is divided by the source kinetic velocity of e𝕪$_s$/-𝕠d$_s$ and the kinetic velocity of the measurer Nancy or Pablo as e𝕪$_0$/-𝕠d$_0$. In the denominator that becomes a fraction with no dimensions, for example 1/1-(3/4)=4. Then the 1/-𝕠d$_0$ kinetic frequency would be multiplied by 4 to give the 1/-𝕠d$_s$ source frequency. This is observing the power P of the wave because the change in frequency is used, the inverse of this would be e𝕪 as a distance between the waves or proportionally a e𝕧 wavelength. Here the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work would use distance not frequency to separate it from power and impulse.

Observing and measuring the Doppler Effect

When the frequency is observed with the Doppler Effect the e𝕪/-𝕘d photons act as particles with e𝕐/-𝕘d light impulse. When the wavelength is measured with e𝕪×-𝕘d they act as waves with -𝔾D×e𝕪 light work. In both cases the kinetic frequency 1/-𝕠d and the kinetic wavelength e𝕪 are linear and inverses of each other. This gives Roy electromagnetism in linear dimensions, they are proportional in Biv space-time as an inertial frequency 1/-𝕚d and the inertial wavelength e𝕧.

Gravitational Doppler Effect

This also applies with gravitational redshifts from +𝕀D×e𝕙 gravitational work, that makes it quantized as is proposed with redshifts in galaxies and for a changing e𝕙 height from the measurer. The formula can also be made relativistic because the e𝕙/+𝕚d gravitational speed comes from the +𝕚d and e𝕙 Pythagorean Triangle with a constant area.

Relativistic Doppler Effect

Comparing two gravitational speed means that e𝕙 height is bigger in the second but the +𝕚d gravitational time is inversely smaller in the second. When the first e𝕙/+𝕚d gravitational speed is far from a gravitational source it is nearly stationary, comparing this to near an event horizon means that e𝕙 is smaller in a nonlinear way because +𝕚d is inversely larger.

$$f_+ = \frac{f_0}{1 - v_s/v} \quad \text{(Doppler effect for an approaching source)}$$
$$f_- = \frac{f_0}{1 + v_s/v} \quad \text{(Doppler effect for a receding source)} \qquad (16.65)$$

Blue shifted photons

The frequency of light waves comes from the -𝕠d and e𝕪   Pythagorean Triangle, this has a constant area under a hyperbola as the does the e𝕪𝕘d photon. When -𝕠d is large then this is like the circle rotating faster, it also has a higher -𝕚d inertial mass. To keep the area of the Pythagorean Triangles the same then e𝕪 decreases, also e𝕧 as the photon wavelength decreases with a blue shift. The circle then is rotating faster but is smaller, this keeps the speed the same.

Red shifted photons

Conversely if the circle rotates slower this gives a smaller -𝕚d value as a lower inertial mass of the photon, the e𝕧 wavelength is larger as the circle radius so it moves at the same speed. The electromagnetic field of the e𝕪𝕘d photon has a smaller -𝕘d value and so it oscillates more slowly with a larger e𝕪 energy component. This gives the photons a red shift.

Height contraction

This gives a constant inertial velocity for light with the Doppler Effect. With a larger e𝕙 height this looks like going backwards in +𝕚d gravitational time. It also acts like an event horizon, the galaxies at greater e𝕙 heights have a e𝕙 height contraction from their +𝕀D gravitational temporal history. This comes from the +𝕀D×e𝕙 gravitational work maintaining a constant Pythagorean Triangle area.

Slower gravitational time

There is also a +𝕚d gravitational time slowing from the Eℍ gravitational displacement history and the Eℍ/+𝕚d gravitational impulse, the two appear as Biv space-time shrinking going backwards in time. This is also an expansion going forwards, because the -𝕚d and e𝕧 Pythagorean Triangle with inertia increases as this gravitational effect from the past weakens, then nearby galaxies are dominated more by this -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse.

Slower inertial velocity of light

Further back in +𝕚d gravitational time the e𝕪×-𝕘d photon inertial velocity would be less than its current value. This is also like photons coming directly out of near an event horizon, they appear to be slowed and redshifted in climbing up the gravitational well. In reverse this looks like Biv space-time is shrinking. The e𝕙 height component is contracting, the e𝕧 length component is not measured because of the large distance.

Gravity and inertia cannot become equal

The two cannot cancel each other out locally so Biv space-time becomes completely flat, that would mean the +𝕚d gravitational field had a curvature of zero and the Pythagorean Triangles would cease to exist. Instead in this model there is an additional value for the -𝕚d and e𝕧 Pythagorean Triangle as inertia, this is where the circular geometry of gravity becomes dominated by the hyperbolic geometry of inertia. The difference is the cosmological constant.

Photon frequency

The frequency of the photons is 1/-𝕘d in this model, that changes according to (16.67). In this model it is not necessarily a fraction, that would be in e𝕪/-𝕘d as a derivative. It can also be e𝕪×-𝕘d as an integral field.

Redshifted galaxies

With a receding source, as appears to be the case for distant galaxies, this is 1/-𝕘d$_0$√([c+v]/[c-v]) by multiplying each term by c. With the -𝕚d and e𝕧 Pythagorean Triangle c corresponds to an angle θ, the apparent e𝕧/-𝕚d inertial velocity of a galaxy is a different angle θ.

Light work and inertial velocity

Taking this as e𝕧 lengths proportional to the e𝕪 light electric charge-, this becomes 1/-𝕘d$_0$√[(e𝕧$_c$+e𝕧$_s$)/(e𝕧$_c$ -e𝕧$_s$)], squaring both sides gives -𝔾D (from -𝔾D×e𝕪 light work) = -+𝔾D$_0$(e𝕧$_c$+e𝕧$_s$)/(e𝕧$_c$ -e𝕧$_s$). Rearranging, -𝔾D$_s$(e𝕧$_c$ -e𝕧$_s$) becomes a change in the e𝕧 wavelength when measured by -𝔾D×e𝕪 light work. This equals -𝔾D$_0$(e𝕧$_c$+e𝕧$_s$) Which is also a change in -𝔾D×e𝕪 light work. On the left-hand side e𝕧 is smaller so -𝔾D increases more as a square. On the right-hand side e𝕧 is larger so -𝔾D decreases more as a square.

Inertial work and light work

The two are opposites, this happens because the photons are mediating the same information as from the inertial velocity of the galaxies. -𝔾D$_0$(e𝕧$_c$+e𝕧$_s$) is measured as a redshift because e𝕧 has increased, the -𝕘d rotational frequency has decreased, and -𝔾D decreased as a square with a light probability. This -𝔾D×e𝕪 light work is proportional to the inertial velocity of the galaxies going away from the measurer as -𝔾D$_s$(e𝕧$_c$ -e𝕧$_s$).

Faster than c and redshift

This can also be calculated without using c, then there are opposing values of e𝕧. It can be regarded as a higher inertial velocity than c with -𝔾D_0(e$𝕧_c$+e$𝕧_s$), in conventional cosmology some galaxies appear to be moving away faster than c like this. The formula here also gives their redshift. In this model it is possible to go faster than c, that is because c has an angle θ in the -𝕚d and e𝕧 Pythagorean Triangle which is greater than zero. This means an inertial velocity greater than c is possible here, the light from a rocket going faster than c would be redshifted like this same formula.

The Doppler Effect for Light Waves

The Doppler effect is observed for all types of waves, not just sound waves. If a source of light waves is receding from you, the wavelength λ_- that you detect is longer than the wavelength λ_0 emitted by the source.

Although the reason for the Doppler shift for light is the same as for sound waves, there is one fundamental difference. We derived Equations 16.65 for the Doppler-shifted frequencies by measuring the wave speed v relative to the medium. For electromagnetic waves in empty space, there is no medium. Consequently, we need to turn to Einstein's theory of relativity to determine the frequency of light waves from a moving source. The result, which we state without proof, is

$$\lambda_- = \sqrt{\frac{1 + v_s/c}{1 - v_s/c}}\,\lambda_0 \quad \text{(receding source)}$$
$$\lambda_+ = \sqrt{\frac{1 - v_s/c}{1 + v_s/c}}\,\lambda_0 \quad \text{(approaching source)} \qquad (16.67)$$

Here v_s is the speed of the source *relative to* the observer.

Superposition and impulse

In this model waves come from work, particles from impulse. Baseballs here would act with a E𝕐/-𝕠d kinetic impulse, if they cross they would collide with an E𝕍/-𝕚d inertial impulse. That would be observed by their crossing at the same -𝕠d kinetic time and -𝕚d inertial time. In this collision they would bounce apart, when this is only described by impulse then the momentum is conserved after the collision.

Superposition and work

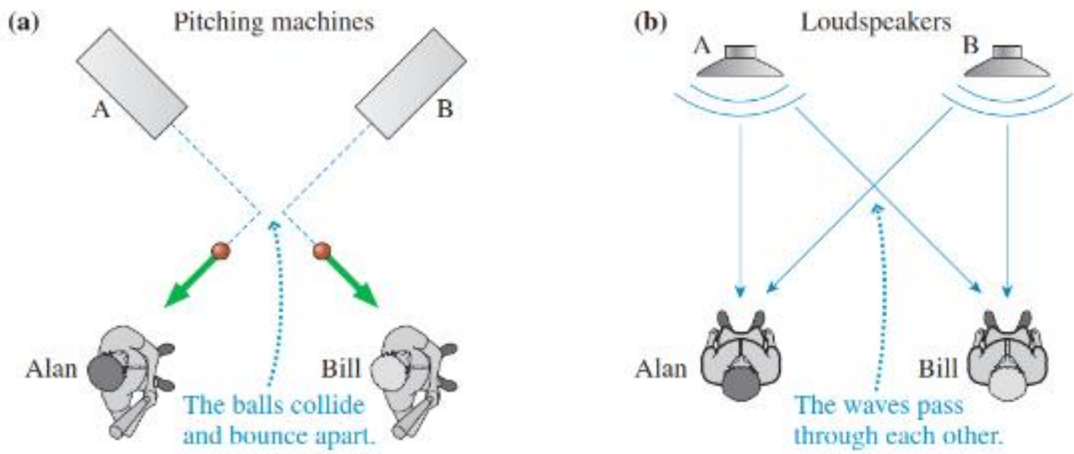
When waves cross each other this is work, they can pass through the same e𝕧 position because the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work is not observing the time they cross. Instead the squared time is a probability, this makes it impossible for the waves to collide with each other.

Same point at the same time

In this model measuring the same point is done with work, the probability of this makes the crossing uncertain. Observing the same time is done with impulse, because it is a displacement there is no point as e𝕧 associated with it.

FIGURE 17.1a shows two baseball players, Alan and Bill, at batting practice. Unfortunately, someone has turned the pitching machines so that pitching machine A throws baseballs toward Bill while machine B throws toward Alan. If two baseballs are launched at the same time, and with the same speed, they collide at the crossing point. Two particles cannot occupy the same point of space at the same time.

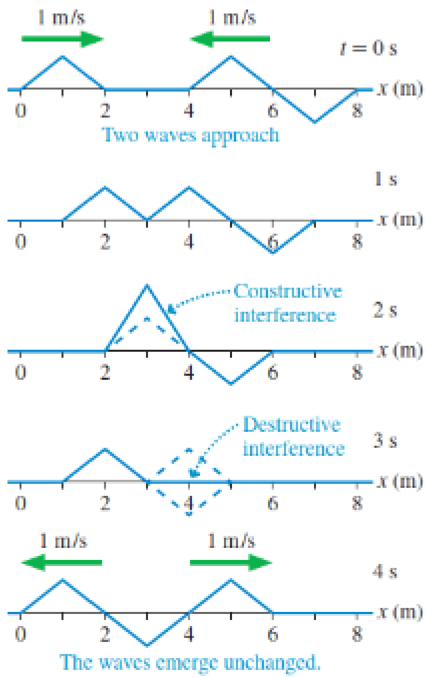
FIGURE 17.1 Unlike particles, two waves can pass directly through each other.



Work from a speaker changing position

In this model the -𝕆D kinetic probability comes from the -𝕆D×e𝕪 kinetic work in making the waves. This is done also with -𝕀D×e𝕧 inertial work, the e𝕧 change in positions as a speaker moves measures the work. Because there is no unsquared time, the integral fields -𝕆D and -𝕀D can add up with constructive and destructive interference. With E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse the air molecules can move as particles, then they cross there would be chaotic collisions different from the interference.

FIGURE 17.2 The superposition of two waves as they pass through each other.



Summing displacements and integrating fields

The displacement of the particles in the medium is observed with the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. These are summed together as Σ instead of being an integral field with ∫. The motion of the particles is chaotic, it approaches β as the second Feigenbaum number with regular tine widths. There is also a cascade of collisions approaching a parabola with the first Feigenbaum number δ.

Chaotic motion in between oscillations

Here β is close to 1/√(2π), that is a perfect oscillation associated with work. The chaotic motion of the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse then fills in between the regular oscillations and quantization of the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. The constant δ is also associated with α as the fine structure constant, combined with 1/√(2π).

Conic sections

In this model conic sections describe the changes of Pythagorean Triangles with work and impulse. δ approaches the parabolic constant called κ here, this is to differentiate it from β as it is sometimes called. The constant e is an integral area under the hyperbola, this is also connected to α and δ.

Principle of superposition When two or more waves are *simultaneously* present at a single point in space, the displacement of the medium at that point is the sum of the displacements due to each individual wave.

Mathematically, the net displacement of a particle in the medium is

$$D_{net} = D_1 + D_2 + \cdots = \sum_i D_i \qquad (17.1)$$

Time lapse and impulse

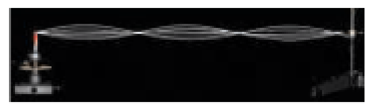
In this model a time lapse image would observe the impulse, the collisions between the particles in the string. When a e𝕧 position is measured the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work has waves in superposition. The term superposition itself can refer to more than one -𝕆D kinetic and -𝕀D inertial probability there. A standing wave maintains the same e𝕧 position while the probabilities becomes uncertain, this happens with constructive and destructive interference.

17.2 Standing Waves

FIGURE 17.3 is a time-lapse photograph of a *standing wave* on a vibrating string. It's not obvious from the photograph, but this is actually a superposition of two waves. To understand this, consider two sinusoidal waves **with the same frequency, wavelength, and amplitude** traveling in opposite directions. For example, FIGURE 17.4a shows two waves on a string, and FIGURE 17.4b shows nine snapshot graphs, at intervals of $\frac{1}{8}T$. The dots identify two of the crests to help you visualize the wave movement.

At *each point*, the net displacement—the superposition—is found by adding the red displacement and the green displacement. FIGURE 17.4c shows the result. It is the wave you would actually observe. The blue dot shows that the blue wave is moving neither right nor left. The wave of Figure 17.4c is called a **standing wave** because the crests and troughs "stand in place" as the wave oscillates.

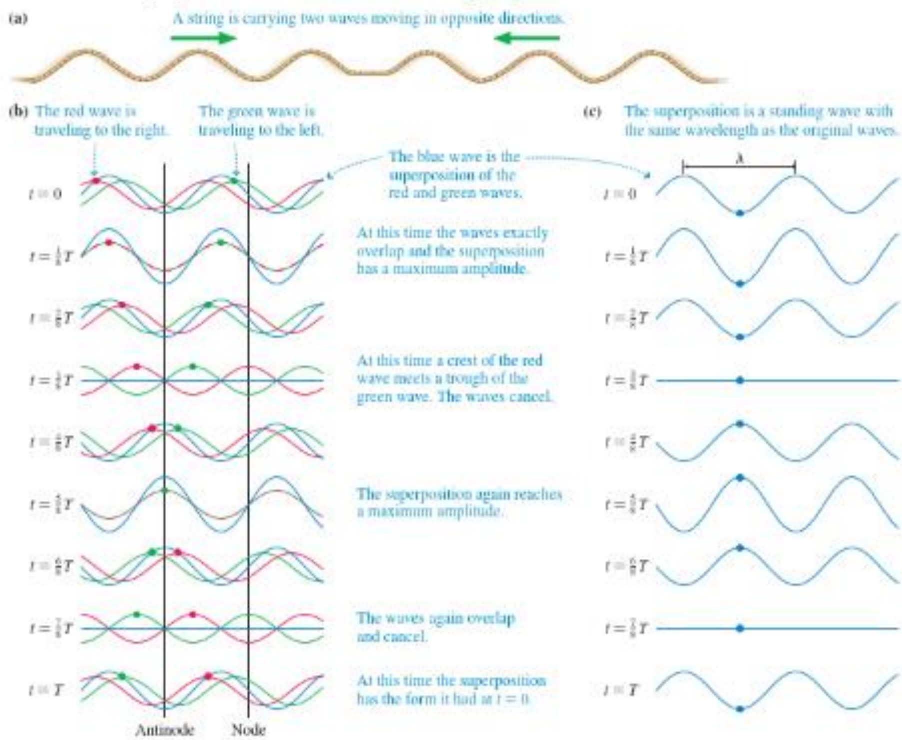
FIGURE 17.3 A vibrating string is an example of a standing wave.



Summing integral fields

When the -𝕆D kinetic and -𝕀D inertial probabilities or torque of the wave combine, they can sum as integral fields. This gives, like a Fourier analysis, other probabilities or torques as overtones or beats.

FIGURE 17.4 The superposition of two sinusoidal waves traveling in opposite directions.



Nodes in the same position

In this model the nodes remain in the same e𝕧 position, moving only occurs with impulse. This is because with the E𝕍/-𝕚d inertial impulse there is an E𝕍 inertial displacement over time. With -𝕀D×e𝕧 inertial work there is no -𝕚d inertial time, only a -𝕀D inertial probability. This probability or torque then changes its e𝕧 position rather than its changing over time.

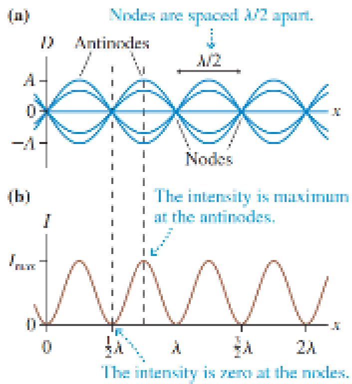
Amplitude is not displacement

The intensity of the wave is proportional to the square of the A amplitude, the wave moves like a rolling wheel that itself cannot be measured because it exist as a field. The amplitude is the same as the e𝕧 spoke of the inertial rolling wheel here. This is not a displacement because, in the transverse wave, there is no motion orthogonal to the direction of motion.

Spin as the spoke

The rolling wheel can also be regarded as having a e𝕧 axle, then the spoke becomes the -𝕚d rotational frequency. If the e𝕧 axle halves in size for example, then the -𝕚d rotational frequency doubles and the rolling wheel maintain the same inertial velocity. When -𝕚d is squared as the -𝕀D inertial torque or probability in a measurement, that is the intensity according to this model. This allows the intensity to be graphed as below. Alternatively the -𝕚d inertial axle can remain the same, then its -𝕀D inertial torque can interfere constructively and destructively to give the same graph.

FIGURE 17.5 The intensity of a standing wave is maximum at the antinodes, zero at the nodes.



Nodes and Antinodes

FIGURE 17.5a has collapsed the nine graphs of Figure 17.4b into a single graphical representation of a standing wave. Compare this to the Figure 17.3 photograph of a vibrating string. A striking feature of a standing-wave pattern is the existence of **nodes,** points that *never move!* **The nodes are spaced λ/2 apart.** Halfway between the nodes are the points where the particles in the medium oscillate with maximum displacement. These points of maximum amplitude are called **antinodes,** and you can see that they are also spaced λ/2 apart.

It seems surprising and counterintuitive that some particles in the medium have no motion at all. To understand this, look closely at the two traveling waves in Figure 17.4a. You will see that the nodes occur at points where at *every instant* of time the displacements of the two traveling waves have equal magnitudes but *opposite signs.* That is, nodes are points of destructive interference where the net displacement is always zero. In contrast, antinodes are points of constructive interference where two displacements of the same sign always add to give a net displacement larger than that of the individual waves.

In Chapter 16 you learned that the *intensity* of a wave is proportional to the square of the amplitude: $I \propto A^2$. You can see in FIGURE 17.5b that maximum intensity occurs at the antinodes and that the intensity is zero at the nodes. If this is a sound wave, the loudness is maximum at the antinodes and zero at the nodes. A standing light wave is bright at the antinodes, dark at the nodes. The key idea is that **the intensity is maximum at points of constructive interference and zero at points of destructive interference.**

Sine and cosine identity

In this model the identity below is approximately correct, multiplying a sine θ as -ⅈd/ζ by a cosine e𝕧/ζ would give for example -ⅈd×e𝕧/$ζ^2$, this acts like an integral field of the -ⅈd and e𝕧 Pythagorean Triangle as the hypotenuse is not observed or measured here. Here kx would refer to the cosine and ωt as the sine.

$$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$$

Doing so gives

$$\begin{aligned} D(x,t) &= a(\sin kx\cos\omega t - \cos kx\sin\omega t) + a(\sin kx\cos\omega t + \cos kx\sin\omega t) \\ &= (2a\sin kx)\cos\omega t \end{aligned} \tag{17.5}$$

Cosine with impulse, sine with work

In (17.6) cosωt can refer to t as -ⅈd inertial time, then observing the E𝕍/-ⅈd inertial impulse as it moves is a displacement E𝕍 dependent on the -ⅈd inertial time. The amplitude function in (17.7) changes according to kx or k𝕧, this would be measuring the -𝕀D×e𝕧 inertial work at different e𝕧 positions.

Oscillating sines

When sinθ is measured here, the -ⅈd and e𝕧 Pythagorean Triangle can be regarded as oscillating as the -𝕀D inertial torque changes. This is like the inertial rolling wheel when the -ⅈd Pythagorean Triangle side acts as the spoke and the e𝕧 Pythagorean Triangle side acts as the axle. Then its maximum force is when -ⅈd points straight upwards, it is lowest pointing forwards or backwards because that would be impulse and -ⅈd would not be squared.

Doubling amplitude doubles the Pythagorean Triangles

When there is constructive interference the amplitude A is doubled, this would be where the e𝕧 axle length is also doubled linearly. Then the intensity would be 4 times larger with -𝕀D as a square. With destructive interference the e𝕧 axle would be pointing in opposite directions and the -𝕀D intensity would be zero.

Adding directions with vectors

This is because the -𝕚d and e𝕧 Pythagorean Triangle, or another Pythagorean Triangle here, has a direction that represents a minimum energy. For example here the inertial rolling wheel has a -𝕚d inertial axle and a e𝕧 spoke, this has two energy states where it can roll forwards and backwards.

Superposing directions as amplitudes

When two inertial rolling wheels superpose then the amplitude doubles like a wheel double the size, when the two wheels are moving in opposite directions then -𝕚d as an inertial spin is canceled to zero. This would not actually be zero in the sense that the -𝕚d and e𝕧 Pythagorean Triangle would disappear, but that the -𝕀D inertial probabilities cancel with some uncertainty.

Adding Pythagorean Triangles

The opposing spins give a handedness, this is not arbitrary because it is defined by relative direction. For example it is the same what spin direction this is when two waves are traveling in the same direction. Here e𝕧 is the same direction with vector addition and so -𝕚d is a spin in the same way such as clockwise. If the waves have opposing directions then e𝕧 cancels like subtracting vectors, then if they cancel the -𝕚d Pythagorean Triangle sides must also cancel which gives a destructive -𝕀D inertial interference.

Annihilating Pythagorean Triangles

There cannot then be two -𝕚d and e𝕧 Pythagorean Triangles where one has e𝕧 in say the right direction but -𝕚d is clockwise in one and counterclockwise in the other. If there was then they would annihilate each other, neither -𝕚d and e𝕧 Pythagorean Triangle would remain and the difference between the -𝕚d spins would be emitted as e𝕪×-𝕘d photons. In this model this is matter and antimatter, the electron is proportionally the -𝕚d and e𝕧 Pythagorean Triangle and the positron is the +𝕚d and e𝕧 Pythagorean Triangle.

Matter and antimatter

In Biv space-time direction must then be consistent with matter, then e𝕙 heights are added with vector addition then +𝕀D×e𝕙 gravitational work adds with a constructive interference. When they are vector subtracted then there is a destructive interference. Again if there was a +𝕚d and e𝕙 Pythagorean Triangle as matter, and a -𝕚d and e𝕙 Pythagorean Triangle as antimatter, then both Pythagorean Triangles would annihilate and +𝕘d×e𝕓 gravitational waves would be emitted like the photons were with the -𝕚d and e𝕧 Pythagorean Triangles.

The square root of +1 and -1

The Pythagorean Triangles then have a handedness that comes from direction, in this model there is a preference for mater where the proton is the +𝕠d and e𝕒 Pythagorean Triangle not the -𝕠d and e𝕒 Pythagorean Triangle as the antiproton. That is because of the square root of -1 as +𝕠d when positive and -𝕠d as negative. Here -𝕠d can be measured as -𝕆D×e𝕪 kinetic work and is a clock gauge for an observation with the E𝕍/-𝕚d inertial impulse. With Biv space-time the square root of

+1 has +𝕚d and -𝕚d as answers, the measurable and observable one is +𝕚d. Then -𝕚d must be subtracted first before this measurement or observation.

The square root cannot have two answers

The +𝕆D×e𝕒 potential work and E𝔸/+𝕠d potential impulse cannot be measured and observed directly only by added to the -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse then the summation is observed and measured. Here this is because the square root of -1 cannot have two answers in physics, it would give two possible universes that would annihilate each other. For one to dominate then the other is only added but not observed or measured by itself. In this model that is why the potential is a reactive force only while the kinetic energy is active.

The Pythagorean Equation

This comes from the Pythagorean Equation, on the left-hand side two squares are subtracted and on the right-hand side two squares are added. When these are subtracted that gives the equation for a hyperbola, when added they give the equation for a circle. The hyperbola then must have an active force as a negative for it to change as a kinetic energy. The circle must have an active force where the second square is not negative, so the first square is an active force as gravity.

An active proton and reactive gravity

If the opposite was true, and the +𝕠d and e𝕒 Pythagorean Triangle had the active force, then the proton's changing potential would cause the electrons to move inwards and outwards. This is what happens with gravitational waves and +𝕘d×e𝕓 gravis. If the circular geometry had inertia as the active force, then their changing inertia would move matter inwards and outwards while gravity remained fixed without any attraction. This is how electrons already move around a proton.

Reversing the flow of time

With antimatter the left-hand side would be the -𝕠d and e𝕒 Pythagorean Triangle as the antiproton and the +𝕠d and e𝕪 Pythagorean Triangle as the positron. But this would add in the same way to the right-hand side where the +𝕚d and e𝕙 Pythagorean Triangle as anti-gravity and the -𝕚d and e𝕧 Pythagorean Triangle as anti-inertia would match it. But this reverses the flow of time only, in this model the +𝕠d spin Pythagorean Triangle side moves backwards in potential time and -𝕠d as kinetic time moves forwards. Also +𝕚d moves backwards in gravitational time and -𝕚d moves forward in inertial time.

Playing reality in reverse like a movie

Reversing all the signs would be like playing a movie in reverse only. It remains as the same physical system, the only difference is the direction of time. We can then measure work and observe impulse the same way. We would not notice a difference because our consciousness would also be in reverse.

Knowing the future and discovering the past

Only the most recent past is knowable, like the closest future. We cannot know with certainty what much of the past is like, with a time reversal we would know the future running backwards which make it the past. Then the past would seem to unfold like the future.

Reactive Pythagorean Triangles cannot annihilate active ones

If parts of the universe were in one direction, other parts in the opposite directions, then they would annihilate each other like with matter and antimatter. So they could never exist as opposites like this. The only way to reconcile this is for one to be reactive and not be observable or measurable. Then these are added and subtracted to give the observation and measurement. If they are swapped then it works the same way, except we experience the time flows reversed but cannot notice any difference.

Creating antimatter to destroy it

If there were separated parts of the universe, some might have all matter and other parts antimatter. If they came together in the future this would cause some to annihilate, that would give an excess of photons and gravis. In this model time flows in both directions, that would means they would have been together initially. Then they would have to separate somehow into matter and antimatter going backwards in time.

Impulse and antimatter

This would be like the Pythagorean Triangles forming spontaneously as opposites, but that would require photons and gravis to be present to cause this. It is like creating antimatter in the laboratory, with enough energy large areas of matter and antimatter could be created then annihilated. But then one form of energy has been changed into another with no loss, the increase in entropy would prevent this continuing to happen. This could only happen with impulse, collisions could continue with no randomizing losses in forming antimatter then destroying it over and over. The annihilation would then be like time flows subtracting and only a displacement occurring.

Creating electrons and positrons from photons

It is possible to turn e𝕪×-𝕘d photons into electrons as the -𝕠d and e𝕪 Pythagorean Triangle and positrons as the +𝕠d and e𝕪 Pythagorean Triangle. This needs to be near a gravitational source, the +𝕚d and e𝕙 Pythagorean Triangle and proportionally the proton's +𝕠d and e𝕒 Pythagorean Triangle, would cause the e𝕪×-𝕘d photons to become an electron and emit the positron.

Gravis and the atomic center of mass

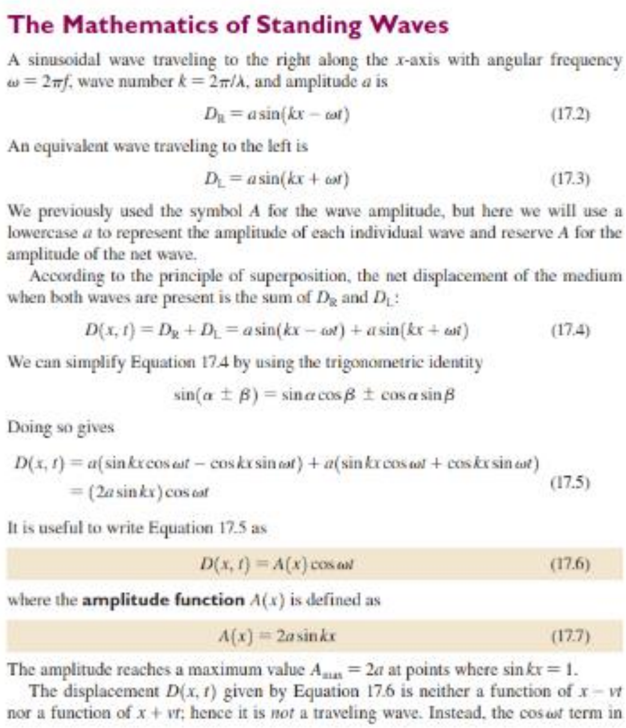
This would also mean gravis were emitted backwards in +𝕚d gravitational time, they would give the proton's change in e𝕙 height from +𝕀D×e𝕙 gravitational work when the electron appeared. That is because the proton and electron rotate around a common center of mass, this would not have existed before the creation of the electron.

Photons as the difference between orbitals

That is because the e𝕪×-𝕘d photons represent the -𝔾D×e𝕪 light work difference between orbitals, this comes from the +𝕠d potential magnetic field and the -𝕠d kinetic magnetic field or the proton and electron. This difference is the same as the +𝕠d positronic magnetic field and the -𝕠d electron's kinetic magnetic field.

Needing gravity to create electrons and positrons

For there to have been equal amounts of matter and antimatter in the early universe, this would have annihilated itself into an excess of photons and gravis. But to turn this back into electrons and positrons it needs protons for the electron, also antiprotons for the positrons. If the protons and antiprotons were also annihilated there is no Roy electromagnetic gradient for the electrons and positrons to reform. With +𝕠d potential time, and +𝕚d gravitational time, in reverse then these would also have to form going backwards from the photons and gravis. But there is then no gravitational or potential gradient to create the electrons and positrons.



The Mathematics of Standing Waves

A sinusoidal wave traveling to the right along the x-axis with angular frequency $\omega = 2\pi f$, wave number $k = 2\pi/\lambda$, and amplitude a is

$$D_R = a\sin(kx - \omega t) \qquad (17.2)$$

An equivalent wave traveling to the left is

$$D_L = a\sin(kx + \omega t) \qquad (17.3)$$

We previously used the symbol A for the wave amplitude, but here we will use a lowercase a to represent the amplitude of each individual wave and reserve A for the amplitude of the net wave.

According to the principle of superposition, the net displacement of the medium when both waves are present is the sum of D_R and D_L:

$$D(x, t) = D_R + D_L = a\sin(kx - \omega t) + a\sin(kx + \omega t) \qquad (17.4)$$

We can simplify Equation 17.4 by using the trigonometric identity

$$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$$

Doing so gives

$$D(x, t) = a(\sin kx\cos\omega t - \cos kx\sin\omega t) + a(\sin kx\cos\omega t + \cos kx\sin\omega t) = (2a\sin kx)\cos\omega t \qquad (17.5)$$

It is useful to write Equation 17.5 as

$$D(x, t) = A(x)\cos\omega t \qquad (17.6)$$

where the **amplitude function** $A(x)$ is defined as

$$A(x) = 2a\sin kx \qquad (17.7)$$

The amplitude reaches a maximum value $A_{max} = 2a$ at points where $\sin kx = 1$.

The displacement $D(x, t)$ given by Equation 17.6 is neither a function of $x - vt$ nor a function of $x + vt$; hence it is *not* a traveling wave. Instead, the $\cos\omega t$ term in

Linear node positions

In (17.9) the n value is linear, this is from the linear e𝕧 positions in the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. The rolling wheel model would have the -𝕚d inertial mass as the axle, it rotates so that the e𝕧 spoke connects to each node. The wheel itself is not measured without work being done by the wave. Then there is a squared -𝕆D kinetic and -𝕀D inertial probability or torque. That is at a maximum when the e𝕧 spoke points upwards, this is because the probability or torque is measured there.

Impulse collisions

When the spoke points forward this would be the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, then work is at a minimum. With opposing displacements from impulse there are chaotic collisions from both sides at the node. In between the nodes the probabilities and torque of the opposing waves superpose.

Equation 17.6 describes a medium in which each point oscillates in simple harmonic motion with frequency $f = \omega/2\pi$. The function $A(x) = 2a \sin kx$ gives the amplitude of the oscillation for a particle at position x.

FIGURE 17.6 graphs Equation 17.6 at several different instants of time. Notice that the graphs are identical to those of Figure 17.5a, showing us that Equation 17.6 is the mathematical description of a standing wave.

The nodes of the standing wave are the points at which the amplitude is zero. They are located at positions x for which

$$A(x) = 2a \sin kx = 0 \qquad (17.8)$$

The sine function is zero if the angle is an integer multiple of π rad, so Equation 17.8 is satisfied if

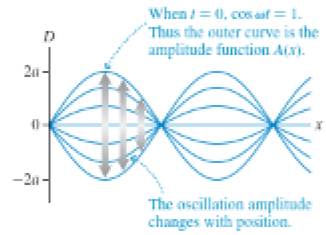
$$kx_m = \frac{2\pi x_m}{\lambda} = m\pi \qquad m = 0, 1, 2, 3, \ldots \qquad (17.9)$$

Thus the position x_m of the mth node is

$$x_m = m\frac{\lambda}{2} \qquad m = 0, 1, 2, 3, \ldots \qquad (17.10)$$

You can see that the spacing between two adjacent nodes is $\lambda/2$, in agreement with Figure 17.5b. The nodes are *not* spaced by λ, as you might have expected.

FIGURE 17.6 The net displacement resulting from two counter-propagating sinusoidal waves.



The wave inertial velocity increases

The wave speed would be the -𝕚d/e𝕧 inertial velocity. In (a) the inertial velocity increases after the discontinuity. This means the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse also increase. Because the E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work are inverses, that means there is less -𝕀D×e𝕧 inertial work done to the right. To conserve this -𝕀D×e𝕧 inertial work part is reflected to the left.

The wave inertial velocity decreases

In (b) the e𝕧/-𝕚d inertial velocity decreases to the right, this means the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse also decrease to the right. The inverse -𝕀D×e𝕧 inertial work then must increase to the right, to conserve the -𝕀D inertial torque and probability a smaller inverted -𝕀D×e𝕧 inertial work is reflected to the left. This is like a subtraction or destructive interference if the two -𝕀D×e𝕧 inertial work waves were subtracted then it would be the same as the original to the left.

The wave is reflected

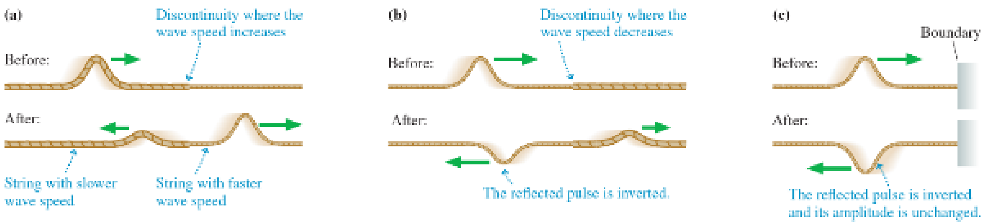
In (c) the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work is totally reflected, this means the wave to the left must be equal and opposite the wave to the right. That is equivalent to a destructive interference if the two waves were added together.

17.3 Standing Waves on a String

Wiggling both ends of a very long string is not a practical way to generate standing waves. Instead, as in the photograph in Figure 17.3, standing waves are usually seen on a string that is fixed at both ends. To understand why this condition causes standing waves, we need to examine what happens when a traveling wave encounters a discontinuity.

FIGURE 17.7a shows a *discontinuity* between a string with a larger linear density and one with a smaller linear density. The tension is the same in both strings, so the wave speed is slower on the left, faster on the right. Whenever a wave encounters a discontinuity, some of the wave's energy is *transmitted* forward and some is *reflected*.

FIGURE 17.7 A wave reflects when it encounters a discontinuity or a boundary.



Canceling impulse

To creating a standing wave the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse must be opposed, this leaves only the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work of the wave. With no impulse the wave cannot move, and so it remains at the same e𝕧 position. There is still a force because the -𝕀D inertial torque of the wave to the right interferes destructively with the wave to the left.

Quantized wavelength

This is quantized as a linear value because the -𝕆D kinetic torque is squared. That measures the -𝕆D×e𝕪 kinetic work on a linear ruler or scale. These have an equal amplitude as e𝕧, they are also separated by a length e𝕧 because the -𝕀D inertial torque must rotate in a quantized complete circle as the rolling wheel.

Boundary condition

The boundary condition at the ends is where the string cannot move backwards and forwards with a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. These act like nodes, because they are equal and opposite then the E𝕍/-𝕚d inertial impulse is canceled out throughout the string.

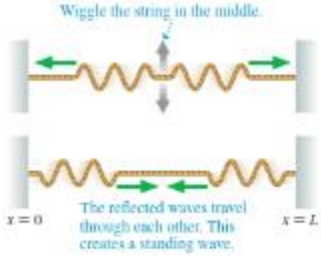
Still chaotic motion

There is still motion where the collisions in the string chaotically have an E𝕍/-𝕚d inertial impulse. This cannot completely cancel out because then it would be quantized, that only happens with work as $1/(\sqrt{2}\pi)$. Instead, the chaos approaches this with β as equal tine widths. Two of these tines are not the same width in the center with chaos, that is the difference between β and $1/(\sqrt{2}\pi)$.

Boson as a standing wave

This is like a boson, such as in the ground state of Helium. The two electrons do -𝕆D×e𝕪 kinetic work in opposing directions and form a standing wave. There is no E𝕐/-𝕠d kinetic impulse and so neither electron can move to a higher orbital. The electrons still exist as their -𝕆D×e𝕪 kinetic work is destructively interfering, either can move out of this orbital if it absorbed a e𝕪×-𝕘d photon.

FIGURE 17.8 Reflections at the two boundaries cause a standing wave on the string.



Creating Standing Waves

FIGURE 17.8 shows a string of length L tied at $x = 0$ and $x = L$. If you wiggle the string in the middle, sinusoidal waves travel outward in both directions and soon reach the boundaries. Because the speed of a reflected wave does not change, **the wavelength and frequency of a reflected sinusoidal wave are unchanged.** Consequently, reflections at the ends of the string cause two waves of *equal amplitude and wavelength* to travel in opposite directions along the string. As we've just seen, these are the conditions that cause a standing wave!

To connect the mathematical analysis of standing waves in Section 17.2 with the physical reality of a string tied down at the ends, we need to impose *boundary conditions*. A **boundary condition** is a mathematical statement of any constraint that *must* be obeyed at the boundary or edge of a medium. Because the string is tied down at the ends, the displacements at $x = 0$ and $x = L$ must be zero at all times. Thus the standing-wave boundary conditions are $D(x = 0, t) = 0$ and $D(x = L, t) = 0$. Stated another way, we require nodes at both ends of the string.

We found that the displacement of a standing wave is $D(x, t) = (2a \sin kx)\cos \omega t$. This equation already satisfies the boundary condition $D(x = 0, t) = 0$. That is, the origin has already been located at a node. The second boundary condition, at $x = L$, requires $D(x = L, t) = 0$. This condition will be met at all times if

$$2a \sin kL = 0 \qquad \text{(boundary condition at } x = L\text{)} \qquad (17.11)$$

Equation 17.11 will be true if $\sin kL = 0$, which in turn requires

$$kL = \frac{2\pi L}{\lambda} = m\pi \qquad m = 1, 2, 3, 4, \ldots \qquad (17.12)$$

kL must be a multiple of $m\pi$, but $m = 0$ is excluded because L can't be zero.

For a string of fixed length L, the only quantity in Equation 17.12 that can vary is λ. That is, the boundary condition is satisfied only if the wavelength has one of the values

$$\lambda_m = \frac{2L}{m} \qquad m = 1, 2, 3, 4, \ldots \qquad (17.13)$$

A standing wave can exist on the string *only* if its wavelength is one of the values given by Equation 17.13. The mth possible wavelength $\lambda_m = 2L/m$ is just the right size so that its mth node is located at the end of the string (at $x = L$).

Wavelength and impulse

Here the modes are in integers, that would be the -𝕀D inertial probability or torque. -𝕚d has d as a square root of an integer, that makes D an integer as m. This is not a frequency, taking the e𝕧 wavelength as the spoke of the rolling wheel this is a scale used to measure the -𝕀D×e𝕧 inertial work. The inverse of e𝕧 is 1/-𝕚d in inertial time as the inertial frequency. But this would only observe the E𝕍/-𝕚d inertial impulse as a particle not -𝕀D×e𝕧 inertial work as a wave. The spoke is the wavelength here because, when it is horizontal twice in a cycle it is impulse, that is not measured as a wave.

FIGURE 17.9 graphs the first four possible standing waves on a string of fixed length *L*. These possible standing waves are called the **modes** of the string, or sometimes the *normal modes*. Each mode, numbered by the integer *m*, has a unique wavelength and frequency. Keep in mind that these drawings simply show the *envelope*, or outer edge, of the oscillations. The string is continuously oscillating at all positions between these edges, as we showed in more detail in Figure 17.5a.

There are three things to note about the modes of a string.

1. *m* is the number of *antinodes* on the standing wave, not the number of nodes. You can tell a string's mode of oscillation by counting the number of antinodes.
2. The *fundamental mode*, with $m = 1$, has $\lambda_1 = 2L$, not $\lambda_1 = L$. Only half of a wavelength is contained between the boundaries, a direct consequence of the fact that the spacing between nodes is $\lambda/2$.
3. The frequencies of the normal modes form a series: f_1, $2f_1$, $3f_1$, $4f_1, \ldots$. The fundamental frequency f_1 can be found as the *difference* between the frequencies of any two adjacent modes. That is, $f_1 = \Delta f = f_{m+1} - f_m$.

The modes

The modes can be regarded as from a rolling wheel, the higher amplitude is where the -𝕀D×e𝕧 inertial work is at a maximum. This -𝕀D×e𝕧 inertial work is a minimum is at the nodes, that is because the amplitude is lowest. The wavelength is highest at a node, this comes from the back and forth motion of the E𝕍/-𝕚d inertial impulse.

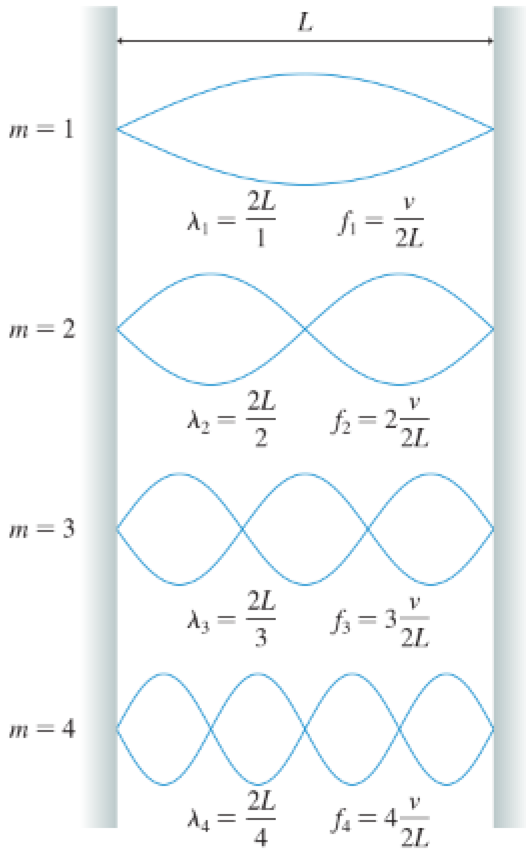
The electron as a rolling wheel

The modes are like the rolling wheel electron moving around an orbital, the nodes allow for an additional vibration to be absorbed into it as a e𝕪×-𝕘d photon. The circular orbital does -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, because they join up the nodes go around the orbital. When there is no observation or measurement, then the -𝕠d and e𝕪 Pythagorean Triangle rotates around the orbital. The -𝕠d kinetic axle rotates and the e𝕪 kinetic spoke turnd like the radius of a wheel.

The spoke has no orientation

Because there are no observations or measurement, this spoke has no known orientation. The rotation must join up to give an integer number, this comes from the -𝕆D×e𝕪 kinetic work if it is measured. If the electron is observed then it need not be in this orbital, the E𝕐/-𝕠d kinetic impulse creating the observation is observed as an Eigenvector with its impulse.

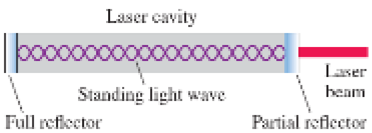
FIGURE 17.9 The first four modes for standing waves on a string of length L.



Electromagnetic standing waves

In this model an electromagnetic wave is a e𝕪×-𝕘d photon. When this reflects on both sides of the cavity the e𝕪/-𝕘d light Pythagorean Triangle slope is opposed and canceled out. This also cancels out the e𝕐/-𝕘d light impulse leaving only the -𝔾D×e𝕪 light work. Because there is no motion from impulse it forms a standing wave. The same can happen with an electron in a box, the E𝕐/-𝕠d kinetic impulse is canceled out by reflecting against the box ends. That leaves the -𝕆D×e𝕪 kinetic work and an integer number of modes from -𝕆D as the square of an integer square root.

FIGURE 17.12 A laser contains a standing light wave between two parallel mirrors.



Standing Electromagnetic Waves

Because electromagnetic waves are transverse waves, a standing electromagnetic wave is very much like a standing wave on a string. Standing electromagnetic waves can be established between two parallel mirrors that reflect light back and forth. The mirrors are boundaries, analogous to the boundaries at the ends of a string. In fact, this is exactly how a laser operates. The two facing mirrors in FIGURE 17.12 form what is called a *laser cavity.*

Because the mirrors act like the points to which a string is tied, the light wave must have a node at the surface of each mirror. One of the mirrors is only partially reflective, to allow some light to escape and form the laser beam, but this doesn't affect the boundary condition.

Because the boundary conditions are the same, Equations 17.13 and 17.14 for λ_m and f_m apply to a laser just as they do to a vibrating string. The primary difference is the size of the wavelength. A typical laser cavity has a length $L \approx 30$ cm, and visible light has a wavelength $\lambda \approx 600$ nm. The standing light wave in a laser cavity has a mode number m that is approximately

$$m = \frac{2L}{\lambda} \approx \frac{2 \times 0.30\ \text{m}}{6.00 \times 10^{-7}\ \text{m}} = 1{,}000{,}000$$

In other words, the standing light wave inside a laser cavity has approximately one million antinodes! This is a consequence of the very short wavelength of light.

Compression and rarefaction

In this model the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse of the air molecules is chaotic. Because of this it cannot be perfectly canceled out, there is still compression and rarefaction from the impulse in the pipe. The modes also approach β and its tines with the chaotic motion, that is close to 1/√(2π) with the oscillations of the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work.

17.4 Standing Sound Waves and Musical Acoustics

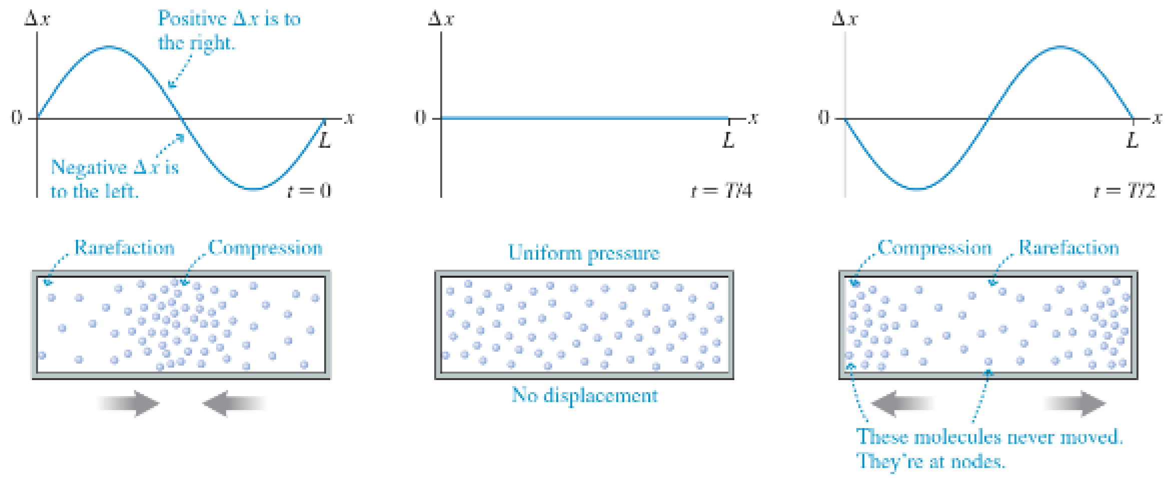
A long, narrow column of air, such as the air in a tube or pipe, can support a *longitudinal* standing sound wave. Longitudinal waves are somewhat trickier than string waves because a graph—showing displacement *parallel* to the tube—is not a picture of the wave.

To illustrate the ideas, FIGURE 17.13 is a series of three graphs and pictures that show the $m = 2$ standing wave inside a column of air closed at both ends. We call this a *closed-closed tube.* The air at the closed ends cannot oscillate because the air molecules are pressed up against the wall, unable to move; hence **a closed end of a column of air must be a displacement node.** Thus the boundary conditions—nodes at the ends—are the same as for a standing wave on a string.

Equal and opposite reaction at the ends

The E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse cause an E𝕐 kinetic and E𝕍 inertial displacement. At the ends there is no displacement so there is no impulse, that is the same as it being canceled out at a node. This is because the end of the tube pushes back with an E𝕍/-𝕚d inertial impulse from the E𝕐/-𝕠d kinetic impulse of the air's motion.

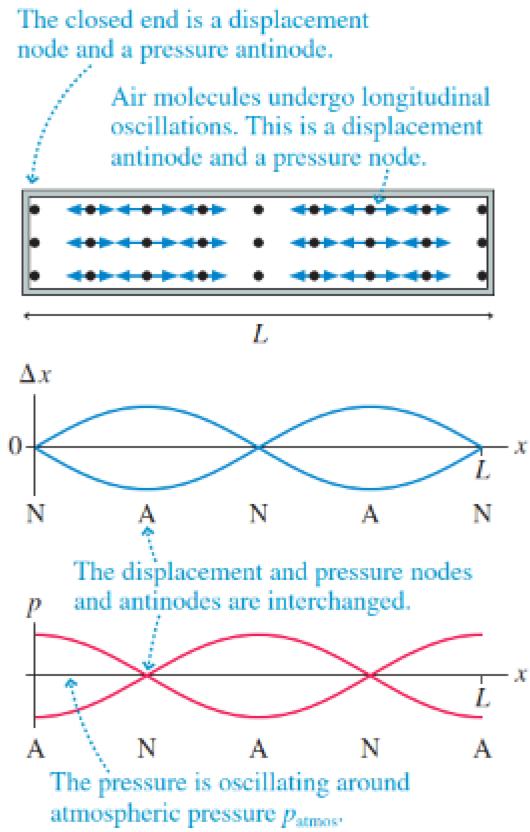
FIGURE 17.13 The $m = 2$ standing sound wave in a closed-closed tube of air.



Displacement and pressure

In this model a displacement wave and a pressure wave are the same thing, as impulse which is not a wave. The nodes are not exact because of the chaotic collisions of particles being observed. Here the displacement is the amplitude, that comes from the positions e𝕧 as -𝕀D×e𝕧 inertial work is done. It is not a displacement as E𝕍 because the -𝕆D inertial torque of the wave is being measured on a scale ruler. The pressure is the E𝕍/-𝕚d inertial impulse as the inverse of this, so the nodes and antinodes are interchanged.

FIGURE 17.14 The $m = 2$ longitudinal standing wave can be represented as a displacement wave or as a pressure wave.



Closed pipe

In (a) the pipe is closed, the -𝕀D×e𝕧 inertial work done goes to zero at the ends because the E𝕍/-𝕚d inertial impulse pressure is at a maximum against the ends of the pipe. These ends react against this pressure with an equal and opposite inertial pressure.

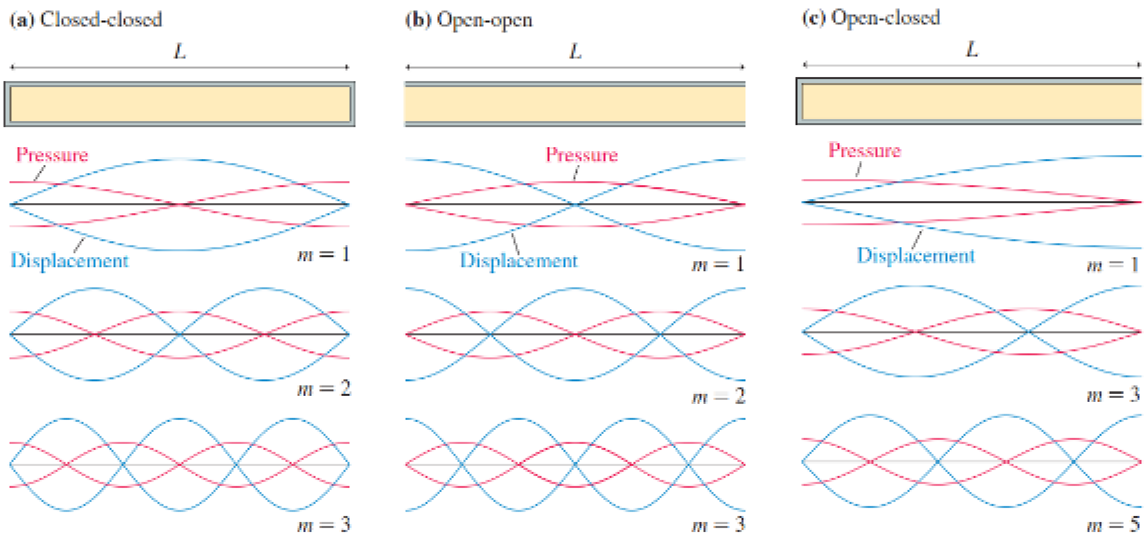
Open pipe

In (b) the pipe is open so there is no pressure from the E𝕍/-𝕚d inertial impulse at the ends. The -𝕀D×e𝕧 inertial work is the inverse of this, so the -𝕀D inertial torque and probability is at a maximum there.

Semi open pipe

In (c) there is pressure on the left-hand side and so there is a maximum E𝕍/-𝕚d inertial impulse there. This means the -𝕀D×e𝕧 inertial work is a minimum on the left-hand side. On the right the pressure goes to approximately zero so the E𝕍/-𝕚d inertial impulse is approximately zero, it cannot be exactly zero because then the -𝕚d and e𝕧 Pythagorean Triangles would have no area. Because of this the -𝕀D×e𝕧 inertial work is at a maximum there, that gives the pipe a resonation such as in a flute.

FIGURE 17.15 The first three standing sound wave modes in columns of air with different boundary conditions.



The frequency of a vibrating string

The fundamental frequency of a vibrating string is e𝕧/-𝕚d × ½ × e𝕧 which leaves ½× 1/-𝕚d. This equals 1/E𝕍 × √(e𝕧/-𝕚d × e𝕧/-𝕚d). Here μ is the -𝕚d inertial mass divided by the e𝕧 length as -𝕚d/e𝕧, inverting this from the denominator gives e𝕧/-𝕚d. The tension T is e𝕧/-𝕚d because there is no force, the string is not changing its e𝕧 length. This allows it to vibrate with -𝕀D×e𝕧 inertial work.

Musical Instruments

An important application of standing waves is to musical instruments. Instruments such as the guitar, the piano, and the violin have strings fixed at the ends and tightened to create tension. A disturbance generated on the string by plucking, striking, or bowing it creates a standing wave on the string.

The fundamental frequency of a vibrating string is

$$f_1 = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{T_s}{\mu}}$$

where T_s is the tension in the string and μ is its linear density. The fundamental frequency is the musical note you hear when the string is sounded. Increasing the tension in the string raises the fundamental frequency, which is how stringed instruments are tuned.

Electromagnetic and acoustic phase

In this model the phase of the e𝕪×-𝕘d photons is like the phase of the sound waves. The photons are emitted and absorbed by the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work done by the sound waves. This phase can also be regarded as a time, like the orientation of a clock hand with the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse of the colliding molecules in the sound. It can also be the collisions of e𝕪/-𝕘d photons in this impulse though they are rarer.

In phase

When this is observed at a -𝕚d inertial time this is the E𝕍/-𝕚d inertial impulse, when it is measured at a e𝕧 position it is -𝕀D×e𝕧 inertial work. When the sound waves are in phase there is constructive interference between them, the -𝕀D×e𝕧 inertial work and -𝕀D inertial probability is highest where the e𝕧 spoke of the rolling wheel points upwards or downwards. Because there are two waves the -𝕀D×e𝕧 inertial work is doubled and the E𝕍/-𝕚d inertial impulse is doubled as pressure.

Out of phase

If the two waves were out of phase the -𝕀D×e𝕧 inertial work would have destructive interference. The E𝕍/-𝕚d inertial impulse would be compressing and rarefying in opposite directions, that would also be approximately canceled out.

FIGURE 17.16 Two overlapped waves travel along the x-axis.

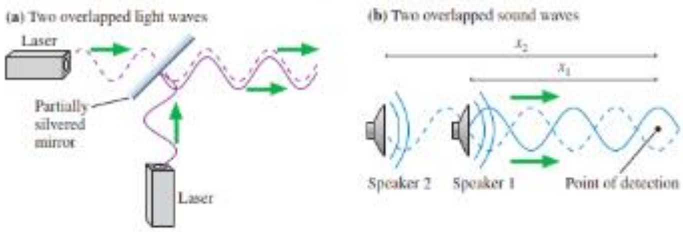


FIGURE 17.16a shows two light waves impinging on a partially silvered mirror. Such a mirror partially transmits and partially reflects each wave, causing two *overlapped* light waves to travel along the x-axis to the right of the mirror. Or consider the two loudspeakers in **FIGURE 17.16b**. The sound wave from loudspeaker 2 passes just to the side of loudspeaker 1; hence two overlapped sound waves travel to the right along the x-axis. We want to find out what happens when two overlapped waves travel in the same direction along the same axis.

Figure 17.16b shows a point on the x-axis where the overlapped waves are detected, either by your ear or by a microphone. This point is distance x_1 from loudspeaker 1 and distance x_2 from loudspeaker 2. (We will use loudspeakers and sound waves for most of our examples, but our analysis is valid for any wave.) What is the amplitude of the combined waves at this point?

Throughout this section, **we will assume that the waves are sinusoidal, have the same frequency and amplitude, and travel to the right along the x-axis.** Thus we can write the displacements of the two waves as

$$\begin{aligned} D_1(x_1, t) &= a\sin(kx_1 - \omega t + \phi_{10}) = a\sin\phi_1 \\ D_2(x_2, t) &= a\sin(kx_2 - \omega t + \phi_{20}) = a\sin\phi_2 \end{aligned} \tag{17.19}$$

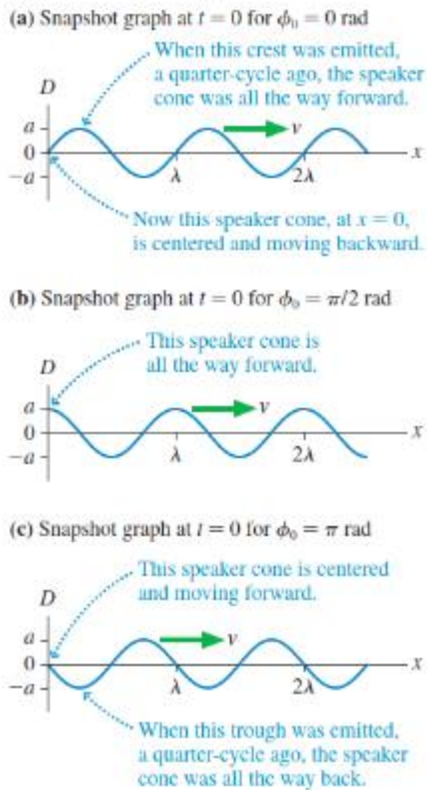
where ϕ_1 and ϕ_2 are the *phases* of the waves. Both waves have the same wave number $k = 2\pi/\lambda$ and the same angular frequency $\omega = 2\pi f$.

The phase constants ϕ_{10} and ϕ_{20} are characteristics of *the sources*, not the medium. **FIGURE 17.17** shows snapshot graphs at $t = 0$ of waves emitted by three sources with phase constants $\phi_0 = 0$ rad, $\phi_0 = \pi/2$ rad, and $\phi_0 = \pi$ rad. You can see that **the phase constant tells us what the source is doing at $t = 0$.** For example, a loudspeaker at its center position and moving backward at $t = 0$ has $\phi_0 = 0$ rad. Looking back at Figure 17.16b, you can see that loudspeaker 1 has phase constant $\phi_{10} = 0$ rad and loudspeaker 2 has $\phi_{20} = \pi$ rad.

The speaker cannot move

With the two waves out of phase the -𝕀D×e𝕧 inertial work would have destructive interference. There would be approximately no sound waves. For a single speaker to produce no sound the E𝕍/-𝕚d inertial impulse from each wave would be opposed. That makes it impossible for the speaker to move, it would have to exert E𝕍 displacement and pressure in both directions at the same -𝕚d inertial time.

FIGURE 17.17 Waves from three sources having phase constants $\phi_0 = 0$ rad, $\phi_0 = \pi/2$ rad, and $\phi_0 = \pi$ rad.



The frequency remains the same

The two speakers with constructive interference, this is the same as a single speaker with double the E𝕍/-𝕚d inertial impulse. The -𝕀D×e𝕧 inertial work is doubled so the 1/-𝕚d inertial frequency remains the same. The amplitude doubles because the e𝕧 spokes of the rolling wheels both point upwards at the same position, the e𝕧 positions are then being measured as doubled on an inertial scale. With destructive interference the E𝕍/-𝕚d inertial impulse would be canceled approximately that would be the same as the speaker not moving.

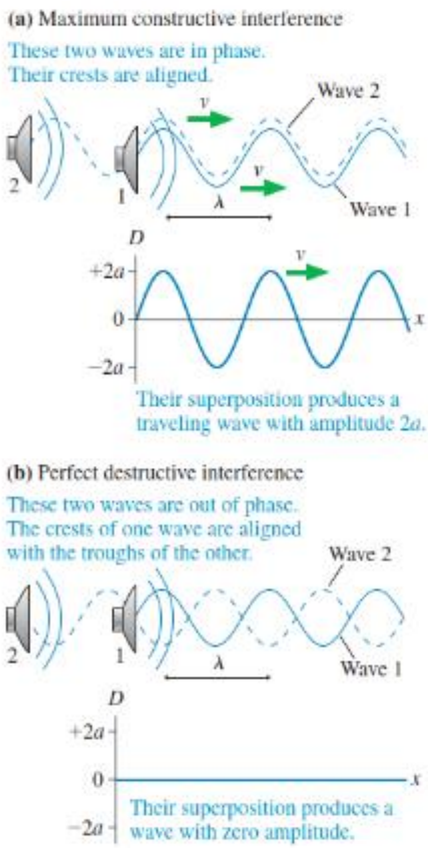


FIGURE 17.18 Interference of two waves traveling along the x-axis.

Positions and displacement

In this model the doubling of the e𝕧 inertial scale is not the same as the E𝕍 inertial displacement.

The two waves of Figure 17.18a have the same displacement at every point: $D_1(x) = D_2(x)$. Two waves that are aligned crest to crest and trough to trough are said to be **in phase.** Waves that are in phase march along "in step" with each other.

When we combine two in-phase waves, using the principle of superposition, the net displacement at each point is twice the displacement of each individual wave. The superposition of two waves to create a traveling wave with an amplitude *larger* than either individual wave is called **constructive interference.** When the waves are exactly in phase, giving $A = 2a$, we have *maximum constructive interference*.

Photon entanglement and destructive interference

With destructive interference the e𝕧 spokes are always pointing in the opposite directions to each other. This is approximately a zero amplitude as a minimum amount of -𝕀D×e𝕧 inertial work. When two e𝕪×-𝕘d photons are entangled they have the e𝕪 kinetic spokes also pointing in opposite directions. The photons move off in opposing directions instead of in the same direction with the opposing spokes. When one is measured the other must have an opposing spoke, the -𝕘d light spin of one photon is measured with -𝔾D×e𝕪 light work to have a probability of pointing up or down.

The two photons remain in destructive interference, the same as if they were moving in the same direction. Because of this there is no overall -𝔾D light torque or light probability. If one photon is measured with its e𝕪 spoke in the up direction the other must be in the down direction.

Maintaining the spoke opposition

If Biv space-time was flat between them, such as their not passing through +𝕚d gravitation fields, then the spokes move with this opposite orientation being maintained. If one passes through a gravitational field then out the other side the spokes regain their opposed directions. This is because gravity causes the e𝕪 spoke to contract, but the -𝕘d rotational frequency to slow with the same proportion. The spokes remain opposed because as one spoke contracts the rolling wheel also slows. This entanglement would remain if the measurement is done while one photon is in a strong gravitational field.

Bosons and entanglement

This also occurs with bosons where two electrons have opposing spins, for example in the ground state with Helium. If there is a gravitational gradient on one electron this does not break up the entanglement. The e𝕪 kinetic spoke of a first electron would be contracted, the -𝕠d kinetic rotational frequency of the electron would also be slowed with the same proportion. As two electron rolling wheels, moving in opposed directions and opposite spin, the e𝕪/-𝕠d kinetic velocity and e𝕧/-𝕚d inertial velocity remain the same. One electron wheel is smaller but rotates more slowly.

In Figure 17.18b, where the crests of one wave align with the troughs of the other, the waves march along "out of step" with $D_1(x) = -D_2(x)$ at every point. Two waves that are aligned crest to trough are said to be *180° out of phase* or, more generally, just **out of phase.** A superposition of two waves to create a wave with an amplitude smaller than either individual wave is called **destructive interference.** In this case, because $D_1 = -D_2$, the net displacement is *zero* at *every point* along the axis. The combination of two waves that cancel each other to give no wave is called *perfect destructive interference.*

> **NOTE** Perfect destructive interference occurs only if the two waves have exactly equal amplitudes, as we're assuming. A 180° phase difference always produces *maximum destructive interference*, but the cancellation won't be perfect if there is any difference in the amplitudes.

Changing the phase

The path length difference is e𝕧, that comes from the rolling wheel. When the e𝕧 spoke rotates at the same inertial frequency then the wheel moves the same e𝕧 length. This maintains the phase, to change this there would need to be a force. A first wheel might have an additional -𝕀D inertial torque, that would increase its frequency and change the relation between the phases.

Changing the phase with impulse

Alternatively, one rolling wheel might encounter a different inertial impulse, such as one sound wave colliding more with air molecules. This might happen if one moved against a wind with a different e𝕧/-𝕚d inertial velocity to the other wave.

The Phase Difference

To understand interference, we need to focus on the *phases* of the two waves, which are

$$\begin{aligned}\phi_1 &= kx_1 - \omega t + \phi_{10} \\ \phi_2 &= kx_2 - \omega t + \phi_{20}\end{aligned} \tag{17.20}$$

The difference between the two phases ϕ_1 and ϕ_2, called the **phase difference** $\Delta\phi$, is

$$\begin{aligned}\Delta\phi = \phi_2 - \phi_1 &= (kx_2 - \omega t + \phi_{20}) - (kx_1 - \omega t + \phi_{10}) \\ &= k(x_2 - x_1) + (\phi_{20} - \phi_{10}) \\ &= 2\pi\frac{\Delta x}{\lambda} + \Delta\phi_0\end{aligned} \tag{17.21}$$

You can see that there are two contributions to the phase difference. $\Delta x = x_2 - x_1$, the distance between the two sources, is called **path-length difference.** It is the extra distance traveled by wave 2 on the way to the point where the two waves are combined. $\Delta\phi_0 = \phi_{20} - \phi_{10}$ is the *inherent phase difference* between the sources.

The condition of being in phase, where crests are aligned with crests and troughs with troughs, is $\Delta\phi = 0, 2\pi, 4\pi$, or any integer multiple of 2π rad. Thus the condition for maximum constructive interference is

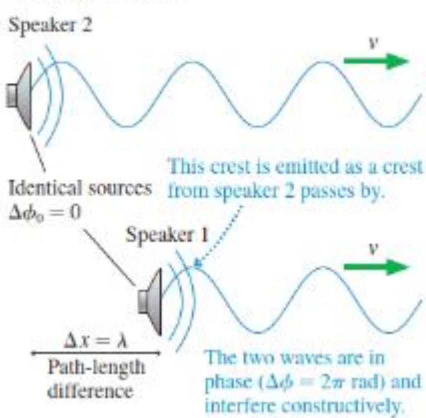
Maximum constructive interference:

$$\Delta\phi = 2\pi\frac{\Delta x}{\lambda} + \Delta\phi_0 = m \cdot 2\pi \text{ rad} \qquad m = 0, 1, 2, 3, \ldots \tag{17.22}$$

One wavelength apart

The wavelength here would be e𝕧×2, that would be the diameter of the rolling wheel where the spoke pointed forwards and backwards.

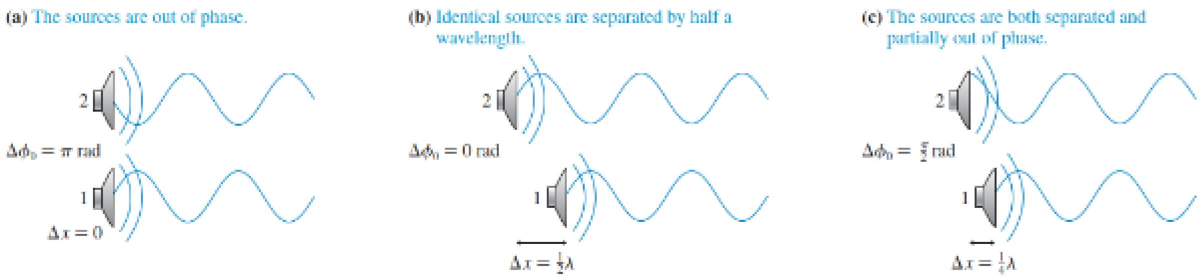
FIGURE 17.19 Two identical sources one wavelength apart.



Phase differences in radians

The phase differences can be measured in radians, this is 1/(2π) of a circle. That is related to β as ≈ 1/√(2π), the rolling wheel has a radius or e𝕧 spoke of 1/(2π), If this radian is a measure of -𝕀D inertial torque then it gives an oscillation instead of the chaotic tines of β.

FIGURE 17.20 Destructive interference three ways.



NOTE Don't confuse the phase difference of the waves ($\Delta\phi$) with the phase difference of the sources ($\Delta\phi_0$). It is $\Delta\phi$, the phase difference of the waves, that governs interference.

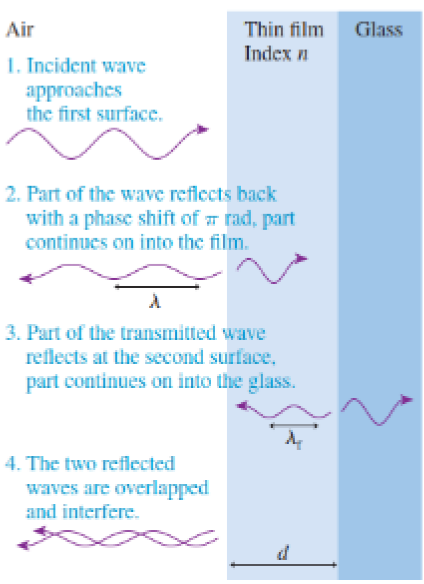
Work and a thin film interference

In the diagram the thin film partially reflects the e𝕪×-𝕘d photons, this gives an interference from the -𝔾D×e𝕪 light work. The e𝕧 length here is the depth of the thin film, that changes the -𝕀D inertial torque of the wave to create an interference pattern.

Electron tunneling with work

In this model electrons can tunnel through a barrier with -𝕆D×e𝕪 kinetic work, this is because the electrons have a -𝕆D kinetic probability of being reflected or going through a barrier. The probability decreases as a square when the e𝕧 length or width of the barrier increases.

FIGURE 17.23 The two reflections, one from the coating and one from the glass, interfere.

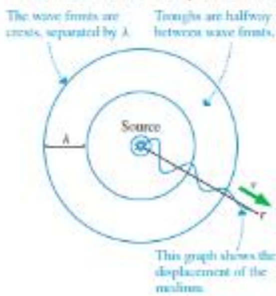


No spherical waves

In this model there are no spherical waves, the e𝕪×-𝕘d photons move outwards as separate Pythagorean Triangles. The motion of the waves below comes from their E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse when initiated, that does not cause the interferences. The -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work are not moving because there is no e𝕧/-𝕚d inertial velocity, the interference pattern then remains static.

17.7 Interference in Two and Three Dimensions

FIGURE 17.24 A circular or spherical wave.



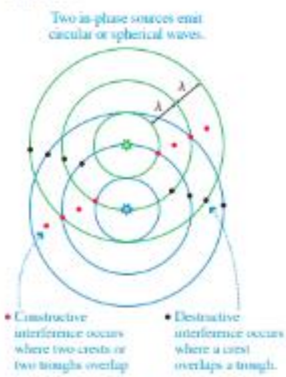
Ripples on a lake move in two dimensions. The glow from a lightbulb spreads outward as a spherical wave. A circular or spherical wave, illustrated in FIGURE 17.24, can be written

$$D(r, t) = a\sin(kr - \omega t + \phi_0) \qquad (17.34)$$

where r is the distance measured outward from the source. Equation 17.34 is our familiar wave equation with the one-dimensional coordinate x replaced by a more general radial coordinate r. Recall that the wave fronts represent the *crests* of the wave and are spaced by the wavelength λ.

What happens when two circular or spherical waves overlap? For example, imagine two paddles oscillating up and down on the surface of a pond. We will assume that the two paddles oscillate with the same frequency and amplitude and that they are in phase. FIGURE 17.25 shows the wave fronts of the two waves. The ripples overlap as they travel, and, as was the case in one dimension, this causes interference. An important difference, though, is that amplitude decreases with distance as waves spread out in two or three dimensions—a consequence of energy conservation—so the two overlapped waves generally do *not* have equal amplitudes. Consequently, destructive interference rarely produces perfect cancellation.

FIGURE 17.25 The overlapping ripple patterns of two sources. Several points of constructive and destructive interference are noted.



Maximum constructive interference occurs where two crests align or two troughs align. Several locations of constructive interference are marked in Figure 17.25. Intersecting wave fronts are points where two crests are aligned. It's a bit harder to visualize, but two troughs are aligned when a midpoint between two wave fronts is overlapped with another midpoint between two wave fronts. Maximum, but usually not perfect, destructive interference occurs where the crest of one wave aligns with a trough of the other wave. Several points of destructive interference are also indicated in Figure 17.25.

A picture on a page is static, but **the wave fronts are in motion**. Try to imagine the wave fronts of Figure 17.25 expanding outward as new circular rings are born at the sources. The waves will move forward half a wavelength during half a period, causing the crests in Figure 17.25 to be replaced by troughs while the troughs become crests.

The important point to recognize is that **the motion of the waves does not affect the points of constructive and destructive interference.** Points in the figure where two crests overlap will become points where two troughs overlap, but this overlap is still constructive interference. Similarly, points in the figure where a crest and a trough overlap will become a point where a trough and a crest overlap—still destructive interference.

The mathematical description of interference in two or three dimensions is very similar to that of one-dimensional interference. The net displacement of a particle in the medium is

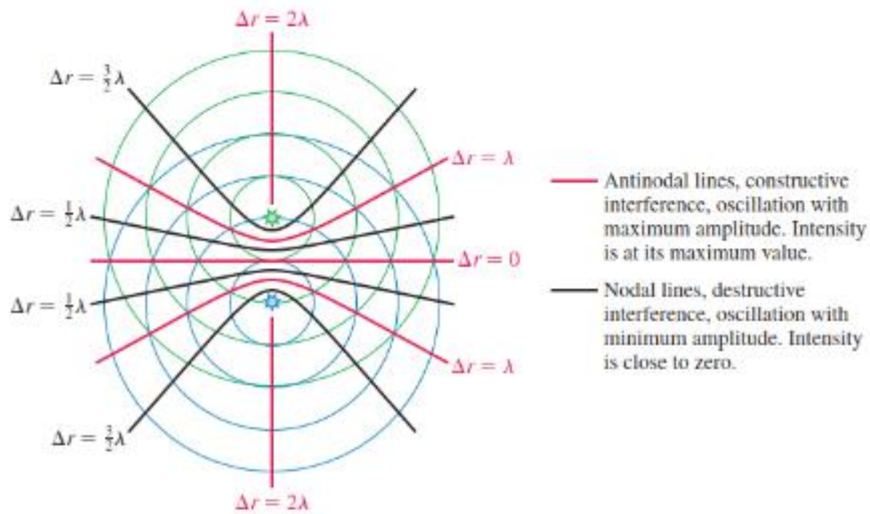
$$D = D_1 + D_2 = a_1\sin(kr_1 - \omega t + \phi_{10}) + a_2\sin(kr_2 - \omega t + \phi_{20}) \qquad (17.35)$$

Nodal and Antinodal lines

Here constructive interference occurs along an antinodal line, this is composed of e𝕧 positions with their -𝕀D inertial probabilities and torque. With destructive interference there is another e𝕧 nodal line, in this model there is no motion along the line because the interference patterns do not move, they have no impulse.

We can now locate the points of maximum constructive interference by drawing a line through *all* the points at which $\Delta r = 0$, another line through all the points at which $\Delta r = \lambda$, and so on. These lines, shown in red in FIGURE 17.27, are called **antinodal lines.** They are analogous to the antinodes of a standing wave, hence the name. An antinode is a *point* of maximum constructive interference; for circular waves, oscillation at maximum amplitude occurs along a continuous *line*. Similarly, destructive interference occurs along lines called **nodal lines.** The amplitude is a minimum along a nodal line, usually close to zero, just as it is at a node in a standing-wave pattern.

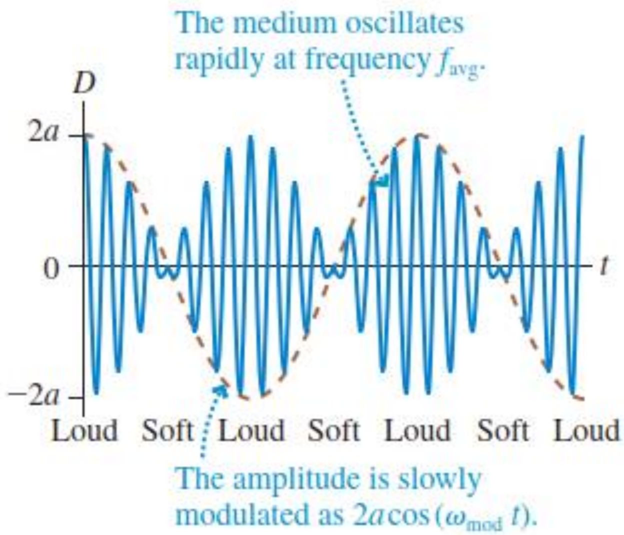
FIGURE 17.27 The points of constructive and destructive interference fall along antinodal and nodal lines.



Beats

In this model beats are caused by the addition of -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work from different waves. The nodes again do not move because there is no E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse in interference.

FIGURE 17.29 Beats are caused by the superposition of two waves of nearly identical frequency.



Beats and a linear scale

Here there is a linear e𝕧 length in between the fence posts. In this model they would not be frequencies, that is only used in impulse here. Because e𝕧 is a linear scale the beats can be measured like waves.

A changed frequency with impulse

If this was observed with a frequency, such as a strobe light flashing on a fan, then the fan would appear to have a different rotational speed. That would not be an oscillation, the rotation of the fan is like an inertial clock gauge observing the -𝕚d inertial time. Instead of the strobe a second fan like shape could have slits in it rotating at a different speed to the fan. When light goes through the slits it would give an image of a fan rotating in a slower -𝕚d inertial time.

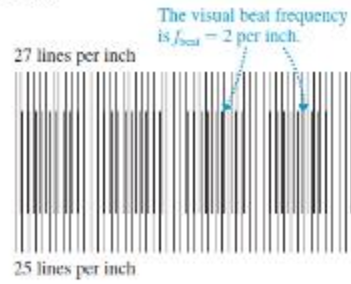
Slits and the double slit experiment

The slits are like the double slit experiment, here the light is observed to go through particular slits so there is no wave being measured. With the fence there is a measurement of the wave like posts as if they were peaks of a wave. An individual post is not being measured, instead the beats come from measuring all the posts with their e𝕧 lengths in between. If one post is observed then the beats disappear, it can only reappear when a number of posts are measured for the different e𝕧 spacings between them.

Beats aren't limited to sound waves. **FIGURE 17.31** shows a graphical example of beats. Two "fences" of slightly different frequencies are superimposed on each other. The difference in the two frequencies is two lines per inch. You can confirm, with a ruler, that the figure has two "beats" per inch, in agreement with Equation 17.43.

Beats are important in many other situations. For example, you have probably seen movies where rotating wheels seem to turn slowly backward. Why is this? Suppose the movie camera is shooting at 30 frames per second but the wheel is rotating 32 times per second. The combination of the two produces a "beat" of 2 Hz, meaning that the wheel appears to rotate only twice per second. The same is true if the wheel is rotating 28 times per second, but in this case, where the wheel frequency slightly lags the camera frequency, it appears to rotate *backward* twice per second!

FIGURE 17.31 A graphical example of beats.



Electric Charges and Forces

Experiment 1

In this model charges come from the -𝕠d and e𝕪 Pythagorean Triangle as the electron, and the +𝕠d and e𝕒 Pythagorean Triangle as the proton. In experiment 1 the rods haven't been rubbed, so there is no inertia from the -𝕚d and e𝕧 Pythagorean Triangle moving the electrons. Some of these electrons are loosely held in their orbitals, they can be lost by the wool as its inertia moves them by rubbing.

Experiment 2

In experiment 2 both rods are rubbed with wool, this imparts an inertia to the wool's electrons so they have enough -𝕚d×e𝕧/-𝕚d inertial momentum to jump to the glass. The electrons are in hyperbolic geometry and so they act on each other with a repulsion. The electrons remain out of the glass atoms, when the rods are brought close together this causes a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse between them so the rods move apart.

Experiment 3

When one rod is rubbed with wool it has an excess of electrons, when the other rod is rubbed with silk it loses electrons. This causes the two rods to attract each other, the rod with fewer electrons has electrons attracted to it by the +𝕠d and e𝕒 Pythagorean Triangle protons. That is similar to gravity, the proton reacts against the electrons trying to stay free. This is like inertia, the motion of the electrons causes an equal and opposite reaction in the protons to capture them.

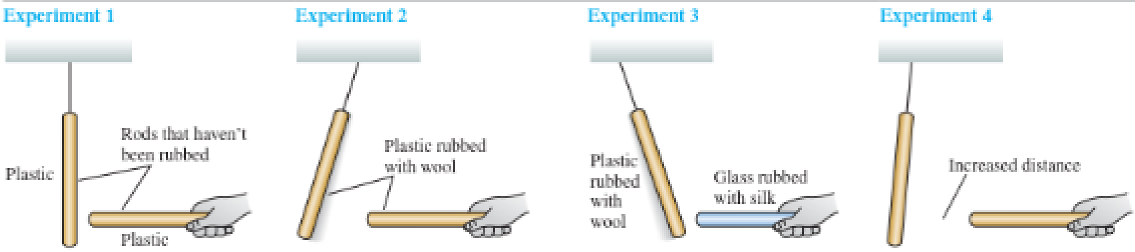
Experiment 4

The strength of this force comes from the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, that is because the force is in a straight-line not as a rotation. The rubbing is also done with impulse as a straight-line motion up and down the rod. With a stronger impulse there are more electrons captured in a rod from the wool, or more electrons are removed by the silk.

Experimenting with Charges

Let us enter a laboratory where we can make observations of electric phenomena. The major tools in the lab are plastic, glass, and metal rods; pieces of wool and silk; and small metal spheres on wood stands. Let's see what we can learn with these tools.

Discovering electricity I



Experiment 1: Take a plastic rod that has been undisturbed for a long period of time and hang it by a thread. Pick up another undisturbed plastic rod and bring it close to the hanging rod. Nothing happens to either rod.

Experiment 2: Rub both plastic rods with wool. Now the hanging rod tries to move away from the handheld rod when you bring the two close together. Two glass rods rubbed with silk also repel each other.

Experiment 3: Bring a glass rod that has been rubbed with silk close to a hanging plastic rod that has been rubbed with wool. These two rods *attract* each other.

Experiment 4: Further observations show that:

- These forces are greater for rods that have been rubbed more vigorously.
- The strength of the forces decreases as the separation between the rods increases.

Experiment 5

When a rod is charged with an excess of electrons, then the electrons in the paper move toward the rod side respectively. This causes the paper to stick to the rod. That is like molecular bonds, the electrons are increasingly shared by the bonds in between the rod and the paper. Here the electrons only have enough e𝕪×-𝕘d photons absorbed to move out of the wool, this would be where the electrons were loosely held in the wool atoms. Because of this the electrons have a low e𝕧/-𝕚d inertial velocity, they move across the rod closer to the +𝕠d and e𝕒 Pythagorean Triangle protons in the paper.

Experiment 6

This also happens with a neutral rod, some of the electrons in it move either towards the charged rod. That is caused by the E𝕐/-𝕠d kinetic impulse and E𝕍×-𝕚d, it is similar to gravity where the Eℍ/+𝕚d gravitational impulse can cause an asteroid to be attracted towards a planet. When it gets closer the +𝕀D×e𝕙 gravitational work tends to curve its trajectory more towards an orbit or a hyperbolic path.

Changing to a curved path

The electrons are also attracted towards atoms in the other rod by the E𝕐/-𝕠d kinetic impulse and E𝔸/+𝕠d potential impulse, when they get closer this is more like -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work where the electrons are in a curved trajectory around the atoms. This tends to hold the electrons around the atoms in a loose orbit like the asteroid.

Moving the rods with impulse

They need not get close enough to be absorbed into an orbital, this is like an asteroid not being close enough to going into orbit around the planet. The main forces here are the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, this makes the rods move more in a straight-line motion towards or away from each other.

Photons in between electrons

The electrons can emit and absorb virtual photons between them as they approach each other. These have a probability from α as $e^{-𝕠d}$, when the electrons do -𝕆D×e𝕪 kinetic work they curve around each other. This curved path comes from the -𝕆D kinetic and -𝕀D inertial torque, it is work because the e𝕪 kinetic electric charge and e𝕧 length between them is decreasing.

Fermions and spin

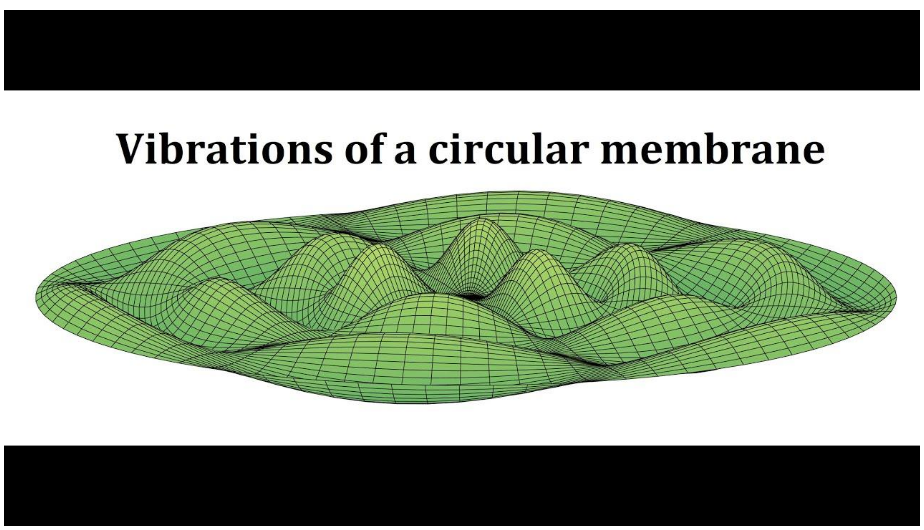
This also causes electrons to spread out away from each other in an atom, as fermions they would have opposing spins and would be like two tops with a clockwise spin hitting each other. This causes a destructive interference in between the electrons, because the -𝕆D kinetic probability and -𝕀D inertial probability are reduced they are less likely to be found moving closer to each other. This causes them to separate.

Molecular bonds and destructive interference

In this model electrons also do that in molecular bonds, they can be shared by two or more atoms. They can be attracted by both atoms, the constructive interference prevents the electrons from repelling each other and breaking up the bonds.

Separated electrons in orbitals

It also causes electrons to remain distant from each other in orbitals, their -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work would interfere with other electrons in same orbital causing them to be separated. Electrons can have a probability density like a cloud as they interfere destructively with each other, that is like vibrations on a drum forming different pattern as the frequency increases. In between there are areas where the -𝕆D×e𝕪 kinetic work of the vibrations interfere with each other, that keeps the vibrations separate. There are also nodes between the waves, but destructive interference appears to repel them from each other.

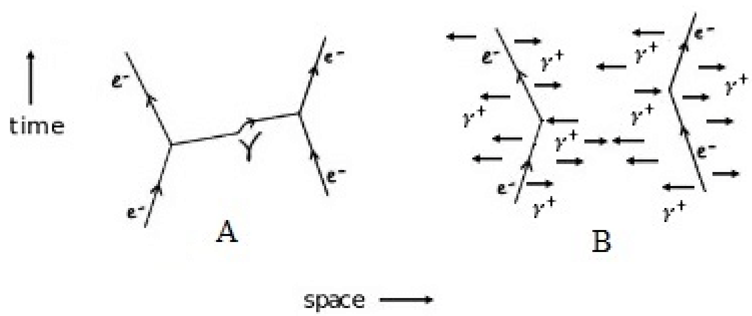


Quantization between electrons

In this model electrons also do -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work on each other, the -𝕆D kinetic and -𝕀D inertial probability acts like quantized levels or orbitals. When they approach each other this is like an electron moving to a lower orbital, it emits a e𝕪×-𝕘d photon. Because a first electron emits the photon from the second electron's approach, the e𝕪×-𝕘d photon is absorbed by the second electron. That acts like a force as the photon does -𝔾D×e𝕪 light work pushing the electrons apart as virtual photons.

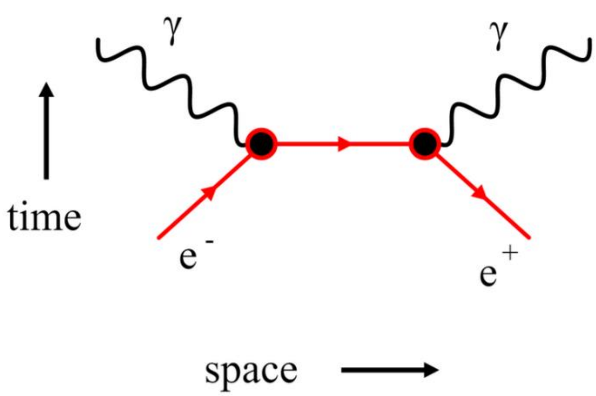
Electron repulsion and α

Because this is quantized the exchange of photons is related to α as $e^{-𝕠d}$, the e𝕧 length between them decreases which is like $e^{-𝕆D}$ as a squared force. This can be illustrated with a Feynman diagram, the virtual photons in between then electrons can form other iotas such as electron positron pairs. That is because the difference between +𝕠d in the positron and -𝕠d in the electron is a value of α like the difference between a +𝕠d proton and its potential magnetic field with the -𝕠d kinetic magnetic field of an electron.



Feynman diagrams with electrons and positrons

Here the electron and positron have quantized work between them, there is the +𝕆D×e𝕪 positronic work and the -𝕆D×e𝕪 kinetic work. In between these the difference is like between a proton with +𝕆D×e𝕒 potential work and an electron with -𝕆D×e𝕪 kinetic work. This is emitted as e𝕪×-𝕘d photons when they come together, the +𝕠d positronic magnetic field and the -𝕠d kinetic magnetic field cancel each other. That is because the positron is going backward in time and the electron forward in time, when they meet there is no overall direction in time so it becomes a measurement of -𝔾D×e𝕪 light work in the present.



The right hand rule

There is a right-hand rule as a convention, then the e𝕧 length would be orthogonal to both. With -𝕆D×e𝕪 kinetic work from a magnetic field an electron would move in a direction e𝕧 with an inertial velocity e𝕧/-𝕚d. The -𝕚d inertial time is proportional to the -𝕠d kinetic magnetic field and the e𝕧 length is proportional to the e𝕪 kinetic electric charge. This can also be regarded as the e𝕪 kinetic electric charge and -𝕠d kinetic magnetic field being orthogonal to each other in the -𝕠d and e𝕪 Pythagorean Triangle. When the -𝕆D×e𝕪 is measured then the change in e𝕧 position would be orthogonal to the -𝕠d kinetic magnetic field and parallel to the e𝕪 kinetic electric charge.

Motion orthogonal to either e𝕪 or -𝕠d

As the E𝕐/-𝕠d kinetic impulse is observed the e𝕪 kinetic electric charge becomes a kinetic displacement E𝕐, then the motion is observed orthogonal to it as the -𝕚d inertial time. This appears as a motion orthogonal to the e𝕪 kinetic electric charge and -𝕠d kinetic magnetic field, as a third direction. The e𝕧/-𝕚d inertial velocity comes from the E𝕐/-𝕠d kinetic impulse, then the -𝕚d inertial time is used to observe this motion. When there is -𝕆D×e𝕪 kinetic work there is the -𝕚d×e𝕧 inertial momentum, then the e𝕧 length is measuring its motion.

The right hand rule cannot be observe or measured

The right-hand rule implies the e𝕪 kinetic electric charge and -𝕠d kinetic magnetic field can be observed and measured at the same time and place. If not, then the diagram cannot be drawn because part is a wave and the other part is a particle.

Flipping an electron twice

In this model an electron can have its spin flipped, in conventional physics an electron must be flipped twice to return to its original state. If the electron has its e𝕪 kinetic electric charge pointing up, and its -𝕠d kinetic spin clockwise looking down at it, then flipping it would have the e𝕪 kinetic electric charge pointing down and the -𝕠d kinetic magnetic field now counterclockwise.

A single flip is a different state

This is a different state here because -𝕆D×e𝕪 kinetic work was done on it, with vector addition the e𝕪 straight Pythagorean Triangle side would give a different answer in relation to other electrons. When the electron is flipped again the e𝕪 kinetic electric charge again points up and the -𝕠d kinetic magnetic field is again clockwise.

Boson pairs

When this flipped electron is paired with an unflipped electron they can form a boson pair in this model. The ground state of Helium would have these two electrons, they represent a lower energy state because the spins oppose each other and the e𝕪 kinetic electric charge also opposes with vector subtraction. The boson then has a lower E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work, this allows it to have a lower orbital energy than a fermion.

Cooper pairs

In superconductivity Cooper pairs of electrons can form as one electron has its spin flipped, this can move them into a lower energy state like a boson pair. That can also be caused by the pressure from other electrons in a lattice around them as well as the low e𝕪 temperature.

No chaotic loss in superconductors

In this model Cooper pairs would be more wave like as with bosons. -𝕆D×e𝕪 kinetic work tends to form a consistent kinetic gradient, in an atom these would be orbitals. In a gas the molecules tend to spread out to a common density throughout as a kind of temperature and pressure gradient. In this model pressure would come from e𝕪 as does temperature, the -𝕆D×e𝕪 kinetic work uses e𝕪 as a ruler to measure the kinetic gradient of the gas. This becomes more like a horizontal gradient with some E𝕐/-𝕠d kinetic impulse disturbing this with chaotic collisions. The gradient then evens the pressure and temperature with -𝕆D×e𝕪 kinetic work from the normal curve.

Only work in superconductors

When electrons are cooled they act less like particles, the superconducting current is more wave like.

Charge Parity Time symmetry

With the Charge Parity Time symmetry hypothesis the universe should be the same if all of these are reversed. In this model Charge is not electric, it comes from the +𝕠d potential magnetic field and the -𝕠d kinetic magnetic field, that gives them a positive and negative value. If these are reversed with antiprotons and positrons that is referred to as Charge reversal, here it is also Time reversal.

Reversing Charge and Time

The antiprotons would move forward in -𝕠d antiproton Time, the positron move backwards in positronic Time. Because this reverses Time the universe would run in reverse, we would not notice this because our consciousness would also be reversed. It also makes inertia act like gravity and gravity like inertia, with everything reversed all physical phenomena would be the same.

Parity and Direction

The third aspect of CPT is P or Parity, this is a mirror image where an -𝕠d and e𝕪 Pythagorean Triangle for example would appear in a mirror with e𝕪 up and the spin say counterclockwise instead of currently clockwise. Charge and Time are the same thing in this model, Feynman suggested positrons go back in time while electrons go forward in time, they cancel each other out so everything looks the same. Parity then needs to cancel out with a fourth symmetry, in this model that is Distance. That gives a CPTD symmetry in this model.

Reversing Direction and Parity

In a mirror the -𝕠d and e𝕪 Pythagorean Triangle would have its spin reversed with the e𝕪 Pythagorean Triangle side pointing up. If e𝕪 was pointing at the mirror then it would also be reversed, the e𝕪 mirror Pythagorean Triangle side would point out of the mirror.

Reversing direction in a movie

This is like time being reversed, we for example point the Pythagorean Triangle at the mirror going north and in the mirror it moves going south. It is the same as our time going in reverse and we moved it going south, in the mirror it would again be reversed as going north. In a reversed movie everything is not only going back in time but every direction is also the opposite. For example in a movie of going to the north pole, it would appear they were retracing their steps going back to the south.

Vector addition and subtraction

In this model the straight Pythagorean Triangle sides only use vector addition and subtraction, they do not have a positive or negative sign like +𝕠d and -𝕠d. The mirror image then would with vector subtraction cancel out all the straight Pythagorean Triangle sides. With Parity reversal these also cancel with vector subtraction.

Annihilation from impulse

Here an electron and positron can collide and annihilate each other, that would be from the E𝕐/+𝕠d positronic impulse and E𝕐/-𝕠d kinetic impulse. If they did not come close enough to each other than this could only be from +𝕆D×e𝕪 positronic work and -𝕆D×e𝕪 kinetic work. Then there is a vector subtraction of e𝕪 in terms of position.

The real and mirror worlds

Vector subtraction with the mirror world would not cause iotas to annihilate each other, a flipped electron would be in this mirror state but would not annihilate an unflipped electron. Instead they can form a boson pair, the -𝕆D positronic and kinetic probabilities destructively interfere.

Reversing Biv spacetime

In conventional physics a matter and antimatter universe might both exist, for example one star might be matter and another antimatter. A mirror universe would appear the same to its inhabitants. Their left becomes right and vice versa, their forward becomes reverse. It would then be like a time reversed movie, each motion would be a e𝕧/-𝕚d inertial velocity or a e𝕙/+𝕚d gravitational speed. Objects would rise up rather than drop down, if they were moving north they would seem to go south in the opposite direction.

Matter and antimatter, reality and mirrored would appear the same

This would be the same as reversing time according to this model, it causes +𝕚d gravity to be like the +𝕠d potential magnetic field in the proton. The +𝕠d kinetic magnetic field of the electron becomes reactive like the -𝕚d inertia and vice versa. Just as the matter and antimatter universes would be the same, the real and mirror universes would also be the same to their measurers and observers.

Bosons as a real and mirrored state

It still allows for some antimatter to exist, such as electrons and positrons, the real and mirrored iotas can also exist for example as unflipped and flipped electrons. When they come together they form a different state as a boson, they can also separate into separate fermions. This also happens with electrons and positrons, when they come together they can annihilate to become photons. These photons can also recombine into electrons and positrons, that is seen in Feynman diagrams. It also happens when photons are in a strong +𝕚d gravitational field.

Spin direction

A Pythagorean Triangle in this model would seem to spin in one direction as a preference, this comes from looking forwards in -𝕠d kinetic time and -𝕚d inertial time. Looking in reverse the spin would appear to be in the opposite direction.

The mirror universe appears to be the same

This mirror universe looks the same when we observe and measure it in a mirror. We can recognize some parity reversals like writing being back to front, but people in the mirror cannot notice this. The question of which way the universe goes, a real way or a mirror way has no meaning, whichever one we are in we cannot tell except when the other one is encountered. In either one we would observe and measure this single direction of spin, the asymmetry of Pythagorean Triangles, and wonder why it is not the other way.

Neutron spin direction

In this model neutrons have the original spin direction, that allows the proton, electron and neutrino to fit together with the spins connecting together. If any of these has their spin flipped then the neutron cannot form, that is because flipping one of them adds energy which is higher than the energy state of the neutron. A single flip puts the electron into a mirror state, this is called an anti-positron in conventional physics.

Only electrons move forward in time

Here there is a difference between matter and antimatter, also the real and mirror universes. That comes from the direction of time, electrons move forward in time so that positrons moving back in time cannot replace their motion.

Cosmological constant an inertia forwards in time

The cosmological constant is also the difference between inertia from the -𝕚d and e𝕧 Pythagorean Triangle moving forward in time, and gravity from the +𝕚d and e𝕙 Pythagorean Triangle moving backwards in time. This gives a bias to moving forwards in time because we observe and measure a motion from the past to the future. This past appears as a big bang from gravity moving backwards, the future appears as a hyperbolic expansion of space as inertia is stronger than gravity moving forward.

Differences in mesons moving forwards in time

In subatomic physics there are some differences between mesons that violate the CPTD or Charge-Parity-Time-Distance symmetry. This is because the differences are observed and measured moving forwards in time. If not then there would be a balance between the circular geometry of the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity, and the hyperbolic geometry of the -𝕠d and e𝕪 Pythagorean Triangle as the electron and the -𝕚d and e𝕧 Pythagorean Triangle as inertia.

Experiment 7

The wool has lost some electrons, it then has a E𝔸/+𝕠d potential impulse where the electrons moved towards their previous orbital e𝕒 altitudes. They have increased their E𝕍/-𝕚d inertial impulse from the wool rubbing, but they can also lose some of the e𝕪×-𝕘d photons they absorbed and tend to go nearer their previous orbitals.

Moving back towards an asteroid belt

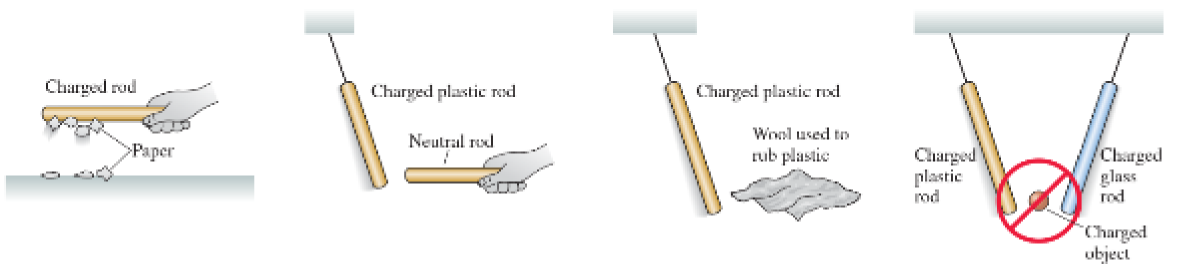
This is like asteroids that are attracted from an asteroid belt by a passing planet, they may tend to go back towards this previous belt e𝕙 height from a star. They have some additional E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse from the planet, if this is lost by collisions with other asteroids then the randomizing effects of this -𝕀D×e𝕧 inertial work would move them closer to the belt. They also have a Eℍ/+𝕚d gravitational impulse attracting the asteroids in the belt.

Casimir effect

According to this model it is related to the Casimir effect, there is a straight-line force between two plates close to each other. In each plate there are atoms with +𝕠d and e𝕒 Pythagorean Triangles as protons. These have reactive forces only, the electrons have a e𝕙 height and e𝕒 altitude above the atoms in their own plate. If not then the electrons would have left the plate already. When the second plate is brought closer, the electrons tend to move to the same e𝕙 height and e𝕒 altitude in this plate as well. That causes a weak attraction until the plates are closer.

Experiment 8

No objects attract both rods, if the object has an excess of electrons it will attract the one with a deficit and repel the other. If it has a deficit of electrons then the opposite will occur.



Discovering electricity II

Experiment 5

Hold a charged (i.e., rubbed) plastic rod over small pieces of paper. The pieces of paper leap up and stick to the rod. A charged glass rod does the same. However, a neutral rod has no effect on the pieces of paper.

Experiment 6

Hang charged plastic and glass rods. Both are attracted to a *neutral* (i.e., unrubbed) plastic rod. Both are also attracted to a *neutral* glass rod. In fact, the charged rods are attracted to *any* neutral object, such as a finger or a piece of paper.

Experiment 7

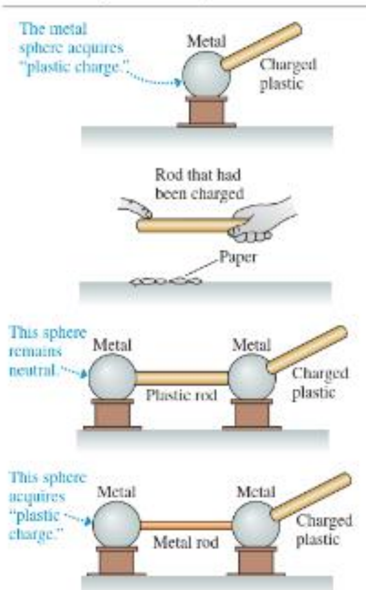
Rub a hanging plastic rod with wool and then hold the *wool* close to the rod. The rod is weakly *attracted* to the wool. The plastic rod is *repelled* by a piece of silk that has been used to rub glass.

Experiment 8

Further experiments show that there appear to be *no* objects that, after being rubbed, pick up pieces of paper and attract *both* the charged plastic and glass rods.

Electrons in metals

In this model electrons are more loosely held in metals. When -𝕆D×e𝕪 kinetic work is done on them, such as in a wire between batteries, then they can flow like particles with a E𝕐/-𝕠d kinetic impulse.



Electric Properties of Materials

We still need to clarify how different types of materials respond to charges.

Discovering electricity III

Experiment 9

Charge a plastic rod by rubbing it with wool. Touch a neutral metal sphere with the rubbed area of the rod. The metal sphere then picks up small pieces of paper and repels a charged, hanging plastic rod. The metal sphere appears to have acquired "plastic charge."

Experiment 10

Charge a plastic rod, then run your finger along it. After you've done so, the rod no longer picks up small pieces of paper or repels a charged, hanging plastic rod. Similarly, the metal sphere of Experiment 9 no longer repels the plastic rod after you touch it with your finger.

Experiment 11

Place two metal spheres close together with a plastic rod connecting them. Charge a second plastic rod, by rubbing, and touch it to one of the metal spheres. Afterward, the metal sphere that was touched picks up small pieces of paper and repels a charged, hanging plastic rod. The other metal sphere does neither.

Experiment 12

Repeat Experiment 11 with a metal rod connecting the two metal spheres. Touch one metal sphere with a charged plastic rod. Afterward, *both* metal spheres pick up small pieces of paper and repel a charged, hanging plastic rod.

Electric charge as vectors

In this model electric charge has no sign, instead they use vector addition and subtraction. This comes from their being straight Pythagorean Triangle sides, the same shape as straight vectors. With a E𝔸/+𝕠d potential impulse for protons, and a E𝕐/-𝕠d kinetic impulse for electrons, the vectors move backward in +𝕠d potential time and forward in -𝕠d kinetic time. This causes them to add as vectors like having a positive and negative charge. The magnetic fields here are positive and negative, so with a battery there would be a +𝕆D potential difference or voltage and a -𝕆D kinetic difference or voltage.

In this model

22.2 Charge

As you probably know, the modern names for the two types of charge are *positive charge* and *negative charge*. You may be surprised to learn that the names were coined by Benjamin Franklin.

So what is positive and what is negative? It's entirely up to us! Franklin established the convention that **a glass rod that has been rubbed with silk is *positively* charged.** That's it. Any other object that repels a charged glass rod is also positively charged. Any charged object that attracts a charged glass rod is negatively charged. Thus **a plastic rod rubbed with wool is negative.** It was only long afterward, with the discovery of electrons and protons, that electrons were found to be attracted to a charged glass rod while protons were repelled. Thus *by convention* electrons have a negative charge and protons a positive charge.

The neutron

In this model the neutron is the main iota, that is because it has its charge neutralized. It also has the +𝕠d potential time going backwards canceled out by the -𝕠d kinetic time going forward. Its +𝕚d gravitational mass goes back in time, this would also be canceled out by the -𝕚d inertia going forwards in time.

Backwards and forwards in time to the neutron

It is in effect an event where +𝕠d and +𝕚d as the proton move backwards in time to connect to it, also -𝕠d and -𝕚d as the electron move forwards in time to connect to it. An electron then moves forward in -𝕠d kinetic time to join the proton there. The proton has a mix of +𝕠d potential time with +𝕠4/3 as two up quarks, and -𝕠1/3 as one bottom quark. When the electron joins it one up quark flips from +𝕠2/3 to -𝕠1/3, the difference being -1 from -𝕠d with d=1. Because this is a 1 value this can act as an integer or a square, they are the same number. Gluons also act as 1 according to this model as the difference between +𝕠2/3 and -𝕠1/3.

Forming a neutron

When the neutron forms this absorbs a -𝕠d electron where d=1. Then a -𝕠1/3 down quark flips to become a +𝕠2/3 up quark because +1 is added to it, this becomes a proton. Both of these occur moving forward in -𝕠d kinetic time.

Neutrino as third direction of spin

In this model the neutrino is the third direction of spin, the proton spins around itself like a planet's axis. It can also be regarded as a rolling wheel which is spinning without rolling along, that is because the proton only reacts to an active force. This also contains the -𝕠1/3 spin, but this is smaller than the +𝕠2/3 The electron has an orthogonal spin, when it is in a ground state orbital it is like a rolling wheel with its axis at right angles to the proton's +𝕠d axle. The -𝕠1/3 is then added to the +𝕠4/3 spins, just as the neutron does not have a negative -𝕠d kinetic magnetic field it is neutralized.

Spin axle in the direction of travel

That leaves a third orthogonal degree of freedom as the neutrino, that would be like a horizontal spin orthogonal to both +𝕠d and -𝕠d. Here this is referred to as 𝕠d with no positive or negative sign. When the neutron decays this emits a 𝕠d antineutrino, when the neutron is reformed it absorbs a 𝕠d neutrino. In conventional physics the neutrino is represents as having a spin axle in the same direction of travel, this would be orthogonal to the e𝕪×-𝕘d photon with its -𝕘d light axle orthogonal to the direction of travel.

Neutrinos observed but not measured

Because this neutrino spin is orthogonal to the proton and electron, also the antiproton and positron, it cannot directly interact with them. It can collide with a 𝕠d×ℕ neutrino impulse, neutrinos are then detected with collisions as a particle not by their work.

Three generations of quarks

In this model the 1/3 and 2/3 values come from the three possible orthogonal +𝕠d and e𝕒 Pythagorean Triangles, each can exist without their values affecting the others directly. That allows for two of these to have a +𝕠2/3 value and the third to have a -𝕠1/3 value. In between is 1 as the gluon. It also means a quark can begin in one orthogonal direction, then with work it can be twisted with a torque to a second then a third orthogonal direction. This gives three generations of quarks because the torque adds +𝕚d gravitational mass to them.

Koide formula

According to the Koide formula each +𝕠2/3 quark does +𝕀D×e𝕙 gravitational work according to their gravitational mass in moving between the generations. This changes it from an up, to a charm, then a top quark. The -𝕠1/3 quark can also change with three orthogonal degrees of freedom, the -𝕀D×e𝕧 inertial work takes it from a down, to a strange to a bottom quark. There is also -𝕆D×e𝕪 kinetic work proportionally done in changing the quark's orientation orthogonally.

4/9 and 5/9

In this model the changing of the quark masses proceeds from the +𝕠2/3 to the -𝕠1/3 down quark, then to the +𝕠2/3 charm quark. When the masses are squared as work, then divided by their squares being added together, that gives 4/9. This is usually written as 2/3, here the squared value comes from the +𝕆D×e𝕒 potential work and the -𝕆D×e𝕪 kinetic work where the torque changes the spin direction added +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work as mass.

Quark work and impulse

The next three quarks go from the -𝕠1/3 strange quark, to the +𝕠2/3 top quark, then the -𝕠1/3 bottom quark which is ≈ 5/9 so the total adds up to 1. The first three are squared as work moving from +𝕠2/3 to +𝕠2/3 through -𝕠1/3. The second three are squared as impulse moving from -𝕠1/3 through +𝕠2/3 to -𝕠1/3.

Three generations of electrons

The three generations of electrons also give 4/9 when squared. There are no additional degrees of freedom for another three generations to add 5/9 to make 1, this is because the -𝕠d values all have d=1. It may be the neutrino masses have this 5/9 relationship, but there is no way currently to measure this.

Three generations of neutrinos

The neutrino also has three orthogonal degrees of freedom, it can change from an electron neutrino to a muon neutrino, then to a τ neutrino. The electron has the same three orthogonal degrees of freedom, it can change from an electron to a muon, to a τ electron.

Changing a neutrino into an electron

The neutrino can change into the electron, or vice versa, with torque on its axis. That changes it from 𝕠d to -𝕠d giving it a -𝕠d kinetic magnetic field instead of a 𝕠d neutrino magnetic field. It also changes it from the 𝕚d neutrino mass into a -𝕚d inertial mass. This allows for the neutrinos to have a 𝕚d neutrino mass, that prevents them from moving at c. In this model the neutrino would be a Marjorana fermion,as 𝕠d is has no positive or negative sign making the neutrino its own antiparticle.

Atoms and Electricity

Now let's fast forward to the 21st century. The theory of electricity was developed without knowledge of atoms, but there is no reason for us to continue to overlook this important part of our contemporary perspective. FIGURE 22.1 shows that an atom consists of a very small and dense *nucleus* (diameter ~ 10^{-14} m) surrounded by much less massive orbiting *electrons*. The electron orbital frequencies are so enormous (~ 10^{15} revolutions per second) that the electrons seem to form an **electron cloud** of diameter ~ 10^{-10} m, a factor 10^4 larger than the nucleus.

Experiments at the end of the 19th century revealed that electrons are particles with both mass and a negative charge. The nucleus is a composite structure consisting of *protons*, positively charged particles, and neutral *neutrons*. The atom is held together by the attractive electric force between the positive nucleus and the negative electrons.

One of the most important discoveries is that **charge, like mass, is an inherent property of electrons and protons.** It's no more possible to have an electron without charge than it is to have an electron without mass. As far as we know today, electrons and protons have charges of opposite sign but *exactly* equal magnitude. (Very careful experiments have never found any difference.) This atomic-level unit of charge, called the **fundamental unit of charge,** is represented by the symbol e. TABLE 22.1 shows the masses and charges of protons and electrons. We need to define a unit of charge, which we will do in Section 22.4, before we can specify how much charge e is.

FIGURE 22.1 An atom.

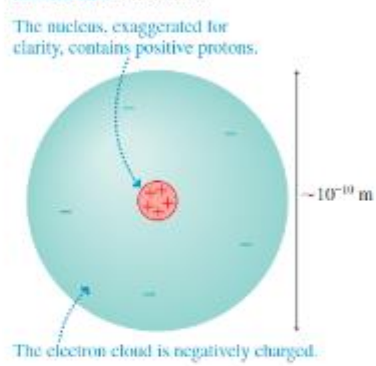


TABLE 22.1 Protons and electrons

Particle	Mass (kg)	Charge
Proton	1.67×10^{-27}	$+e$
Electron	9.11×10^{-31}	$-e$

Gluon work

In this model the three orthogonal +𝕠d and e𝕒 Pythagorean Triangles can be regarded as red, green, and blue. The gluon probabilities come from work which is a square, they act like a gluon torque twisting in between the Pythagorean Triangles. That gives gluon probabilities of 1/3 + 1/3 +1/3 =1. A red-antired combination for example is 1/3, here +𝕦rd would be +𝕦r√1/3 and -𝕦rd would be -𝕦r√1/3. When gluon work is done this would become +𝕌D as 1/3 and -𝕌 as -1/3.

Gluon combinations

With rb¯+br¯ this can be written as a torque from red to antiblue, positive as +𝕌bd is positive, when squared as gluon work that would have a probability of ½. There would also be rb¯-br¯ because blue here would be -𝕌bd. In this model quarks can be written as increments of 1/3 because of there being red, green, and blue orthogonal Pythagorean Triangles.

Forbidden singlet states

A forbidden singlet state would be rr¯ for example, that would have +𝕦d and -𝕦d canceling out completely. They would be in Pythagorean Triangles so that there is gluon work done over a distance, here this can be called e𝕘𝕝 and squared as E𝔾𝕃 to make a e𝕘𝕝 +𝕦d Pythagorean Triangle and e𝕘𝕝 -𝕦d Pythagorean Triangle. Then there would be +𝕌D×e𝕘𝕝 for +gluon work and -𝕌D×e𝕘𝕝 for negative gluon work. In this model there would be +𝕌D×e𝕘𝕝 +gluon work done in changing a +𝕠2/3 to a -𝕠1/3, -𝕌D×e𝕘𝕝 -gluon work would change a -𝕠1/3 into an +𝕠2/3.

The color singlet state is:[7]

$$(r\bar{r} + b\bar{b} + g\bar{g})/\sqrt{3}.$$

In words, if one could measure the color of the state, there would be equal probabilities of it being red-antired, blue-antiblue, or green-antigreen.

Eight gluon colors [edit]

There are eight remaining independent color states, which correspond to the "eight types" or "eight colors" of gluons. Because states can be mixed together as discussed above, there are many ways of presenting these states, which are known as the "color octet". One commonly used list is:[7]

$$\begin{array}{ll} (r\bar{b} + b\bar{r})/\sqrt{2} & -i(r\bar{b} - b\bar{r})/\sqrt{2} \\ (r\bar{g} + g\bar{r})/\sqrt{2} & -i(r\bar{g} - g\bar{r})/\sqrt{2} \\ (b\bar{g} + g\bar{b})/\sqrt{2} & -i(b\bar{g} - g\bar{b})/\sqrt{2} \\ (r\bar{r} - b\bar{b})/\sqrt{2} & (r\bar{r} + b\bar{b} - 2g\bar{g})/\sqrt{6}. \end{array}$$

These are equivalent to the Gell-Mann matrices. The critical feature of these particular eight states is that they are linearly independent, and also independent of the singlet state, hence $3^2 - 1$ or 2^3. There is no way to add any combination of these states to produce any other, and it is also impossible to add them to make $r\bar{r}$, $g\bar{g}$, or $b\bar{b}$ [8] the forbidden singlet state. There are many other possible choices, but all are mathematically equivalent, at least equally complicated, and give the same physical results.

Balancing electric charge and magnetic fields

When an object is electrically neutral, then its +𝕠d potential magnetic fields and -𝕠d kinetic magnetic fields are balanced. That also means their e𝕒 potential electric charge and e𝕪 kinetic electric charge are also balanced, these can be vector subtracted while the magnetic fields are added with positive and negative values. This also balances their +𝕚d gravitational mass and -𝕚d inertial mass, however because the proton is much heavier than the electron this is a +𝕚d gravitational mass overall.

The Micro/Macro Connection

Electrons and protons are the basic charges of ordinary matter. Consequently, the various observations we made in Section 22.1 need to be explained in terms of electrons and protons.

NOTE Electrons and protons are particles of matter. Their motion is governed by Newton's laws. Electrons can move from one object to another when the objects are in contact, but neither electrons nor protons can leap through the air from one object to another. An object does not become charged simply from being close to a charged object.

Charge is represented by the symbol q (or sometimes Q). A macroscopic object, such as a plastic rod, has charge

$$q = N_p e - N_e e = (N_p - N_e)e \qquad (22.1)$$

where N_p and N_e are the number of protons and electrons contained in the object. An object with an equal number of protons and electrons has no *net* charge (i.e., $q = 0$) and is said to be *electrically neutral.*

Charge quantization

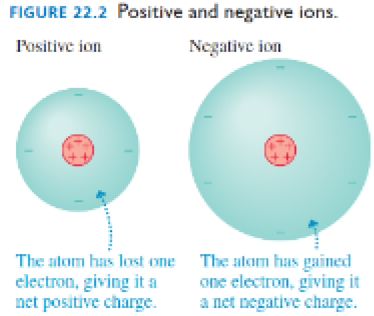
In this model work is quantized rather than charge, it is measured on a charge scale such as with -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work. When electrons are observed this is a E𝕐/-𝕠d kinetic impulse, that is also quantized because of the energy levels the electrons came from. The actual motion of electron particles here is chaotic not quantized. Ions can separate in a solution into positively and negative magnetic fields.

A charged object has an unequal number of protons and electrons. An object is positively charged if $N_p > N_e$. It is negatively charged if $N_p < N_e$. Notice that an object's charge is always an integer multiple of e. That is, the amount of charge on an object varies by small but discrete steps, not continuously. This is called **charge quantization.**

In practice, objects acquire a positive charge not by gaining protons, as you might expect, but by losing electrons. Protons are *extremely* tightly bound within the nucleus and cannot be added to or removed from atoms. Electrons, on the other hand, are bound rather loosely and can be removed without great difficulty. The process of removing an electron from the electron cloud of an atom is called **ionization.** An atom that is missing an electron is called a *positive ion.* Its *net* charge is $q = +e$.

Some atoms can accommodate an *extra* electron and thus become a *negative ion* with net charge $q = -e$. A saltwater solution is a good example. When table salt (the chemical sodium chloride, NaCl) dissolves, it separates into positive sodium ions Na^+ and negative chlorine ions Cl^-. **FIGURE 22.2** shows positive and negative ions.

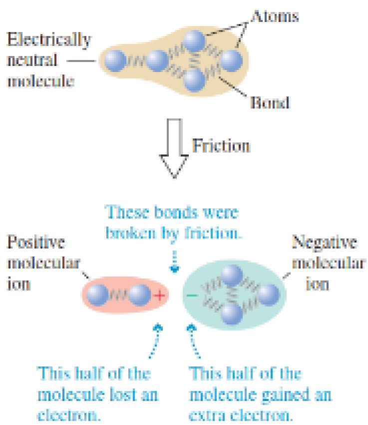
FIGURE 22.2 Positive and negative ions.



Charge conservation

When the rods were rubbed there was a back and forth motion, this is the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. The inertia breaks apart some molecules creating some with excess -𝕠d and e𝕪 Pythagorean Triangles and some with fewer. Charge is conserved because the Pythagorean Triangles are not destroyed.

FIGURE 22.3 Charging by friction usually creates molecular ions as bonds are broken.



All the charging processes we observed in Section 22.1 involved rubbing and friction. The forces of friction cause molecular bonds at the surface to break as the two materials slide past each other. Molecules are electrically neutral, but **FIGURE 22.3** shows that *molecular ions* can be created when one of the bonds in a large molecule is broken. The positive molecular ions remain on one material and the negative ions on the other, so one of the objects being rubbed ends up with a net positive charge and the other with a net negative charge. This is the way in which a plastic rod is charged by rubbing with wool or a comb is charged by passing through your hair.

Charge Conservation and Charge Diagrams

One of the most important discoveries about charge is the **law of conservation of charge:** Charge is neither created nor destroyed. Charge can be transferred from one object to another as electrons and ions move about, but the *total* amount of charge remains constant. For example, charging a plastic rod by rubbing it with wool transfers electrons from the wool to the plastic as the molecular bonds break. The wool is left with a positive charge equal in magnitude but opposite in sign to the negative charge of the rod: $q_{wool} = -q_{plastic}$. The *net* charge remains zero.

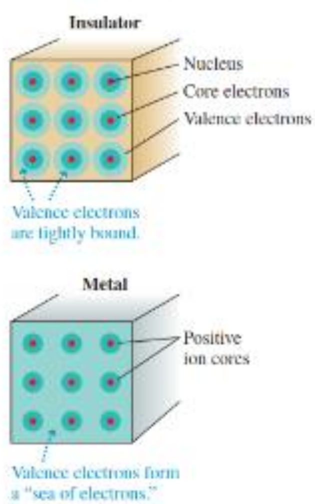
Diagrams are going to be an important tool for understanding and explaining charges and the forces on charged objects. As you begin to use diagrams, it will be important to make explicit use of charge conservation. The net number of plusses and minuses drawn on your diagrams should *not* change as you show them moving around.

Insulators and conductors

In an insulator the +𝕠d and e𝕒 Pythagorean Triangles as proton are more dominant, there is a reaction against -𝕠d and e𝕪 Pythagorean Triangle electrons moving. In a conductor some electrons are more weakly bound, this enables them to leave the atoms and to act as particles.

22.3 Insulators and Conductors

FIGURE 22.4 A microscopic look at insulators and conductors.



You have seen that there are two classes of materials as defined by their electrical properties: insulators and conductors. **FIGURE 22.4** looks inside an insulator and a metallic conductor. The electrons in the insulator are all tightly bound to the positive nuclei and not free to move around. Charging an insulator by friction leaves patches of molecular ions on the surface, but these patches are immobile.

In metals, the outer atomic electrons (called the *valence electrons* in chemistry) are only weakly bound to the nuclei. As the atoms come together to form a solid, these outer electrons become detached from their parent nuclei and are free to wander about through the entire solid. The solid *as a whole* remains electrically neutral, because we have not added or removed any electrons, but the electrons are now rather like a negatively charged gas or liquid—what physicists like to call a **sea of electrons**—permeating an array of positively charged **ion cores.**

The primary consequence of this structure is that electrons in a metal are highly mobile. They can quickly and easily move through the metal in response to electric forces. The motion of charges through a material is what we will later call a **current,** and the charges that physically move are called the **charge carriers.** The charge carriers in metals are electrons.

Metals aren't the only conductors. Ionic solutions, such as salt water, are also good conductors. But the charge carriers in an ionic solution are the ions, not electrons. We'll focus on metallic conductors because of their importance in applications of electricity.

Insulating rods and electrons

When the rod is an insulator the excess -𝕠d and e𝕪 Pythagorean Triangles cannot go into the molecular orbitals. This causes the electrons to remain as particles with a E𝕐/-𝕠d kinetic impulse.

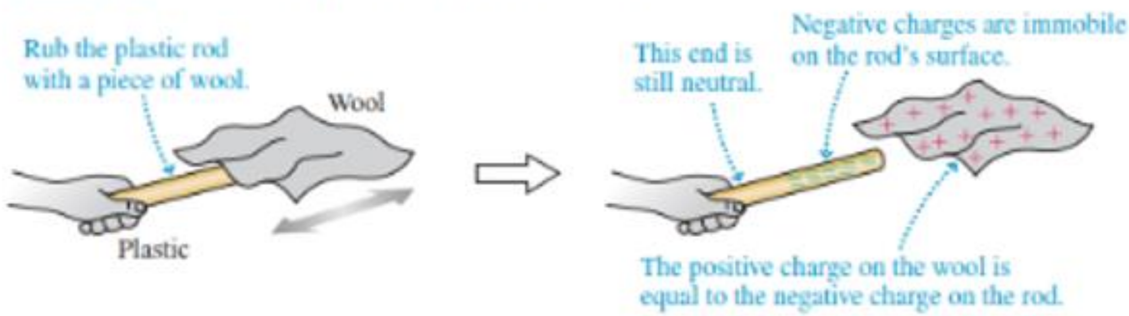
Electrostatic equilibrium

If there are no external forces on the electrons there is approximately no -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work being done. Also there is approximately no E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. The molecules themselves still have all these forces. The excess electrons move to the outside of a conductors, this is because they cannot become part of the molecular bonds doing -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work.

Charging

Insulators are often charged by rubbing. The charge diagrams of FIGURE 22.5 show that the charges on the rod are on the surface and that charge is conserved. The charge can be transferred to another object upon contact, but it doesn't move around on the rod.

FIGURE 22.5 An insulating rod is charged by rubbing.



Metals usually cannot be charged by rubbing, but Experiment 9 showed that a metal sphere can be charged by contact with a charged plastic rod. FIGURE 22.6 gives a pictorial explanation. An essential idea is that **the electrons in a conductor are free to move.** Once charge is transferred to the metal, repulsive forces between the negative charges cause the electrons to move apart from each other.

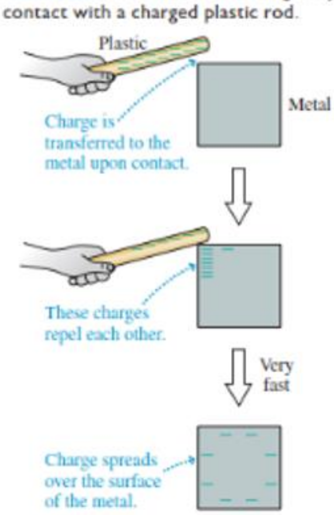
Note that the newly added electrons do not themselves need to move to the far corners of the metal. Because of the repulsive forces, the newcomers simply "shove" the entire electron sea a little to the side. The electron sea takes an extremely short time to adjust itself to the presence of the added charge, typically less than 10^{-9} s. For all practical purposes, a conductor responds *instantaneously* to the addition or removal of charge.

Other than this very brief interval during which the electron sea is adjusting, the charges in an *isolated* conductor are in static equilibrium. That is, the charges are at rest (i.e., static) and there is no net force on any charge. This condition is called **electrostatic equilibrium.** If there *were* a net force on one of the charges, it would quickly move to an equilibrium point at which the force was zero.

Electrostatic equilibrium has an important consequence:

In an isolated conductor, any excess charge is located on the surface of the conductor.

FIGURE 22.6 A conductor is charged by contact with a charged plastic rod.



Discharging electrons

The electrons tend to repel each other, that causes them to spread out. This happens because they do -𝕆D×e𝕪 kinetic work on each other, this forms quantized levels between them where e𝕪×-𝕘d photons are exchanged. Because they are outside the atom these electrons move with a E𝕐/-𝕠d kinetic impulse, the e𝕪×-𝕘d photons push them apart so they act more like particles. In between the

-𝕆D kinetic probabilities destructively interfere, this makes the electrons less likely to be found close together.

Discharging

The human body consists largely of salt water. Pure water is not a terribly good conductor, but salt water, with its Na^+ and Cl^- ions, is. Consequently, and occasionally tragically, humans are reasonably good conductors. This fact allows us to understand how it is that *touching* a charged object discharges it, as we observed in Experiment 10. As **FIGURE 22.9** shows, the net effect of touching a charged metal is that it and the conducting human together become a much larger conductor than the metal alone. Any excess charge that was initially confined to the metal can now spread over the larger metal + human conductor. This may not entirely discharge the metal, but in typical circumstances, where the human is much larger than the metal, the residual charge remaining on the metal is much reduced from the original charge. The metal, for most practical purposes, is discharged. In essence, two conductors in contact "share" the charge that was originally on just one of them.

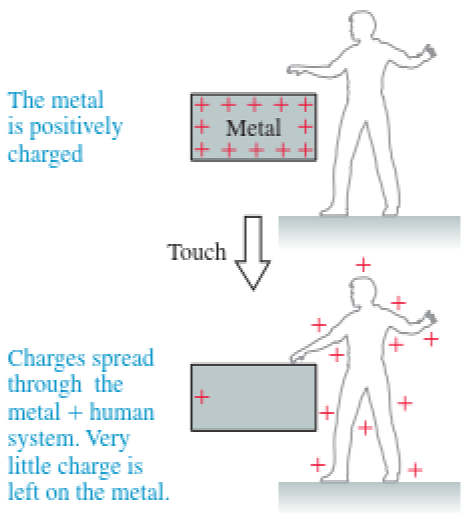
Moist air is a conductor, although a rather poor one. Charged objects in air slowly lose their charge as the object shares its charge with the air. The earth itself is a giant conductor because of its water, moist soil, and a variety of ions. Any object that is physically connected to the earth through a conductor is said to be **grounded.** The effect of being grounded is that the object shares any excess charge it has with the entire earth! But the earth is so enormous that any conductor attached to the earth will be completely discharged.

The purpose of *grounding* objects, such as circuits and appliances, is to prevent the buildup of any charge on the objects. The third prong on appliances and electronics that have a three-prong plug is the ground connection. The building wiring physically connects that third wire deep into the ground somewhere just outside the building, often by attaching it to a metal water pipe that goes underground.

Electrons spreading with impulse

Here the metal has a deficit of electrons, because of this the -𝕠d and e𝕪 Pythagorean Triangle electrons move with a E𝕐/-𝕠d kinetic impulse colliding with each other. That also causes them to spread out more evenly in the metal and body.

FIGURE 22.9 Touching a charged metal discharges it.



Electrons more likely to be near the rod

Here the -𝕠d and e𝕪 Pythagorean Triangle electrons have a greater -𝕆D kinetic probability of being closer to the rod. This is because the rid has a deficit of electrons and orbitals that can absorb electrons. It is more -𝕆D kinetically probable for the electrons to be absorbed, and more probable for them to move closer to the atoms. That causes the deficit of electrons to spread out.

Protons as spinning tops

The +𝕠d and e𝕒 Pythagorean Triangles as protons react against a change, they also can be represented by spinning tops. As with electrons it is like two clockwise spinning tops coming into contact, they do -𝕆D×e𝕪 kinetic work on each other. This gives a destructive interference between them as a -𝕆D kinetic probability and a -𝕀D inertial probability, that moves them apart. The atoms also act like particles with a E𝕐/-𝕠d kinetic impulse and an E𝕍/-𝕚d inertial impulse, these collisions move them apart.

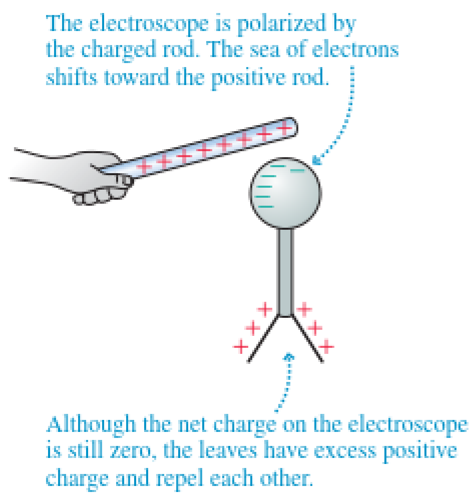
Proton probability and repulsion

When the protons are closer together there is a destructive interference between them as a +𝕆D potential probability. This makes it less likely for the protons to be close to each other, like the electrons this moves them further apart.

Iota spin and repulsion

The protons in this model spin with a vertical axis, their +𝕠d potential spin is in the same direction for example counterclockwise. The electrons also act like a rolling wheel, their axis is orthogonal to the proton so they approach each other like tops on their sides. The -𝕆D kinetic destructive interference between them pushes them apart like two wheels on a frictionless surface colliding then rebounding. Neutrinos in this model also act like spinning wheels, here the 𝕠d neutrino axis points in the direction of motion. That would not cause the 𝕆D neutrino probability to destructively interfere so they would not repel each other.

FIGURE 22.10 A charged rod held close to an electroscope causes the leaves to repel each other.



Electrons more likely to move to the rod

Here the -𝕠d and e𝕪 Pythagorean Triangle electrons are attracted to the rod's deficit of electrons. This makes the electrons act more like waves, their -𝕆D×e𝕪 kinetic work is more likely to be absorbed into the electrons as the e𝕪 distance decreases and -𝕆D increases as a square. That causes the electrons in the metal to move closer to the rod, more electrons have left the atom so they can move as particles with a E𝕐/-𝕠d kinetic impulse.

A current flow as impulse

When electrons flow in a metal this is a current as a e𝕪/-𝕠d kinetic velocity. They do this by colliding with each other, that pushes others more in the direction of the current. Because particles move with impulse this is a derivative slope of the -𝕠d and e𝕪 Pythagorean Triangle. That gives a fraction as a current, when they move with work this is a field as -𝕠d×e𝕪 like the area of the Pythagorean Triangle.

Electrons move as a wave with voltage

Some electrons also move as waves because a wire connecting a battery has a +𝕆D potential difference or voltage and a -𝕆D kinetic difference or voltage between the terminals. These electrons then have a greater -𝕆D kinetic probability of being absorbed into the positive ions with a deficit of electrons. The -𝕆D kinetic difference comes from the negative terminal, this does -𝕆D×e𝕪 kinetic work on the electrons near it in the wire.

The negative terminal does work on the electrons

As with two electrons they do -𝕆D×e𝕪 kinetic work on each other as well, the -𝕆D destructive interference makes it less likely for the electrons to remain near each other and near the -𝕆D kinetic difference of the terminal. This also moves the electrons in the current, they act as particles and waves in this model. This voltage is not the same as pressure from a e𝕪/-𝕠d kinetic current, that comes from the E𝕐/-𝕠d kinetic impulse. Instead voltage comes from an increased -𝕆D kinetic probability of where the electrons will be measured.

Charge Polarization

One observation from Section 22.1 still needs an explanation. How do charged objects exert an attractive force on a *neutral* object? To begin answering this question, FIGURE 22.10 shows a positively charged rod held close to—but not touching—a *neutral* electroscope. The leaves move apart and stay apart as long as you hold the rod near, but they quickly collapse when it is removed.

The charged rod doesn't touch the electroscope, so no charge is added or removed. Instead, the metal's sea of electrons is attracted to the positive rod and shifts slightly to create an excess of negative charge on the side near the rod. The far side of the electroscope now has a deficit of electrons—an excess positive charge. We say that

Electrons are more likely to be near atoms

In this model most of the electrons have already been absorbed into atoms, some in the metal are in free space and act like particles with a E𝕐/-𝕠d kinetic impulse. They are also attracted to atoms in the metal, to be absorbed with -𝕆D×e𝕪 kinetic work while causing other electrons to be emitted and becomes particles. The electrons are then more likely to be near atoms from their -𝕆D kinetic probability. When the electrons move this is as particles with a E𝕐/-𝕠d kinetic impulse, that causes them to collide with each other giving a drift e𝕧/-𝕚d inertial velocity as a derivative slope.

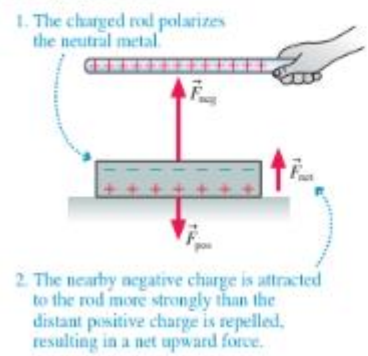
the electroscope has been *polarized*. **Charge polarization** is a slight separation of the positive and negative charges in a neutral object. Because there's no net charge, the electron sea quickly readjusts when the rod is removed.

Why don't *all* the electrons rush to the side near the positive charge? Once the electron sea shifts slightly, the stationary positive ions begin to exert a force, a restoring force, pulling the electrons back to the right. The equilibrium position for the sea of electrons shifts just enough that the forces due to the external charge and the positive ions are in balance. In practice, the displacement of the electron sea is usually *less than* 10^{-15} *m*!

Charge polarization is the key to understanding how a charged object exerts an attractive force on a neutral object. FIGURE 22.11 shows a positively charged rod near a neutral piece of metal. Because the electric force decreases with distance, **the attractive force on the electrons at the top surface is slightly greater than the repulsive force on the ions at the bottom.** The net force toward the charged rod is called a **polarization force.** The polarization force arises because the charges in the metal are separated, *not* because the rod and metal are oppositely charged.

A negatively charged rod would push the electron sea slightly away, polarizing the metal to have a positive upper surface charge and a negative lower surface charge. Once again, these are the conditions for the charge to exert a *net attractive force* on the metal. Thus our charge model explains how a charged object of *either* sign attracts neutral pieces of metal.

FIGURE 22.11 The polarization force on a neutral piece of metal is due to the slight charge separation.



Electrons more likely to share between atoms

In this model the electrons in an atom do -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work as waves. They also have a -𝕆D kinetic probability of being near other atoms. That causes atoms to combine in molecules and solids. When these -𝕆D kinetic probabilities are weaker, this forms a liquid. A solid can become a liquid as the e𝕪 temperature increases, because e𝕪 is larger then the -𝕆D kinetic probability decreases as a square. That cause the electrons to be less dense around atoms breaking some molecular bonds.

Less magnetism to the side of a magnet

When the electron spins align with each other in a magnet they destructively interfere. This causes the -𝕆D×e𝕪 kinetic work to attract fewer electrons to the side of a magnet instead of the poles. As the -𝕠d kinetic axles of the electrons line up in parallel there is a constructive interference in the direction of the poles. That causes the electrons to have a stronger +𝕠d kinetic magnetic field together and to do more -𝕆D×e𝕪 kinetic work on other electrons in iron for example.

Magnetizing iron

When the magnet approaches the iron the electrons also tend to spin in parallel, that turns the iron into a magnet. The electrons are spinning in the same direction, for example clockwise compared to the electrons above and below it. That makes it more likely for the electrons to magnetically attract each other, and to attract another magnet. The -𝕆D kinetic probability constructively interferes when the e𝕧 length is pointing between the poles. This increased probability also makes it more likely the other magnet will be near the first magnet, that causes them to be attracted to each other.

Like magnetic poles repel

This happens with a north pole to south pole interactions between magnets. When two north poles, or two south poles, approach each other there is destructive interference. This is like two tops with opposing spins, the north pole might appear to be spinning clockwise for example looking into the magnet. The second magnet also appears to be spinning clockwise looking into it, when brought together the first magnet measures the second as having the opposing spin.

This destructively interferes, the -𝕆D kinetic probability means they are less likely to be near each other and so the magnets repel. This is the same as two electrons approaching each other in free space, their spins are the same say clockwise. Like two tops the same spin is opposed between them, the destructive interference causes them to be less likely to be near each other and so they move apart.

Diamagnetism

Some materials like aluminum are diamagnetic, the electrons are more tightly held in the orbitals. Because of this some cannot reorient themselves to the same spin direction as in a magnet. The opposing spins between alumium and iron means that the iron is less likely to be near the aluminum with a destructive interference. That causes the iron and aluminum to repel each other.

Magnetizing metal and current

A similar process happens with ions, negative ions repel each other because the -𝕆D kinetic probability destructively interferes. If the material can be magnetized, then the ions might come together even when charged. This would be like a magnet with a negative charge for example. An iron wire might be magnetized and still carry a current of electrons as particles, some electrons also remain in the iron atoms and line up with a constructive interference on each other.

Electric charge is separate from magnetism

This is why electric charge does not occur along with a metal being magnetized. Some of the electrons remain in the atoms and give a constructive interference with the magnetism. Others can move in a current, their spins might be aligned with the magnet but they can still be attracted to a

+𝕆D potential difference of a battery connected to the iron wire. Being free electrons, they are also more likely to be absorbed into atoms where the positive battery terminal has a +𝕆D potential difference.

Positive ions repel

With positive ions they also destructively interfere when closer to each other. This increases as the e𝕒 altitude decreases between them, the +𝕆D potential probability increases as a square. That makes it less likely they will stay close to each other and so positive ions, like negative ions, repel each other.

The weak force

In this model protons tend to move apart from each other unless they are in the nucleus. This is from the same destructive interference between them. When a neutron decays, the electron moves up to the ground state level as α or $e^{-𝕠d}$. If many neutrons are decaying then their protons will destructively interfere and repel each other, also their electrons will repel each other.

The strong force

In this model gluons bind protons and neutrons together in the nucleus. This happens because the +𝕠2/3 up quark and -𝕠1/3 down quark have a difference of 1. That acts like a boson, the proton has one -𝕠1/3 down quark which is attracted to the +𝕠2/3 up quark of another proton or neutron. This is a constructive interference, they then do +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work on each other like a proton would do to an electron in a Hydrogen atom.

Potential and gravitational impulse

In this model there is a balance of the +𝕆D potential probability repelling protons from each other, and a Eℍ/+𝕚d gravitational impulse pulling them together. This would also act as a Eℍ/+𝕚d gravitational impulse pulling the protons together, and a E𝔸/+𝕠d potential impulse as the protons collide together and tend to separate. When they get too close there would be a +𝕀D gravitational destructive interference, this makes it less gravitationally probable for the protons to have too close a reduced e𝕙 height between them.

Kinetic and inertial interference

There would also be a -𝕀D inertial probability between the -𝕠1/3 down quarks, the inertial interference between them would make the quarks move away from each other faster along with their -𝕆D kinetic destructive interference. When the e𝕧 length between them increased the E𝕍/-𝕚d inertial impulse would be stronger, then the -𝕠1/3 down quarks would react more against this repulsive gravitational interference.

Separating quarks

This could appear as the force needed getting stronger as quarks are separated. When they are closer together an +𝕠2/3 up quark and a -𝕠1/3 down quark have this gravitational and inertial interference with other quarks. That makes it easier to pull a quark apart from the others, as this e𝕙 height and e𝕧 length increases it becomes more of a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. This causes the constructive interference between the up quark and down quark to increase, the destructive interference would be reducing as a square from +𝕀D and -𝕀D.

Quarks remaining separate in the nucleus

The +𝕀D gravitational interference and -𝕀D inertial interference would happen at much closer e𝕙 heights and e𝕧 lengths than the Roy electromagnetic interactions in an atom. That would make the quarks more like separate iotas in the nucleus. The interference prevents them getting too close, the E𝕙/+𝕚d gravitational impulse prevents them getting too far apart.

Black holes and gravitational interference

In this model that also prevents black holes from collapsing. The matter around them has a +𝕀D gravitational and -𝕀D inertial interference. That acts like an anti-gravity effect holding back the matter, also its reduced inertia allows it to move more quickly. Here black holes can only form in galaxies, that is because the increased +𝕀D×e𝕙 gravitational work done there has a stronger +𝕀D gravitational probability towards the center. That causes a smaller black hole, like the repulsion in between quarks, to expand to a larger event horizon.

Gluons as work and impulse

Also the gluon interactions as ±1 would occur both in Roy electromagnetism and proportionally Biv space-time. When the quarks get too close this gluon interaction becomes destructive interference as work. When they get too far apart it act like particles with impulse.

Electrons approaching an atom

This can also be regarded as being like Roy electromagnetic impulse and work, when an electron approaches an atom. In free space the electrons move with a E𝕐/-𝕠d kinetic impulse, they can collide with atoms and bounce off. This is like the Compton effect with e𝕪/-𝕘d photons colliding with a e𝕐/-𝕘d light impulse onto electrons in atoms. When the electrons get closer they increasingly interact with -𝕆D×e𝕪 kinetic work perhaps being absorbed with a -𝕆D kinetic probability.

Quarks with work and impulse

With quarks they can attract each other with a E𝕐/-𝕠d kinetic impulse and a E𝔸/+𝕠d potential impulse, the -𝕠d kinetic time moves forward and the +𝕠d potential time moves backwards. When they get closer this becomes -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work, then there is a destructive interference keeping them from getting too close.

Gluon combinations

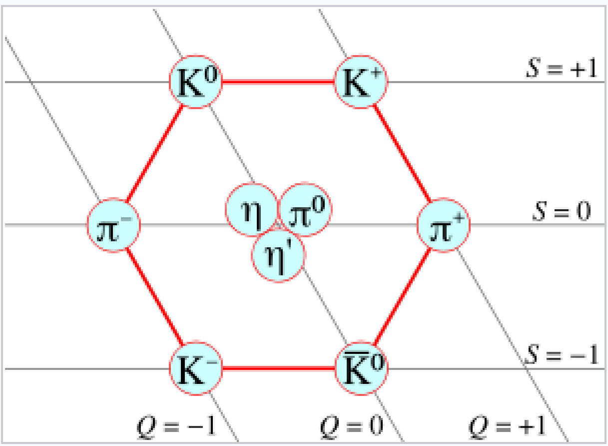
Taking the -𝕠1/3 down quark, this can also refer to the same charge of the gluon, it can be +𝕠1/3 and -𝕠1/3. There would be one of each, +𝕠r1/3 would be red and -𝕠r1/3 would be antired, +𝕠b1/3 would be blue and -𝕠b1/3 antiblue, +𝕠g1/3 would be green and -𝕠g1/3 would be antigreen. These can add up to 1 as a boson, each can be squared to give work. Then there can be +𝕠r1/3 and -𝕠g1/3 for example where two colors are mixed. Because each quark has a spin of ½ from the Pythagorean Triangle two together make a boson. This is like two electrons paired in a Helium atom as a boson, the spins are opposed. The photon is also a boson because it has no ½ spin, instead it is the difference between two ½ spin electrons in different orbitals. That gives it a spin of 1.

Other gluon combinations

There can also be another set of gluons, these would act as fields because the two acts as a square. There would be +𝕠b2/3 and -𝕠g2/3 for example as a combination of blue and antigreen. This allows for 1 to add up as a probability of between an up quark and down quark, also with the other three generations.

A nonet

Here the mesons can be arranged into a nonet, the pions use +𝕠2/3 and +𝕠1/3 as 1, also -𝕠2/3 and -𝕠1/3 as 1. The K^+ Kaon is +𝕠2/3 as an up quark and +𝕠1/3 as antistrange, in this model strange would be the next higher generation of quark. This is reached by the ±1 difference between quark pairs in the Koide formula, there is +𝕠2/3 as the up quark and -𝕠1/3 as the down quark to give ±1 as a gluon. Because this has a positive or negative sign it comes from spin not straight Pythagorean Triangles sides. Then to make the strange quark there is another ±1 gluon between +𝕠2/3 and -𝕠1/3. The K^0 Kaon has a -𝕠1/3 down quark and a +𝕠1/3 antistrange quark making it neutral.



Combinations of one u, d, or s quark and one u, d, or s antiquark in $J^P = 0^-$ configuration form a nonet.

Pions

In this model the pions also act as ±1, the π^+ has +𝕠2/3 and +𝕠1/3 to give a total of +𝕠d with d=1. The π^- is -𝕠2/3 and -𝕠1/3 as -𝕠d with d=1. The ratio of the pion mass to the proton is ≈ 1/(√2π) as β, this acts like a tine in chaos that approaches a quantized level related to α. This causes the pion to mediate the strong force as a tine or quantized distance between protons and neutrons.

The exact u and d quark composition determines the charge, because u quarks carry charge $+\frac{2}{3}$ whereas d quarks carry charge $-\frac{1}{3}$. For example, the three pions all have different charges

- $\pi^+ = (u\,\bar{d})$
- π^0 = a quantum superposition of $(u\,\bar{u})$ and $(d\,\bar{d})$ states
- $\pi^- = (d\,\bar{u})$

Neutral mesons

The complete table of flavored mesons uses the ±1 boson difference between +𝕠2/3 and -𝕠1/3, or -𝕠2/3 and +𝕠1/3. The neutral mesons use a quark and antiquark of different generations such as T^0 for +𝕠2/3 as a top quark and -𝕠2/3 as an antiup quark. A $B^0{}_s$ would be a -𝕠1/3 strange quark and a +𝕠1/3 antibottom quark.

Meson quantization

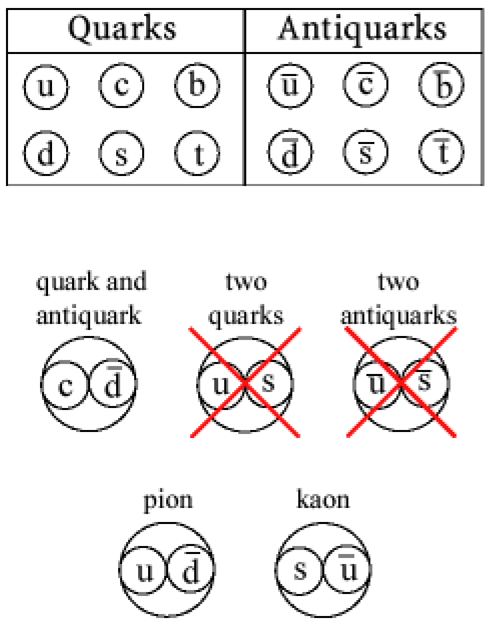
This gives an attraction between the quarks like with the gluons, the +𝕠d and -𝕠d Pythagorean Triangle sides add together when work is done giving a force. It is a kind of quantization where each possible addition gives a probability of the mesons being measured. When this is ±1 it is a whole number, that can act as a field or integral in this model instead of a derivative fraction as impulse. The neutral mesons can also do work because they do not add to a fraction. When they are observed as particles they decay in a time with impulse.

Nomenclature of flavoured mesons

Quark	Antiquark					
	up	down	charm	strange	top	bottom
up	—	[i]	$\overline{D}^0$	K^+	$\overline{T}^0$	B^+
down	[i]	—	D^-	K^0	T^-	B^0
charm	D^0	D^+	—	D_s^+	$\overline{T}_c^0$	B_c^+
strange	K^-	$\overline{K}^0$	D_s^-	—	T_s^-	B_s^0
top	T^0	T^+	T_c^0	T_s^+	—	T_b^+
bottom	B^-	$\overline{B}^0$	B_c^-	$\overline{B}_s^0$	T_b^-	—

Not two quarks or antiquarks together in a meson

It is not possible to have two quarks such as an up and a strange, this would be +𝕠2/3 and +𝕠2/3. The two would have a destructive interference between them according to this model. That would mean they were less likely to be measured together.



Physicist believe there are six quarks - up (u), down (d), charm (c), strange (s), top (t), and bottom (b) and their antiquarks - antiup, antidown, anticharm, antistrange, antibottom, and antitop. Antiquarks are labeled with a letter with a bar over it.

Each meson consists of one quarks and one antiquark represented by small circles within the larger circle. Quarks are labeled with a letter. A meson cannot be made of two quarks or two antiquarks.

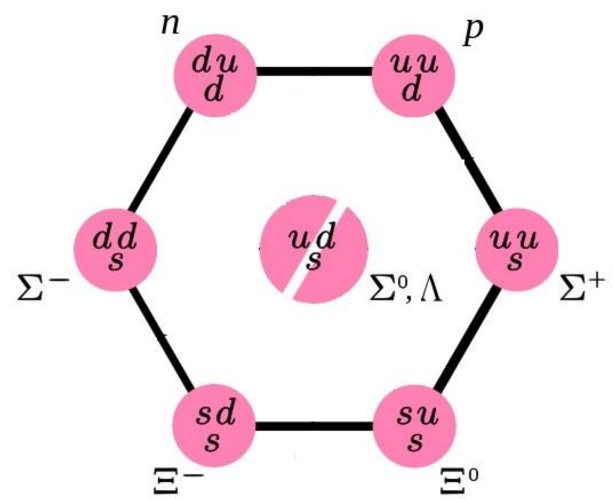
Examples of mesons are the pion and the kaon.

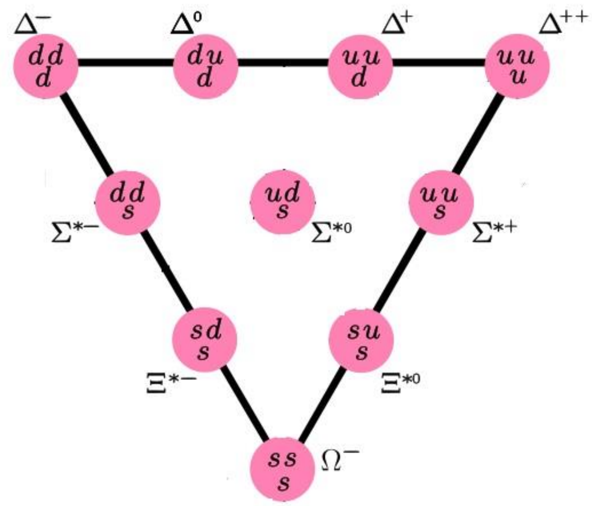
Gluons as quantization levels between quark changes

In this model three quarks together must also add to give ±1 or 0, this is again a quantization from work. The generations increase by a torque on a Pythagorean Triangle, going from a red to a blue Pythagorean Triangle for example would be an orthogonal twist similar to in octonions. Then a third torque would change it from a green Pythagorean Triangle to a blue Pythagorean Triangle.

A quantized change leads to a torque

This happens by increments of ±1 like with electron orbitals, as the +𝕠2/3 up quark becomes a -𝕠1/3 down quark there is a quantized increase of 1 as gluon work. Then a second change to a +𝕠2/3 charm quark is also +1 as a gluon, the torque from the red Pythagorean Triangle to the blue Pythagorean Triangle needed for this becomes an increase in +𝕚d gravitational and -𝕚d inertial mass alternately. That is in the Koide formula, this gravitational and inertial torque adds up as increasing masses. This can also happen in electron orbitals, such as when a circular orbital changes to an elliptical orbital.





The W boson

In this model the W^- boson is -1 as another quantization level, as the neutron changes into a proton this is emitted as an -𝕠d and e𝕪 Pythagorean Triangle electron and a 𝕠d and 𝕞 Pythagorean Triangle neutrino. Here the neutron begins with 3 different spins, +𝕠d as potential spin, -𝕠d as kinetic spin, and 𝕠d as neutrino spin. These are orthogonal to each other as three degrees of freedom. The neutron becomes the proton and loses two orthogonal spins, they become the W^- boson. This then decays to two separate spins as -𝕠d and 𝕠d.

A boson in between two half spins

Here the +𝕠2/3 up and -𝕠1/3 strange quarks also have 1 between them, this is a boson because +𝕠2/3 and -𝕠1/3 both come from a spin Pythagorean Triangle side. Because of this the difference has no ½ spin, this is like the e𝕪×-𝕘d photon which is in between two half spin -𝕠d electrons. They are half spin because this spin can be clockwise or counterclockwise. Two electrons can act like a boson because the difference in the spins is quantized as 1, this is between two half spins.

The positron as +α

The W^- boson below can decay into an -𝕠d and e𝕪 Pythagorean Triangle electron, this is -1 because in the ground state $e^{-𝕠d}$ has d=1. That leaves an additional half spin that must be conserved, this becomes the neutrino. Here α can be referred to as -α because its exponent is negative, then the positron is +α. With the +𝕚d gravitational mass +α becomes a tan as e𝕙/+𝕚d as a positron +𝕚d gravitational mass, -α is e𝕙/-𝕚d as an electron's inertial mass.

The W^- as other quantization values

The +𝕠2/3 up and -𝕠1/3 strange quarks can also decay with the W^- boson as another quantization level, they become the -𝕠1/3 and -𝕠2/3 antiup quark. This is also 1 as a quantization value. In between +𝕠2/3 as strange and -𝕠1/3 as charm there is another quantization level, that can be any of the three generations of electron, muon, and τ electron. Each has a -𝕠d value of d=1, that leaves 𝕠d as the electron neutrino, the muon neutrino, and the τ neutrino. From a +𝕠2/3 charm and dq1 antibottom quark it can also decay into a -𝕠1/3 down and a -𝕠2/3 antiup quark as another quantization level.

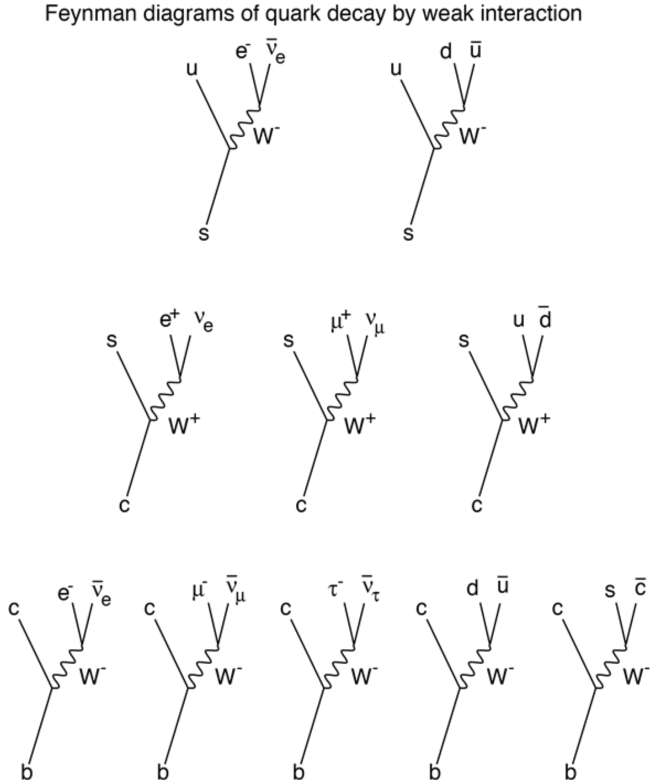
The W$^+$ boson's quantization values

The W$^+$ boson below is between charm as +𝕠2/3 and strange as -𝕠1/3, as a quantized boson this can also decay into a positron which has a value of 1 in $e^{+𝕠d}$. That leaves no additional value of d outside the quantization value, this is the neutrino. Rotating the neutrino with a -𝕆D kinetic torque of 1 can turn it into an electron.

Isospin is not used

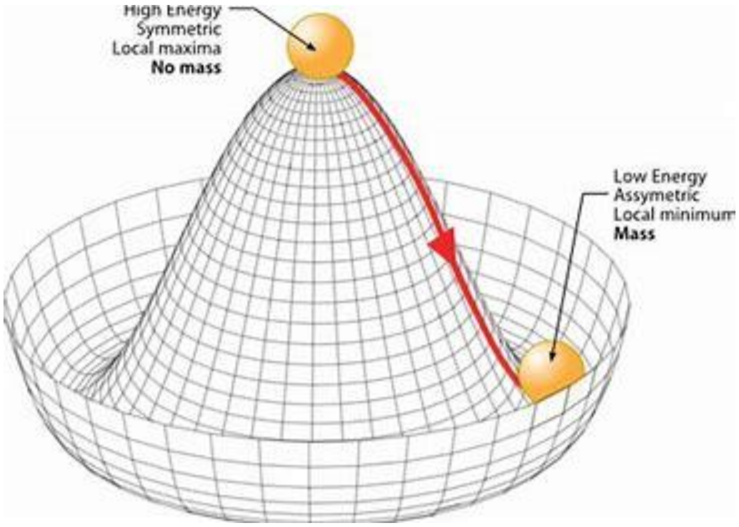
In between strange and charm there is +𝕠2/3 and -𝕠1/3, this is 1 as another quantization value. It can decay into an +𝕠2/3 up quark and +𝕠1/3 which is also a quantized value. In this model there is no need for isospin, the same Roy electromagnetic spins are used.

Feynman diagrams of quark decay by weak interaction



Electron to the ground state

In this model the nucleus contains both a +𝕚d gravitational mass and a -𝕚d inertial mass. This is from the +𝕚2/3 up quark for example as its gravitational mass, the -𝕚1/3 down quark has an inertial mass. That makes it a quantized boson in between two half spins. When the electron is emitted with the decay of the neutron, that has a -𝕚d inertial mass with d=1. Inside the nucleus the +𝕚d and -𝕚d quarks are held together with quantized values as gluons and meson of ±1. The electron is emitted as a quantized value of -𝕚d of -1, this now has an inertial mass.



Different quantization levels

In this diagram the W^+ boson comes from a +𝕠2/3 and -𝕠2/3 or a -𝕠1/3 and a +𝕠1/3. This can form an electron with a -𝕠1 kinetic magnetic field, and a neutrino with 𝕠d. The differences between +𝕠d and -𝕠d can be added with photons as a difference like between positrons and electrons. Because this difference comes from the e𝕧 length between quarks, the additional -𝕆D×e𝕪 kinetic work and positronic +𝕆D×e𝕪 kinetic work can allow for the probabilities of these decay products to occur. This is like different electrons in an atom changing orbitals so that e𝕪×-𝕘d photons emitted have different -𝕘d rotational frequencies.

Probabilities give decay products

Because these are probabilities, the different ways for these quantized bosons to decay can be more or less likely. That gives the different percentages of each. These are also jets at different angles because they do different work, a more direct collision would do more work and so the probabilities of the decay products would change.

Speculative quantized interactions

Many of these interactions are speculative. The point here is the quantization values between +𝕠d and -𝕠d. Many of these are ±1, some are a fraction similar to comparing circular and elliptical orbitals in an atom. This is allowed because an elliptical orbital can have an energy value in between the circular orbitals as a fraction. Here the fractional +𝕠2/3 and -𝕠1/3, or -𝕠2/3 and +𝕠1/3, can fit with the 1 values of bosons between them. The h value as -𝕠d ×e𝕐/-𝕠d or +𝕠d × e𝔸/+𝕠d would be observing these differences in forming particles from work.

Three orthogonal Pythagorean Triangles

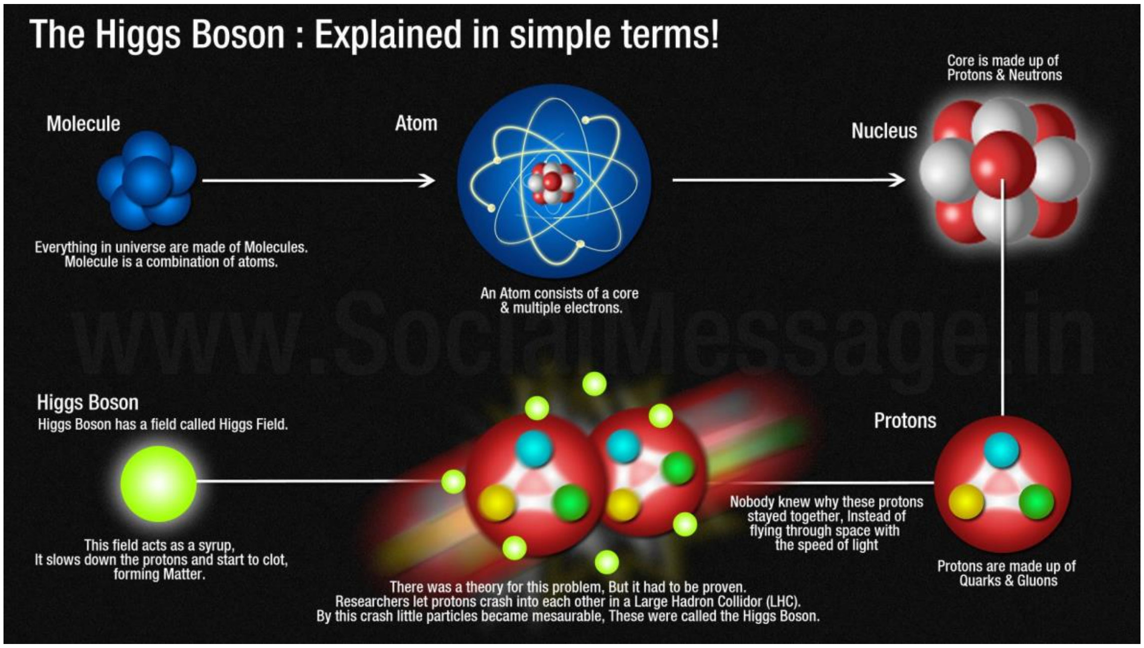
These quantized values would form because three orthogonal Pythagorean Triangles can connect to each other. This can happen as +𝕠d and e𝕒 Pythagorean Triangles and -𝕠d and e𝕪 Pythagorean Triangles in the nucleus with +𝕠d and -𝕠d values. The proton is referred to as +𝕠d and e𝕒 Pythagorean Triangles here because the positive values are larger than the negative ones.

More possible bosons with fractional spin

This model of quarks and gluons is similar to between protons and electron, the difference is the fractional values giving more possible bosons than the e𝕪×-𝕘d photon. These have a +𝕚d gravitational mass and a -𝕚d inertial mass combined, the e𝕪×-𝕘d photon has no inertial mass itself except as a difference between electrons and their -𝕚d inertial mass. This causes the photon to collide or be absorbed with a proportional change in inertial masses.

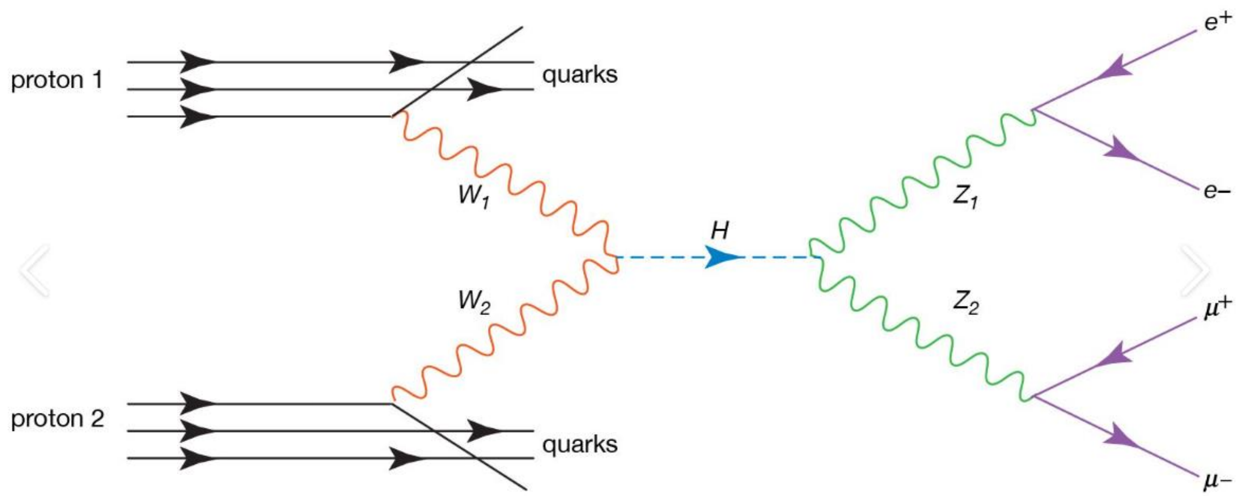
The Higgs field

Here the Higgs field would come from the +𝕚d gravitational fields and the -𝕚d inertial fields. These interact proportionally in the nucleus with gluons, there would be +𝕚2/3 and -𝕚1/3 in Biv space-time giving these quarks mass. The Higgs boson can decay from these as well as from +𝕠2/3 and -𝕠1/3. There are quantized values between these fractions that give bosons, the Higgs boson has a spin 0 and would be where one iota has its Pythagorean Triangle flipped.



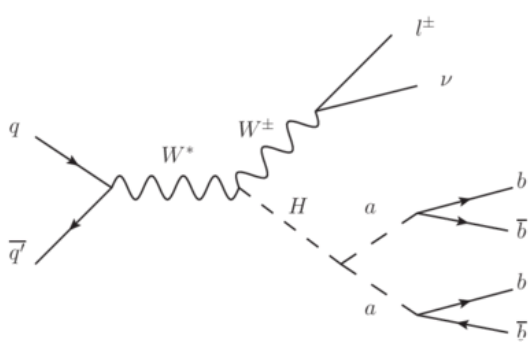
Two protons forming the Higgs boson

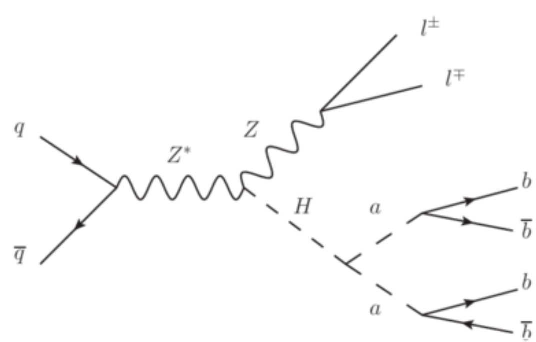
Here the W bosons come from two separate protons, with opposing spins they can form the Higgs boson with spin 0. That decays into two Z bosons each, can decay into the difference between a +𝕠d positron and a -𝕠d electron.



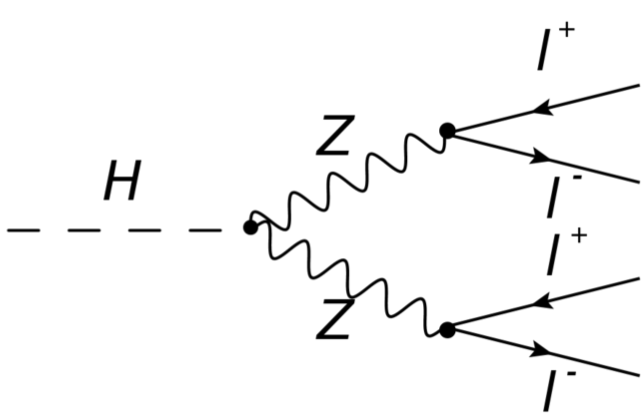
Higgs decay

Here the Higgs decays into two pairs of leptons. These are also probabilities so work is being done. This process would be the fusion of two bosons into a spin 0 iota, instead of the boson having a spin 1 between two spin ½ iotas. This might occur when the pair of bosons or quarks have their spins opposed, then there would be a quantized value of 1 but the opposed spins are different to the Z boson. If one of these has its spin opposed then it would have been flipped over, as an asymmetric Pythagorean Triangle. Because of this there is an additional quantized value in torque, this is conserved in the production of the Higgs boson.

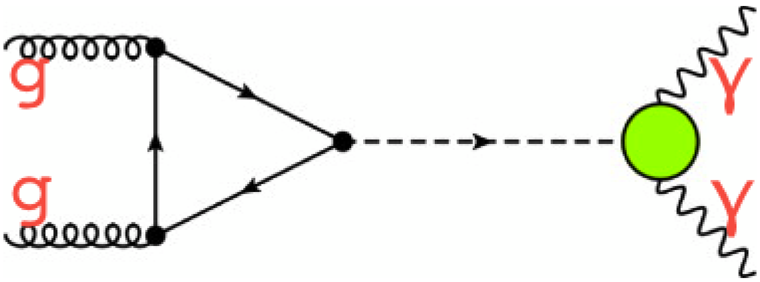




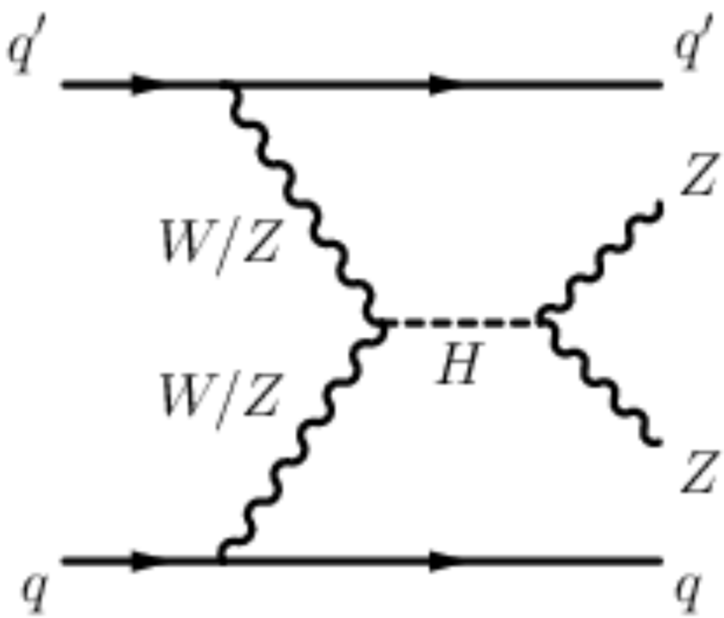
Here a Higgs boson decays into two Z bosons, then two pairs of +𝟘1 and -𝟘1 leptons.



Here a Higgs is formed by a fusion of two gluons, each would have a quantized value of 1. This forms e𝕪×-𝕘d photons as the difference in the gluons becomes a difference between +𝕠d and -𝕠d as a proton and electron with photons. It could also be the difference between a +𝕠d positron and -𝕠d electron also decaying into e𝕪×-𝕘d photons. The gluons here may also have their spin opposed to form a Higgs boson of spin 0, then this emits e𝕪×-𝕘d photons each other spin 1.

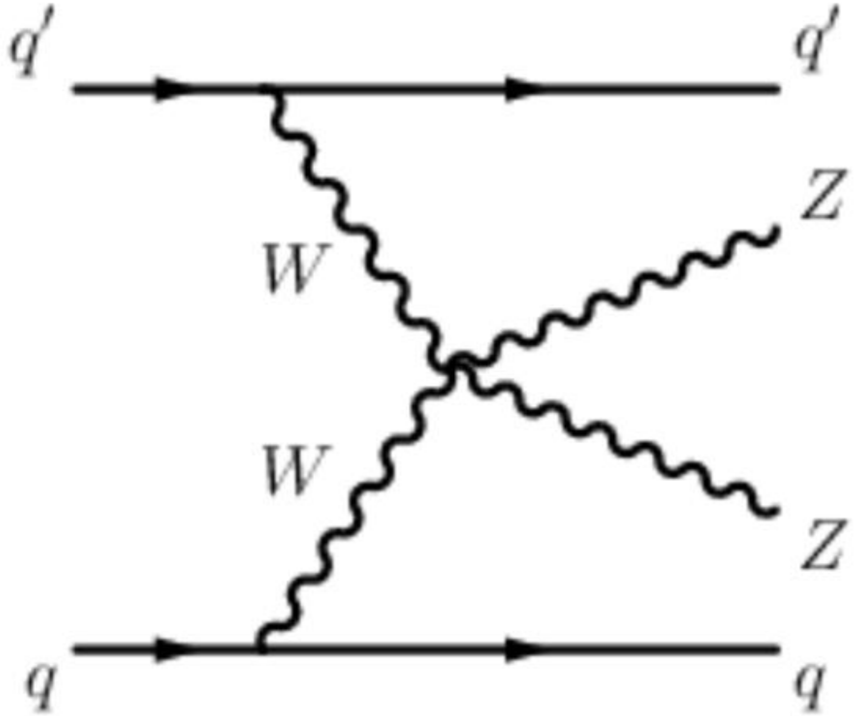


The diagram shows an interaction between a quark and antiquark. One may be flipped to a quantized higher level, this would be like an electron having -𝕆D×e𝕪 kinetic work done to flip it once. That enables the two electrons to form a boson pair in an orbital. Here two W or Z bosons would form the Higgs with a spin 0 from the opposing spins. That can decay into two Z bosons.

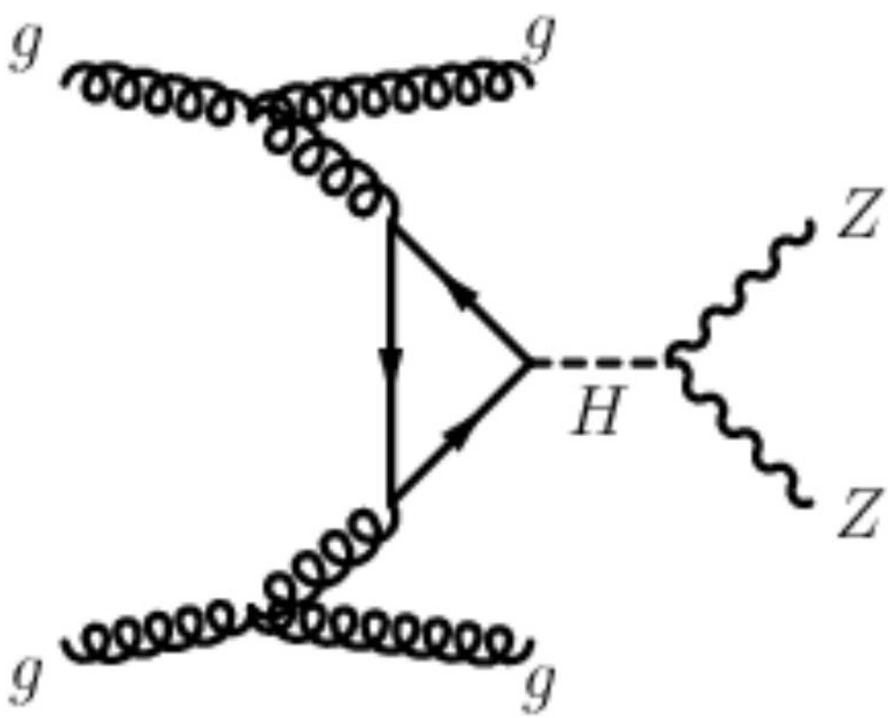


\textbf{Typical diagrams for the production of $ZZjj$.} The relevant EW VBS diagrams are shown in the first row for (a) the s-channel and (b) the t-channel production through a Higgs boson, (c) the weak-boson self-interaction process, and (d) the production through exchange of a W boson. The relevant QCD diagrams are shown in the second row for (e to g) the tree-level production with different quark and gluon initial states, (h) the box diagram without a Higgs boson, and the (i) the triangle diagram through a Higgs boson.

Here one of the W bosons may come from a flipped quark, then it would be formed by the quantized work from its being flipped. Together they can decay into two Z bosons each with a quantized value.

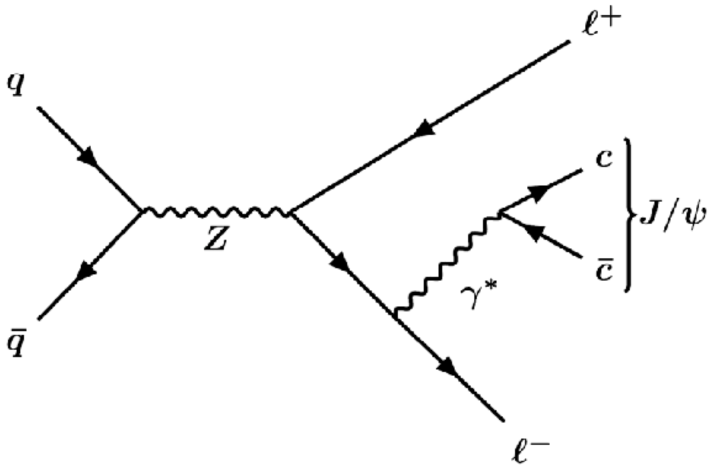


Here the gluons may be opposed because their quark pair both had flipped spin. That would give a Higgs with spin 0 and two Z bosons with opposed spins.

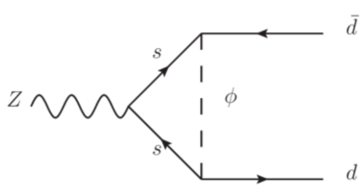


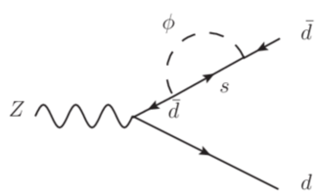
The Z boson

In this model it can form with a W+ and W- boson, because these are positive and negative they give a quantized level of 2. It can also form from a quark to an antiquark, this can be +𝕠2/3 to -𝕠2/3 or -𝕠1/3 to +𝕠1/3. This can form two leptons as +𝕠d and -𝕠d, the difference there is 2. This additional energy would be needed to increase the difference between them from 2/3 or 4/3 to 2. In the diagram the Z boson decays to 4 leptons.



In this diagram the Z boson decays into a -𝕠1/3 down quark and a +𝕠1/3 antidown quark. This is still a boson because it is in between two spin Pythagorean Triangle sides, the W- boson would be between an +𝕠2/3 up quark and a -𝕠1/3 down quark to give a value of -1.





Gravitational and inertial work and impulse

The Eℍ/+𝕚d gravitational impulse also moves the protons closer together through the +𝕠2/3 up quark which would proportionally have a +𝕚2/3 fractional gravitational mass. Then as they get too close the +𝕀D×e𝕙 gravitational work destructively interferes forcing them apart. The -𝕠1/3 down quarks would have a -𝕚1/3 inertial mass, the E𝕍/-𝕚d inertial impulse in the nucleus destructively interferes when the -𝕀D×e𝕧 inertial work dominates at smaller e𝕧 lengths.

Gravitation is proportional to the fractional charges

In this model the quarks have a fractional charge in Biv space-time. This would be +𝕚2/3 as the gravitational mass of the up quark, and -𝕚1/3 as the inertial mass of the down quark. This would increase with higher generations of the quark according to the Koide formula.

Gravity and inertia as an action and reaction pair

Because these are equal and opposite action/reaction pairs, the +𝕀D gravitational probability interferes moving the +𝕠2/3 up quarks apart. The -𝕀D inertial probability reacts against this with the -𝕠1/3 down quarks. The inertia would react against the gravity, reducing the overall force pushing the quarks apart.

Kinetic force overcomes inertia

In this model an active force overcomes a reactive force. This is like pushing a block on a frictionless surface, the inertia pushes back against this kinetic force. Because it is a reaction only, it cannot increase like an electric charge so a continuing E𝕐/-𝕠d kinetic impulse on the block will overcome the inertia and the block moves.

Gravity overcomes inertia

An asteroid might have inertia when passing a planet, but as a reactive force this cannot be increased against an active force as with the block. The +𝕀D×e𝕙 gravitational work of the planet curves the asteroid towards it, the -𝕀D inertial probability is subtracted from the +𝕀D gravitational probability of the planet. When the +𝕀D value is stronger than -𝕀D the asteroid will be captured into an orbit or fall onto the planet.

Gravitational and inertial interference

If the +𝕀D gravitational probability can interfere destructively with other matter, then there would be an antigravitational effect. The two materials should repel each other like protons do, but as an active force. If inertia could interfere destructively it might also cancel out, then a rocket for example could move with much less inertia saving fuel. This would require a kind of gravitational magnet, if the +𝕚2/3 up quarks in a material could be aligned like a magnet then it might attract or repel another gravitational magnet. If there was a kind of gravitational diamagnetism then it might repel other matter and act like a thrust in a rocket against a planet for example. An inertial magnet would increase or reduce inertia when pointed at another inertial magnet.

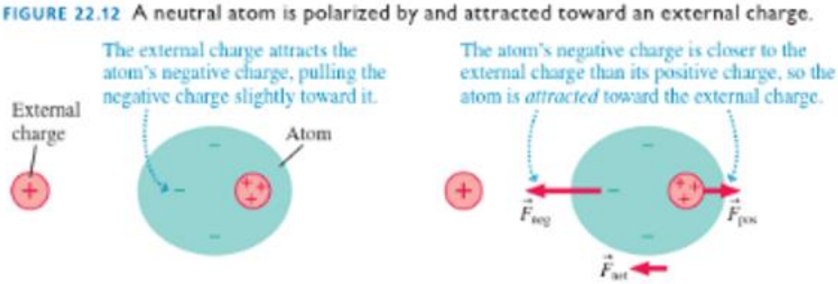
Neutrons make a nucleus more stable

In this model neutrons make a nucleus more stable, this is because the neutron has a balanced +𝕆D potential probability and a -𝕆D kinetic probability. The neutron has one +𝕠2/3 up quark and two -𝕠1/3 down quarks. Each of these can have a constructive interference to quarks in other protons and neutrons.

The Electric Dipole

Polarizing a conductor is one thing, but why does a charged rod pick up paper, which is an insulator? Consider what happens when we bring a positive charge near an atom. As **FIGURE 22.12** shows, the charge polarizes the atom. The electron cloud doesn't move far, because the force from the positive nucleus pulls it back, but the center of positive charge and the center of negative charge are now slightly separated.

FIGURE 22.12 A neutral atom is polarized by and attracted toward an external charge.



A polarization force as work

Each atom in the rod has its -𝕠d and e𝕪 Pythagorean Triangles more on one side, the paper has a deficit of electrons. The rod's electrons have a greater -𝕆D kinetic probability of being closer to the paper, as the e𝕧 length between them decreases the -𝕆D kinetic probability increases as a square. That causes the force between them to be an inverse square.

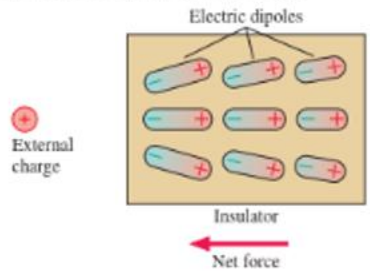
Two opposite charges with a slight separation between them form what is called an **electric dipole.** (The actual distortion from a perfect sphere is minuscule, nothing like the distortion shown in the figure.) The attractive force on the dipole's near end *slightly* exceeds the repulsive force on its far end because the near end is closer to the external charge. The net force, an *attractive* force between the charge and the atom, is another example of a polarization force.

An insulator has no sea of electrons to shift if an external charge is brought close. Instead, as FIGURE 22.13 shows, all the individual atoms inside the insulator become polarized. The polarization force acting *on each atom* produces a net polarization force toward the external charge. This solves the puzzle. A charged rod picks up pieces of paper by

- Polarizing the atoms in the paper,
- Then exerting an attractive polarization force on each atom.

This is important. Make sure you understand all the steps in the reasoning.

FIGURE 22.13 The atoms in an insulator are polarized by an external charge.



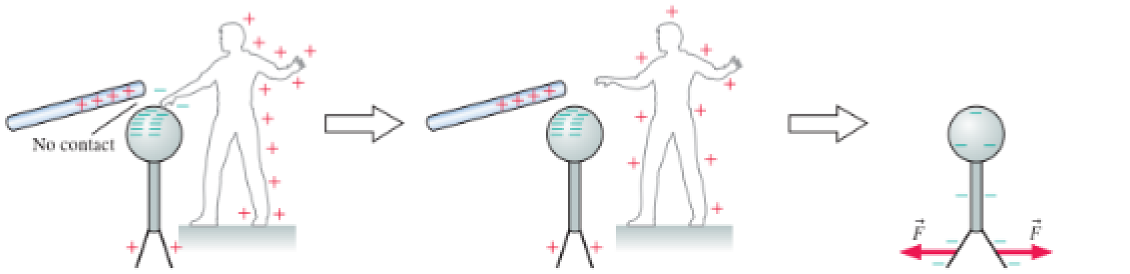
Inducing work

The person transfers electrons to the electroscope, this comes from the electroscope's atoms doing -𝕆D×e𝕪 kinetic work to be nearer the rod. It acts like a higher voltage as seen in van de Graff generators. There is a strong +𝕆D potential difference in the rod which induces a strong -𝕆D kinetic difference in the electroscope. As the electrons move to the top the +𝕠d and e𝕒 Pythagorean Triangles as the protons in the leaves destructively interfere with +𝕆D×e𝕒 potential work. That causes them to separate. When the rod is removed the electrons go to the leaves, then there is constructive interference from the -𝕆D kinetic probability. The leaves again move apart.

Charging by Induction

Charge polarization is responsible for an interesting and counterintuitive way of charging an electroscope. **FIGURE 22.14** shows a positively charged glass rod held near an electroscope but not touching it, while a person touches the electroscope with a finger. Unlike what happens in Figure 22.10, the electroscope leaves hardly move.

FIGURE 22.14 A positive rod can charge an electroscope negatively by induction.



1. The charged rod polarizes the electroscope + person conductor. The leaves repel slightly due to polarization.

2. The negative charge on the electroscope is isolated when contact is broken.

3. When the rod is removed, the leaves first collapse as the polarization vanishes, then repel as the excess negative charge spreads out.

Charge polarization occurs, as it did in Figure 22.10, but this time in the much larger electroscope + person conductor. If the person removes his or her finger while the system is polarized, the electroscope is left with a net *negative* charge and the person has a net positive charge. The electroscope has been charged *opposite to the rod* in a process called **charging by induction.**

Inverse square law as work

In this model it would be the magnetic forces, from +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work that decreases with an increased e𝕒 distance. This is an inverse square, the +𝕆D potential probability decreases as a square with the increasing e𝕒 altitude. That is proportional to the +𝕚d and e𝕙 Pythagorean Triangle as gravity, with +𝕀D×e𝕙 gravitational work the increase e𝕙 height decreases the +𝕀D gravitational probability also as an inverse square.

Inverse square law as impulse

The E𝔸/+𝕠d potential impulse here is the inverse of the square law, then electrons are further from the nucleus the e𝕒 altitude decreases as a square. This would be a potential acceleration as +𝕠d/E𝔸 proportional to the Eℍ/+𝕚d gravitational impulse as +𝕚d/Eℍ in seconds/meter^2. Further from the nucleus the E𝔸 and Eℍ values decrease as a square. That means the downward acceleration is lower further away from the nucleus as the inverse square law again.

Coulomb's law as work and impulse

In the atom the inverse square law is work, there can be +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work where electrons are more -𝕆D kinetic likely to be closer to the positive object. If this is a rod for example then there is also a E𝕐/-𝕠d kinetic impulse towards it, that is because electrons can move in a metal rod near it in a e𝕪/-𝕠d kinetic current as particles. That allows for electrons to move to one side of a metal rod, this increasing the attraction with Coulomb's Law.

22.4 Coulomb's Law

The first three sections have established a *model* of charges and electric forces. This model has successfully provided a qualitative explanation of electric phenomena; now it's time to become quantitative. Experiment 4 in Section 22.1 found that the electric force decreases with distance. The force law that describes this behavior is known as *Coulomb's law*.

Charles Coulomb was one of many scientists investigating electricity in the late 18th century. Coulomb had the idea of studying electric forces using the torsion balance scheme by which Cavendish had measured the value of the gravitational constant *G* (see Section 13.4). This was a difficult experiment. Despite many obstacles, Coulomb announced in 1785 that the electric force obeys an *inverse-square law* analogous to Newton's law of gravity. Today we know it as **Coulomb's law.**

Electromagnetic and gravitational constants

Here there is an electrostatic constant, when this is compared to G there are two proportional constants. In this model they come from α. With Roy electromagnetism it is $e^{-\mathbb{o}d}$ where the electron inertial velocity is in the ground state. With Biv space-time this is equivalent to a tangent of an angle angle θ with the -𝕚d and e𝕧 Pythagorean Triangle. That gives the inertial velocity as a fraction of a complete circle as π/24.

Two kinds of α

This gives two kinds of α constants, the first comes from the logarithm and the second from the angle in the inertial velocity. These two most be proportional to each other, if not then the electromagnetic forces in the ground state would be pushing against the inertial mass of the electron. In this model that comes from using the +𝕚d gravitational mass of the proton compared to the electron as a base.

Work and point positions

In this model the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work use positions that are points. The electron is also the -𝕚d and e𝕧 Pythagorean Triangle so its -𝕀D×e𝕧 inertial work has a position e𝕧 as a point. Here the electron is not a particle, it is a -𝕆D kinetic probability wave.

Displacement and electric forces

When this is observed as the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse between particles, then it is on a +𝕠d potential clock gauge and a -𝕠d kinetic clock gauge. Then the force would come from the E𝔸 potential displacement and the E𝕐 kinetic displacement at an instant.

Discrete and continuous spectrums

In this model the two are attractive with work, there is a quantization between them with a discrete spectrum of photons being emitted. When the impulse is observed there is no quantization, the force is continuous and photons would have a continuous spectrum.

Repulsion from destructive interference

The +𝕠d and e𝕒 Pythagorean Triangle with the positive charge has e𝕒 as the potential electric charge. This does not repel other protons, instead they would collide and separate. As they get closer to each other there is +𝕆D×e𝕒 potential work, they have destructive interference between them. That means there is a lower +𝕆D potential probability of their being close together and they repel each other.The -𝕠d and e𝕪 Pythagorean Triangle as the electron also has destructive interference with -𝕆D×e𝕪 kinetic work making them less kinetically likely to be near each other.

Coulomb's law

1. If two charged particles having charges q_1 and q_2 are a distance r apart, the particles exert forces on each other of magnitude

$$F_{1 \text{ on } 2} = F_{2 \text{ on } 1} = \frac{K|q_1||q_2|}{r^2} \qquad (22.2)$$

where K is called the **electrostatic constant.** These forces are an action/reaction pair, equal in magnitude and opposite in direction.

2. The forces are directed along the line joining the two particles. The forces are *repulsive* for two like charges and *attractive* for two opposite charges.

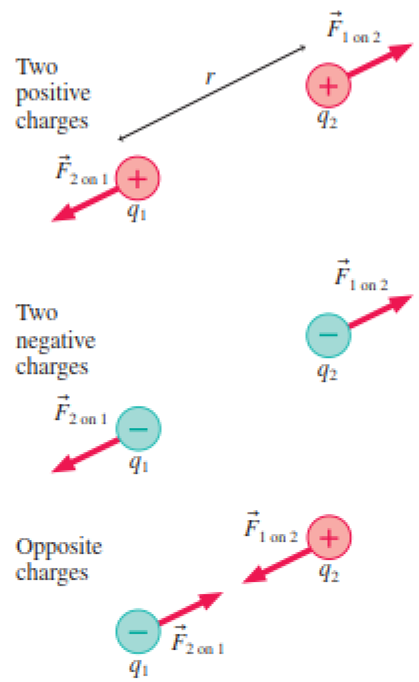
We sometimes speak of the "force between charge q_1 and charge q_2," but keep in mind that we are really dealing with charged *objects* that also have a mass, a size, and other properties. Charge is not some disembodied entity that exists apart from matter. Coulomb's law describes the force between charged *particles,* which are also called **point charges.** A charged particle, which is an extension of the particle model we used in Part I, has a mass and a charge but has no size.

Coulomb's law looks much like Newton's law of gravity, but there is one important difference: The charge q can be either positive or negative. Consequently, the absolute value signs in Equation 22.2 are especially important. The first part of Coulomb's law gives only the *magnitude* of the force, which is always positive. The direction must be determined from the second part of the law. FIGURE 22.15 shows the forces between different combinations of positive and negative charges.

Attraction as probability

Here the attraction is because +𝕠d is added to -𝕠d. The +𝕠d and e𝕒 Pythagorean Triangle as the proton has reactive forces only, its +𝕆D×e𝕒 potential work cannot be measured except in how it adds to the electron's -𝕆D×e𝕪 kinetic work. This causes the electron to move towards the proton into a quantized level. With +𝕆D×e𝕒 potential work as the e𝕒 altitude decreases then the +𝕆D potential probability increases as a square. That means the electron would kinetically accelerate towards its more kinetically probable position closer to the proton. Because the E𝔸/+𝕠d potential impulse is the inverse of the +𝕆D×e𝕒 potential work, this is also observed to be the electron as a particle kinetically accelerating towards the proton.

FIGURE 22.15 Attractive and repulsive forces between charged particles.



The unit of charge

This comes from the current as e𝕒/+𝕠d and e𝕪/-𝕠d, being a derivative slope of a Pythagorean Triangle, this comes from the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. The Coulomb is an ampere second, here that would be e𝕪/-𝕠d × -𝕠d for the -𝕠d and e𝕪 Pythagorean Triangle electron. The proton would be e𝕒/+𝕠d × +𝕠d or e𝕒. The Coulomb force would then be observed as the E𝕐/-𝕠d kinetic impulse and E𝔸/+𝕠d potential impulse.

The electrostatic constant and c

The electrostatic constant in this model is used with Maxwell's equations to give the inertial velocity of c as e𝕧/-𝕚d. It is also referred to as the permittivity constant where it is multiplied by 4π and inverted. Here $1/(\sqrt{2}\pi)$ is ≈ β as the second Fiegenbaum constant. This approaches a quantization series of levels as tines in chaos. It is not exactly $1/(\sqrt{2}\pi)$ because that would be quantized. With a circumference of 1 as a quantized value, the radius would be $1/(2\pi)$ or β^2. The circumference can be regarded as a circular orbital, then as it goes up by an integer n the radius would increase as E𝔸 with a E𝔸/+𝕠d potential impulse. That is approximate because impulse is chaotic here, it approaches this π value as β^2 giving impulse.

$$k_e = \frac{1}{4\pi\varepsilon_0}$$

Its value is[6][7]

$$\varepsilon_0 \stackrel{\text{def}}{=} \frac{1}{c_0^2 \mu_0} \approx 8.854\,187\,8128(13) \times 10^{-12}\ \text{F/m}$$

The electrostatic constant

In this model there are two charges q_1 and q_2, when multiplied together in Coulombs, and divided by a squared length E𝕍 this is (e𝕪/-𝕠d × -𝕠d)(e𝕪/-𝕠d × -𝕠d)/E𝕐. All the terms cancel out for some value. That is multiplied by Newtons as -𝕠d×e𝕪/-𝕆D which cancels to e𝕪/-𝕠d. The formula and constant then observe the kinetic current e𝕪/-𝕠d, at different distances between the charges this changes as the E𝕐 square or r^2. This is a constant because it is multiplied by a squared formula in Newtons. That changes with the inverse square law, it is equivalent to using g for the gravitational constant for a particular planet.

Repulsive potential

This can be written in terms of the repulsive positive charge (e𝕒/+𝕠d × +𝕠d)(e𝕒/+𝕠d × +𝕠d)/E𝔸 where the terms all cancel again. That would be measured in Newtons as +𝕠d×e𝕪/-𝕆D as a constant again, that is because the repulsion between positive charges is also an inverse square law.

Gravitational constant

In this model there is a gravitational speed in the similar equation for gravity, at a given e𝕙 height over a planet the gravitational speed would be e𝕙/+𝕚d. This means for gravity the same equation can be written as (e𝕙/+𝕚d × +𝕚d)(e𝕙/+𝕚d × +𝕚d)/Eℍ with a planet and a moon for example. That can be measured by +𝕚d×e𝕙/+𝕀D in Newtons as well, then it is the +𝕚d gravitational mass times meters/second^2. For a given planet there would be a g value giving this Newton constant. For gravitational generally there is the Gravitational constant G.

Gravitational momentum

The formula +𝕚d×e𝕙/+𝕚d is is also the gravitational momentum, as +𝕚d would be the gravitational mass and e𝕙/+𝕚d the gravitational speed. That can also be measured in Newtons as +𝕚d×e𝕙/+𝕀D which is also the e𝕙/+𝕚d gravitational speed when this is counteracted by the inertia of an orbiting moon. The inertia would be an equal and opposite as the gravity, so the moon stays at a fixed e𝕙 height above the planet and has a fixed e𝕧/-𝕚d inertial velocity.

Separating momentum from work

The electrostatic constant then separates the -𝕠d×e𝕪/-𝕠d kinetic momentum, and the +𝕠d×e𝕒/+𝕠d potential momentum, from the equation in Newtons that does -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work. This +𝕠d×e𝕒/+𝕆D is like the potential work times a given +𝕠d potential mass. In this model the +𝕠d potential magnetic field is proportional to a give a +𝕚d gravitational field, when this value is set such as in an electrostatic experiment, then that leaves the +𝕆D×e𝕒 potential work. This can be converted to e𝕒/+𝕆D by changing the measuring units, for example +𝕆D here acts as seconds^2 and for hours^2 it would likely become a denominator.

Roy and Biv work is proportional

Both equations can give a constant value, with two electric charges attracting each other they could for example be rotating each other, then the inertia would maintain a constant e𝕒/+𝕠d potential speed around each other. This is like in a hydrogen atom, there are electrostatic forces but there are also gravitational and inertial forces. These must be proportional or else for example an electron might move out of its orbital if its -𝕚d inertial mass was higher. Then the orbitals would no longer be quantized.

Inverses of momenta and constants

When the positive and negative iotas are combined it becomes (e𝕒/+𝕠d × +𝕠d) (e𝕪/-𝕠d × -𝕠d)/e𝕒×e𝕪. The two are inverses, when one gets larger the other gets inversely smaller. This comes from the constant Pythagorean Triangle areas. This can also be done with Biv space-time, the (e𝕙/+𝕚d × +𝕚d)(e𝕧/-𝕚d × -𝕚d)/e𝕙×e𝕧 equation is also equal to a constant. This means they would remain constants and proportional for all orbital levels, also in between charged materials the gravity and inertia also remains proportional. When the changes are measured in Newtons as work then this is also a constant, it is measuring the inverse square law.

Changing the momentum inversely as a constant

For example if e𝕙 doubles then +𝕚d halves, so the left hand bracket is doubled. But then with an orbit the e𝕧 length halves, this is because at twice the height a moon would move at half the e𝕧 length in its inertial velocity. When e𝕧 halved then -𝕚d is doubled so the inertial velocity would be a quarter, but when e𝕙 doubles +𝕚d halves so the gravitational speed increases by 4 times.

Comparing gravity to inertia as a constant

With (e𝕙/+𝕚d × +𝕚d)(e𝕧/-𝕚d × -𝕚d)/e𝕙×e𝕧 this can then compare the +𝕚d gravitational mass of a planet with the -𝕚d inertial mass of a moon. By adjusting this the two bracketed equations can be swapped, then the left-hand bracket is the +𝕚d gravitational mass of the moon and the right-hand bracket is the -𝕚d inertial mass of the planet.

Gravity and inertia are inverses

Because these are equal to each other the planet and moon exert an equal gravitational and inertial attraction to each other. This is because a planet with a larger +𝕚d gravitational mass also has the same proportionally larger -𝕚d inertial mass from its electrons. It can attract a moon which has the same proportions of +𝕚d and -𝕚d.

Combined Roy and Biv in atoms

In an atom the proton has a +𝕠d×e𝕒/+𝕠d potential momentum, the electron has a -𝕠d×e𝕪/-𝕠d kinetic momentum. The circular orbital would be like the planet and moon, the proton has a proportional +𝕚d gravitational mass and the electron has a proportional -𝕚d inertial mass. The Roy electromagnetic and Biv space-time equation are then combined proportionally in the atom. This makes the +𝕚d gravitational mass and -𝕚d inertial mass approximately equal to each other.

Momentum is not observable or measurable

With the Coulomb equation this has the e𝕒/+𝕠d potential speed and the e𝕪/-𝕠d kinetic velocity in the Hydrogen atom. They are not observed or measured because there is no force. Electrons in an orbital then can be like a moon moving on a geodesic in Biv space-time without forces.

Repulsion and probability

If there are two positive charges, there are two +𝕠d×e𝕒/+𝕠d potential momentums in Coulombs that repel with their +𝕆D potential probability doing work. With two negative charges there are two -𝕠d×e𝕪/-𝕠d kinetic momentums also in Coulombs, they repel each other with a -𝕆D kinetic probability. Using Newtons this is measuring the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work because the square is the spin Pythagorean Triangle side as $seconds^2$.

Units of Charge

Coulomb had no *unit* of charge, so he was unable to determine a value for K, whose numerical value depends on the units of both charge and distance. The SI unit of charge, the **coulomb** (C), is derived from the SI unit of *current*, so we'll have to await the study of current in Chapter 27 before giving a precise definition. For now we'll note that the fundamental unit of charge e has been measured to have the value

$$e = 1.60 \times 10^{-19}\ \text{C}$$

This is a very small amount of charge. Stated another way, 1 C is the net charge of roughly 6.25×10^{18} protons.

The electrostatic constant and ϵ_0

This equation gives a constant, the Newtons are a fixed inverse square force in work. That is when the Coulombs and distance between them is squared. Moving the charges closer to each other will have a constant force change because of this inverse square law. Changing the number of protons or electrons would change the Coulombs, that is because these are the potential and kinetic momenta from the iotas.

NOTE The amount of charge produced by friction is typically in the range 1 nC (10^{-9} C) to 100 nC. This is an excess or deficit of 10^{10} to 10^{12} electrons.

Once the unit of charge is established, torsion balance experiments such as Coulomb's can be used to measure the electrostatic constant K. In SI units

$$K = 8.99 \times 10^{9}\ \text{N m}^2/\text{C}^2$$

It is customary to round this to $K = 9.0 \times 10^{9}\ \text{N m}^2/\text{C}^2$ for all but extremely precise calculations, and we will do so.

Surprisingly, we will find that Coulomb's law is not explicitly used in much of the theory of electricity. While it *is* the basic force law, most of our future discussion and calculations will be of things called *fields* and *potentials*. It turns out that we can make many future equations easier to use if we rewrite Coulomb's law in a somewhat more complicated way. Let's define a new constant, called the **permittivity constant** ϵ_0 (pronounced "epsilon zero" or "epsilon naught"), as

$$\epsilon_0 = \frac{1}{4\pi K} = 8.85 \times 10^{-12}\ \text{C}^2/\text{N m}^2$$

Maxwell and the kinetic velocity

The electrostatic forces move between the iotas at the e𝕧/-𝕚d inertial velocity of c. In this model that is proportional to the e𝕪/-𝕠d kinetic velocity. That gives two constants, e𝕪 is the √ϵ because the force in Newtons as work is a square. This is called the permittivity constant. The -𝕠d kinetic time is proportional to the -𝕚d inertial time in c, this is another constant. According to this model that is μ_0 as the permeability constant also another square. This was discovered by Maxwell, that $1/(\sqrt{\epsilon}\times\mu)$ was equal to c. Here the permeability constant is $1/\mu$.

Impulse instead of work between the charges

That gives a ratio between ϵ and μ, the electrostatic constant can then measure the charges with work here instead of impulse. If this was converted to the E𝔸/+𝕠d potential impulse and E𝕍/-𝕚d inertial impulse, then instead of the distance between the charges there would be the time of motion. A negative charge then after a second would move E𝕐 as meters^2, after another second this would increase as a square. Instead of meters/second^2 as work this would be the equivalent meters^2/second.

Electric and magnetic flux

In terms of the electrical charges these would be mediated by impulse, but the magnetic fields are mediated by work which uses an unsquared electrical charge as a linear ruler or scale. Using work can measure the magnetic flux in between iotas, and from magnets. Using impulse can observe the electric flux between them, but in this model flux implies a field. Here the electric charges are mediated as particles.

Particle wave duality of light

This is similar to the duality of photons as waves or particles, that goes back to the time of Newton and Thomas Young, Newton thought they were particles and Young thought they were waves. In this model that comes from the e𝕐/-𝕘d light impulse and -𝔾D×e𝕪 light work. In this model protons and electrons can also be wavelike, for example giving diffraction patterns in double slit experiments.

Potential and kinetic energy

When positive and negative charges are used, this would also be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy which are in joules with conventional physics. In this model they would combine two forces, E𝕐 would be from the E𝕐/-𝕠d kinetic impulse and -𝕆D from -𝕆D×e𝕪 kinetic work. Combining these leads to uncertainty because the two forces are being observed at the same instant and measured at the same position.

Changing energies and c

When the charges are further from each other, the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy are weaker, that is proportional to a slower e𝕒/+𝕠d potential speed and a e𝕪/-𝕠d kinetic velocity. These are moving towards each other because they are not in a stable orbital. These have a limit at c, so the electrostatic constant would also have this limit as it increased with the distance squared decreasing between them. This would not reach c at the lowest e𝕒 altitude between the proton and electron in the ground state, below this the electron would join the proton in a neutron.

Gravity and c, the electrostatic constant and rocket fuel

This connects ϵ and μ with c, the electrostatic force here can increase towards c like gravity would decrease the e𝕙/+𝕚d gravitational speed towards an event horizon as 1/c. This is inverted because a rocket moving towards a black hole would have its e𝕧/-𝕚d inertial velocity increasing towards c. In reacting against the event horizon, the rocket would burn fuel which relies on the same electrostatic constant and the e𝕪/-𝕠d kinetic velocity as c. This is why the rocket would have difficulty getting away from the event horizon with its fuel.

Energy mass equivalence

In this model that also gives the energy mass equivalence discovered by Einstein. The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy is proportional to the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation, if some protons are annihilated then their gravitational mass drops by the same amount, this would be emitted as gravis. There would also be some photons because the protons are a combination of +𝕠d and -𝕠d. The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is proportional to the ½×e𝕍/-𝕀d ×-𝕚d linear inertia, if electrons are annihilated then their -𝕚d inertial mass is converted into e𝕪×-𝕘d photons.

Energy mass equivalence approaching c

In this model the ½×e𝕍/-𝕀d ×-𝕚d linear inertia would reach a limit as -𝕚d×E𝕍/-𝕀D as mc^2 where e𝕧/-𝕚d is c. The change happens because the electrostatic and gravitational constants including a constant amount of work in Newtons. This would give a constant force increasing to towards c where the mass energy equivalence is also the same as mc^2. With the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation this would decrease towards 1/c as $1/(mc^2)$ as it approached an event horizon. At all gravitational speeds there would be the energy mass equivalence.

Energy mass equivalence and momenta

When there is no force, like a coasting rocket, this becomes the momentum equivalence. Then the -𝕠d×e𝕪/-𝕠d kinetic momentum as a kind of energy is proportional to the -𝕚d×e𝕧/-𝕚d inertial momentum as a kind of -𝕚d inertial mass.

Work from points of length

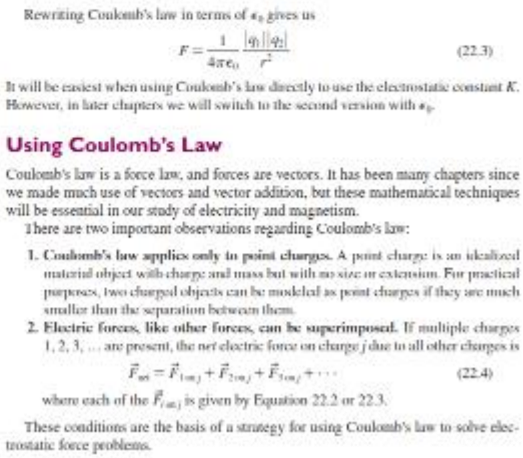
Coulomb's law refers to point charges, in this model electrons have no e𝕙 height because they come from the -𝕚d and e𝕧 Pythagorean Triangle. That gives them a e𝕧 point position when -𝕆D×e𝕪 kinetic work is being measured. It would also be the center of -𝕆D×e𝕪 kinetic work being done with -𝕆D destructive interference, opposing positions outside this point would cancel out leaving the point e𝕧. When the -𝕆D×e𝕪 kinetic work of an electron is measured, to get closer to it with e𝕧, then this creates enough -𝕆D kinetic probabilities around it to form other iotas.

Work from points of height

With a proton it can be regarded as a point charge with its +𝕆D×e𝕒 potential work. On opposite points on a positively charged sphere there would be a destructive interference, that only leaves the +𝕆D potential probability at a maximum in the center. This is like Newton showing that gravity appears to combe from the center of a planet. In this model that happens from +𝕀D×e𝕙 gravitational work, then the +𝕀D gravitational probabilities destructively interfere on opposite sides with an equal e𝕙 height from the center. That only leaves the center as the measured source of +𝕀D×e𝕙 gravitational work.

Impulse is not observed with points

With a E𝕐/-𝕠d kinetic impulse electrons are not observed as points, they bounce off each other. According to Zeno this would be impossible with two points, there would always be points in between them so they could never collide. They could only become one point. Protons also collide as if they are not points. A planet may have its +𝕀D×e𝕙 gravitational work coming from its center, but its E𝕳/+𝕚d gravitational impulse comes from its particles which have a larger size. This allows for balls to collide with a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, they also deform with the E𝔸/+𝕠d potential impulse and E𝕳/+𝕚d gravitational impulse in them. They have size greater than points, even though the positive and negative charges appear as points with work.


Rewriting Coulomb's law in terms of ϵ_0 gives us

$$F = \frac{1}{4\pi\epsilon_0}\frac{|q_1||q_2|}{r^2} \quad (22.3)$$

It will be easiest when using Coulomb's law directly to use the electrostatic constant K. However, in later chapters we will switch to the second version with ϵ_0.

Using Coulomb's Law

Coulomb's law is a force law, and forces are vectors. It has been many chapters since we made much use of vectors and vector addition, but these mathematical techniques will be essential in our study of electricity and magnetism.

There are two important observations regarding Coulomb's law:

1. **Coulomb's law applies only to point charges.** A point charge is an idealized material object with charge and mass but with no size or extension. For practical purposes, two charged objects can be modeled as point charges if they are much smaller than the separation between them.
2. **Electric forces, like other forces, can be superimposed.** If multiple charges 1, 2, 3, … are present, the net electric force on charge j due to all other charges is

$$\vec{F}_{net} = \vec{F}_{1 on j} + \vec{F}_{2 on j} + \vec{F}_{3 on j} + \cdots \quad (22.4)$$

where each of the $\vec{F}_{i on j}$ is given by Equation 22.2 or 22.3.

These conditions are the basis of a strategy for using Coulomb's law to solve electrostatic force problems.

No electric field

In this model there is no electric field, only a magnetic field. With electric charge this is observed only with impulse in collisions. When two electrons as -𝕠d and e𝕪 Pythagorean Triangles approach each other there is also -𝕆D×e𝕪 kinetic work done, the electrons emit e𝕪×-𝕘d photons towards each other like quantized orbital levels. That comes from the -𝕆D kinetic probability density between them, this has a destructive interference so it appears as if there is only an electric charge collision.

Electrons move apart in the atom

The destructive interference makes it less likely the electrons would be measured close to each other, so they move apart. This also happens in atoms, the destructive interference between them causes gaps in the electron clouds of -𝕆D kinetic probability density. That appears like electrons colliding and moving into more stable orbitals away from each other.

Bosons pairs, positrons and electrons attract

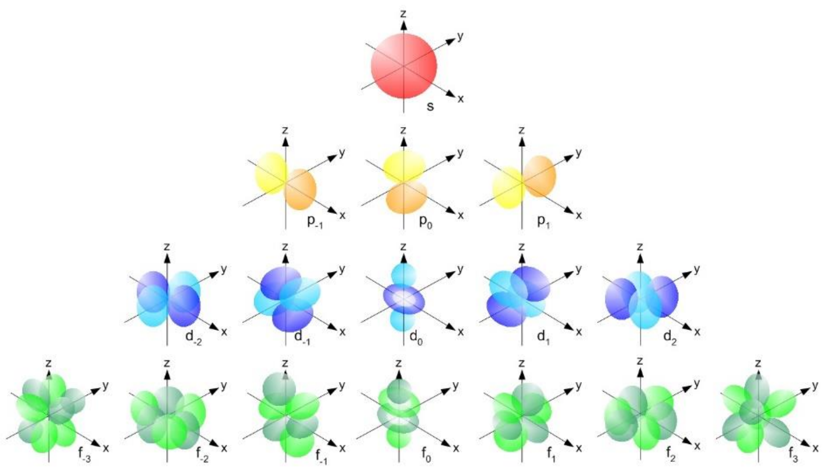
They also form boson pairs, in this model that is where one electrons flips over. Then they have a constructive interference, they can stay close to each other in the same orbital. Positrons and electrons also have constructive interference, they can move closer to each other like a proton and electron. When they come together they are annihilated, the difference between +𝕠d and -𝕠d is emitted as e𝕪×-𝕘d photons.

Two boson pairs

In the diagram the electrons form boson pairs, this makes them more likely to approach each other with a constructive interference. The two pairs in the $4d_1$ orbital would have constructive interference with each other. For example if two pairs were north south, the southern electron might be flipped. This has a constructive interference with an electron to the east, but to the west the other flipped electron has a destructive interference with it.

Rounded electron probability densities

In this model the constructive interference joins them together, the destructive interference keeps them separated to some degree. They curve away from each other because of the destructive interference, then the outer part of the electron probability densities is curved. This is because a higher e𝕒 altitude is less +𝕆D potentially probable for the electrons. In the d_0 orbital two electrons form a ring with constructive interference, one is flipped. The other two electrons destructively interfere so they are pushed away from one side of the ring.



Vectors as scales

In this model a vector comes from the straight Pythagorean Triangle side, for an electron this is e𝕪 and for a proton it is e𝕒. When work is being measured this is on a ruler or scale as a linear vector. When there is a force vector this is the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse, the particles are observed to move apart after a collision.

Photons mediate √ϵ and √μ changes between atoms

This time in traveling between iotas comes from photons according to this model. The inertial velocity e𝕧/-𝕚d of c comes from the permittivity constant as ϵ and the permeability constant as μ, these have a kinetic velocity of c as e𝕪/-𝕠d or √(ϵ×μ) where μ is a fraction. The photon mediates changes between atoms, transmitting them to other atoms. These changes cause electron to change their orbitals, the size of these is proportional to the electrostatic constant as ϵ and the magnetic or permeability constant as μ.

Constants are proportional to Biv spacetime

If these constants were different, then there would be a different e𝕒 altitude and e𝕙 height between the orbitals. These must be proportional to each other, a change would mean electrons would be pulled down by the electrostatic constant for example but move upwards as their inertia was stronger than gravity in that orbital. This would affect the electron cloud shapes and elliptical orbitals.

Photons as a rolling wheel

The e𝕪/-𝕠d kinetic velocity in this model transmits the changes between orbitals, because this is proportional to e𝕧/-𝕚d as the inertial velocity in space-time then c is fixed. The photon does not have a fixed kinetic velocity, here this is e𝕪/-𝕘d where -𝕘d is the rotational frequency of the photon rolling wheel. Instead the rolling wheel can change in size, the -𝕘d rotational frequency can double for example and the photons can liberate more electrons with the photoelectric effect.

Constant forces

In this model ϵ and μ are constant forces, that is like a constant acceleration. A change in the angle θ of the photon causes it to do different amounts of -𝔾D×e𝕪 light work or have a different e𝕐/-𝕘d light impulse at an atom. The constant has not changed, the constant acceleration has a different momentum according to the orbital it left from.

Gravitational and inertial constants

This is like gravity having a G gravitational constant as an acceleration, when the photon is absorbed by an atom this gravitational constant will correspond to the same gravitational acceleration. In this model there would be an Inertial constant, using V from length.

Constant gravitational and inertial forces

This allows for a stronger Eℍ/+𝕚d gravitational impulse closer to a planet, a falling asteroid would have this constant gravitational acceleration at all e𝕙 heights. There is also an inertial constant where inertially accelerating a rocket is the same force at different inertial velocities. With special relativity this inertial constant still appears to be the same on the rocket. When the photon is absorbed by an atom this gravitational constant is proportional to the ϵ and μ constants as squares.

Height and length are equivalent

In this model these constants are then like the gravitational and inertial constants. These are equal to each other with the +𝕚d gravitational mass and the -𝕚d inertial mass. With the electrostatic constant this would refer to e𝕙 and e𝕧 as equivalent to each other, also Eℍ and E𝕍 would be equivalent forces in the Equivalence Principle.

Inertial and electrostatic constant

In Roy electromagnetism there is $\epsilon_{e𝕪}$ proportional to the inertial constant. This gives the kinetic and inertial acceleration in between electrons as they repel each other, that occurs with the squared forces the -𝕆D×e𝕪 kinetic work and the E𝕐/-𝕠d kinetic impulse.

Gravitational and electrostatic constant

When two protons repel each other there is $\epsilon_{e𝕒}$ which is proportional to the G gravitational constant. When a proton and an electron attract each other with constructive interference, this is like gravity and inertia, ϵ is then like Eℍ as well as E𝕍. It would in Roy electromagnetism be E𝔸 and E𝕐.

The equivalence principle in Roy electromagnetism

With μ this is also two forces proportional to each other with gravity and inertia, they are proportional in the Equivalence principle. Here $\mu_{+𝕠d}$ would be the potential magnetic field, and $\mu_{-𝕠d}$ would be proportional to the kinetic magnetic field. That allows for two protons to repel each other with +𝕆D×e𝕒 potential work, two electrons repel each other with -𝕆D×e𝕪 kinetic work, the proton and electron attract each other with +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. This is a second equivalence principle, just as +𝕀D as the gravitational probability and -𝕀D as the inertial probability are equivalent, then +𝕆D as the potential probability and -𝕆D as the kinetic probability are equivalent.

Planck's and the electrostatic constant

This also happens with Planck's constant, in this model that is -𝕠d ×e𝕐/-𝕠d for the -𝕠d and e𝕪 Pythagorean Triangle electron and +𝕠d × e𝔸/+𝕠d for the +𝕠d and e𝕒 Pythagorean Triangle proton. Both of these are squares, they observe the E𝕐/-𝕠d kinetic impulse for the electron and the E𝔸/+𝕠d potential impulse for the proton. When an electron is an orbital it acts as a wave with work, to observe this the wave function of its -𝕆D×e𝕪 kinetic work collapses into the E𝕐/-𝕠d kinetic impulse observed as h.

Quantization and the two constants

Both constants are related, the difference is the electrostatic forces are with charges outside the atom. These are not quantized because the electron moves with a E𝕐/-𝕠d kinetic impulse there. This is because it is not in a curved orbital, there is little -𝕆D kinetic torque. This changes when the same charges are brought together, then there is +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work done between the positive and negative charges respectively.

Blackbody curve and Planck's constant

In a blackbody the -𝕠d and e𝕪 Pythagorean Triangle electrons were in atoms, because of this the e𝕪×-𝕘d photons emitted were quantized in some cases. This caused the cooler temperatures to drop off, that happened because there were a limited number of orbitals where the -𝕆D×e𝕪 kinetic work could emit these discrete frequencies of photons. With hotter temperatures photons also collided with atoms and electrons, these produce a more continuous spectrum.

Planck's constant and particles

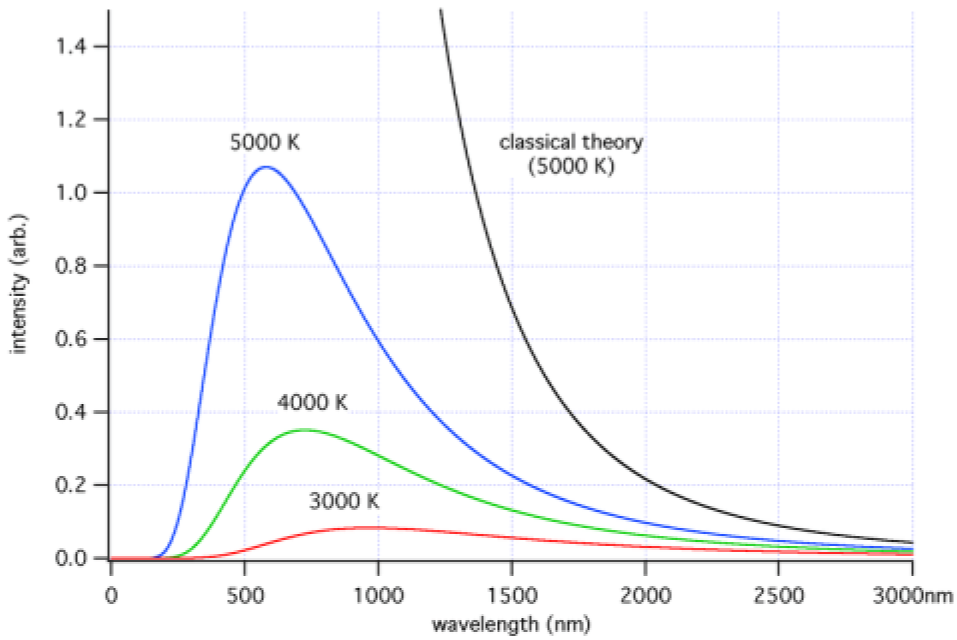
To observe this spectrum Planck's constant is not itself quantized, it observes quantized orbitals which matched the blackbody curve. This produced a different constant to the Boltzmann constant which measured the collisions between the atoms as particles. Because of this using the Boltzmann constant caused the ultraviolet catastrophe, while it was measuring waves and work it could not measure the waves in the atoms. This is because atoms colliding gives a continuous distribution of e𝕪/-𝕘d photons. The two constants act as inverses to each other in the blackbody curve, that causes the left hand side to change from an exponential curve.

Higher wavelength and the photon rolling wheel

As the wavelength goes up with photons, this increases the e𝕪 radius of the rolling wheel. That causes the higher wavelengths to come from collisions between molecules. When the wavelength is lower then the rolling wheel photons have a smaller radius. This makes the -𝕘d rotational frequency inversely faster, as with the photoelectric effect this causes electrons to jump more in orbitals so the spectrum is more discrete. Conversely this lowers the effect from the E𝕐/-𝕠d kinetic impulse because the electrons are emitting photons more from work, fewer photons are left to be affected by impulse.

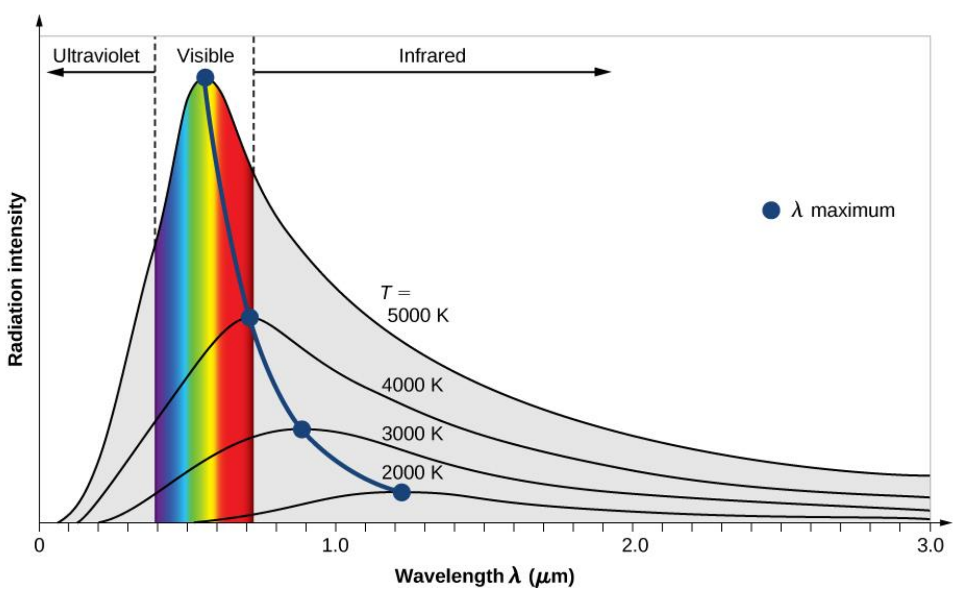
Classical theory

Classical theory predicted the photon intensity would increase more with lower wavelengths, this assumed that a continuous spectrum would have an infinite number of possible frequencies for photons. As the frequencies increased then there should be more possible oscillators, the photon intensity would then go up as an exponential. In this model the spin exponential dominates with higher frequencies doing -𝕆D×e𝕪 kinetic work.



Work is stronger at lower wavelengths

When the temperature as eⅺ increases, this has little effect on electrons in orbitals. That is called their Fermi energy, in this model increasing the E𝕐/-𝕠d kinetic impulse of electron can make them wobble in their orbitals but it has less effect on their -𝕆D×eⅺ kinetic work. Here the -𝕆D kinetic torque causes the electrons to change orbitals, the lower wavelength then causes an increase in the discrete spectrum. As the Fermi energy increases with temperature the peak of the blackbody curve is moved to the left a small amount.

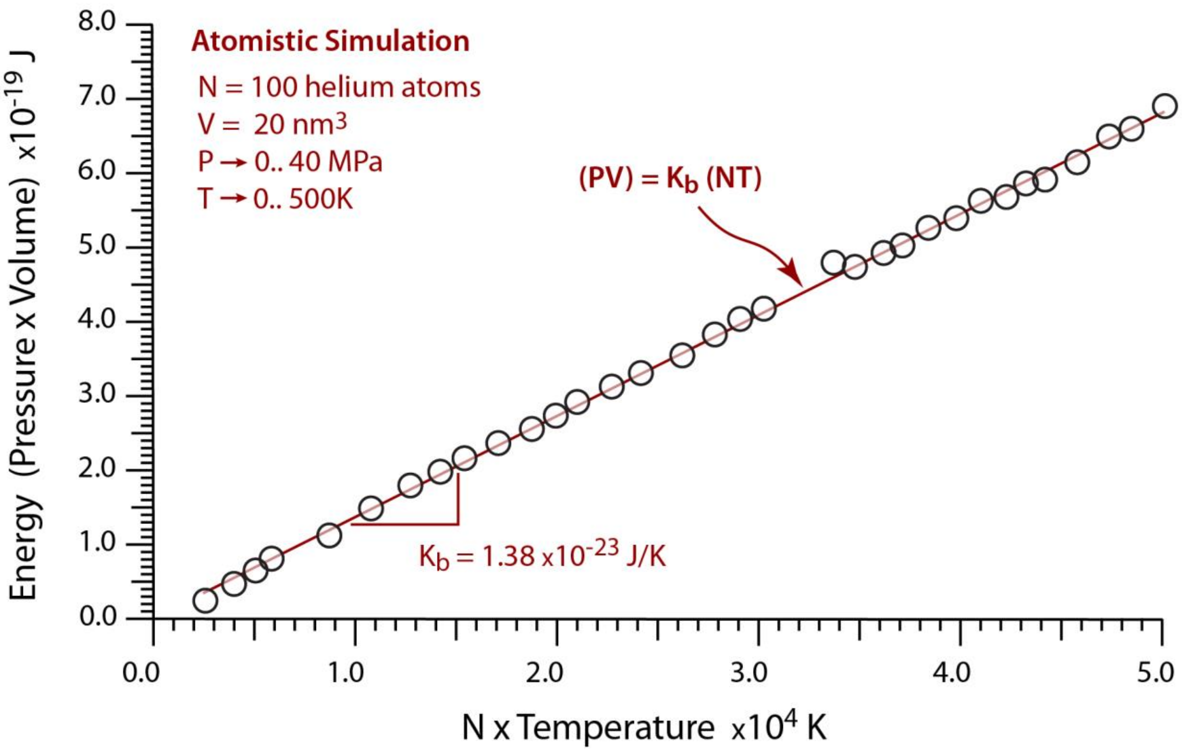


The Boltzmann constant and electrostatics

The Boltzmann constant or k force also changes as a squared constant, that is the same as the electrostatic constant which measured the -𝕠d×eⅺ/-𝕆D square. In this model k is also -𝕠d ×eⅺ/-𝕆d as k or the Boltzmann constant. Because k has a squared spin Pythagorean Triangle side it measures a probability, this is why according to the model gases tend to distribute their iotas randomly. In a gas the molecules would be attracted and repelled by each other when measured in Newtons.

Joules per kelvin

In the diagram an increased e𝕪 temperature increases the e𝕪/-𝕠d kinetic velocity. This increases the pressure of the gas as E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse. This is in Joules per Kelvin or degree of \y temperature. From the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy this removes one e𝕪 from the numerator to give ½×-𝕠d× e𝕪/-𝕆D, this is the same as the electrostatic constant using Newtons.



Spin exponentials and impulse exponentials

The squared spin Pythagorean Triangle side is like a negative squared exponent here, for example $e^{-𝕆D}$ +through the integers gives an integral normal curve. The straight Pythagorean Triangle side squared with the electrostatic and Planck's constant, that is not negative and so the exponent e^{ey} would give an exponential curve. Here then the normal curve is a spin exponential from work, the exponential curve comes from impulse.

F=ma and work

When the electrostatic constant is measured, this uses Newtons which is from work. The equation F=ma is also from work, here it would be -𝕠d×e𝕪/-𝕆D or with the -𝕚d and e𝕧 Pythagorean Triangle kilograms per meters/second^2 as -𝕚d×e𝕧/-𝕀D.

22.5 The Electric Field

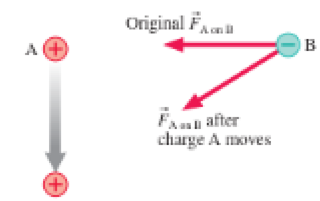
Electric and magnetic forces, like gravity, are *long-range* forces; no contact is required for one charged particle to exert a force on another. But this raises some troubling issues. For example, consider the charged particles A and B in FIGURE 22.20. If A suddenly starts

moving, as shown by the arrow, the force vector on B must pivot to follow A. Does this happen *instantly*? Or is there some *delay* between when A moves and when the force $\vec{F}_{A\ on\ B}$ responds?

Neither Coulomb's law nor Newton's law of gravity is dependent on time, so the answer from the perspective of Newtonian physics has to be "instantly." Yet most scientists found this troubling. What if A is 100,000 light years from B? Will B respond *instantly* to an event 100,000 light years away? The idea of instantaneous transmission of forces had become unbelievable to most scientists by the beginning of the 19th century. But if there is a delay, how long is it? How does the information to "change force" get sent from A to B? These were the issues when a young Michael Faraday appeared on the scene.

Michael Faraday is one of the most interesting figures in the history of science. Because of the late age at which he started his education—he was a teenager—he never became fluent in mathematics. In place of equations, Faraday's brilliant and insightful mind developed many ingenious *pictorial* methods for thinking about and describing physical phenomena. By far the most important of these was the field.

FIGURE 22.20 If charge A moves, how long does it take the force vector on B to respond?



A curved magnetic field

In this model the magnetic field is curved because of the -𝕆D×e𝕪 kinetic work being done by the magnet. This has a -𝕆D kinetic torque which turns the iron filings. The space around the magnet is linear, it is measured on a straight ruler as e𝕪 and proportionally a e𝕧 length. This separates the squared work force from the linear increments of e𝕧 length like millimeters on a ruler.

Vectors at different positions and probabilities

As the magnet moves the -𝕆D×e𝕪 kinetic work done also moves the iron filings to different e𝕧 positions. A field here can assign a vector to every e𝕧 position in Biv space-time, this has the -𝕆D kinetic torque of the magnetic field orthogonal to it. These are also -𝕆D kinetic probability densities. As the magnet moves, the iron filings are more -𝕆D kinetically probable to be measured somewhere else and so they move to a new pattern.

A particle trajectory

There is no electric field in this model, the with particles they move according to a change in time according to this model. They are not a series of positions, instead they are displacements as forces in between a starting instant and a final instant. This gives a particle a trajectory, it moves along this with a E𝕐/-𝕠d kinetic impulse as an electron. It can also do -𝕆D×e𝕪 kinetic work as a field, then it moves with a path integral where the field is an integral and the path is a series of e𝕧 positions.

The Concept of a Field

Faraday was particularly impressed with the pattern that iron filings make when sprinkled around a magnet, as seen in FIGURE 22.21. The pattern's regularity and the curved lines suggested to Faraday that the *space itself* around the magnet is filled with some kind of magnetic influence. Perhaps the magnet in some way alters the space around it. In this view, a piece of iron near the magnet responds not directly to the magnet but, instead, to the alteration of space caused by the magnet. This space alteration, whatever it is, is the *mechanism* by which the long-range force is exerted.

FIGURE 22.22 illustrates Faraday's idea. The Newtonian view was that A and B interact directly. In Faraday's view, A first alters or modifies the space around it, and particle B then comes along and interacts with this altered space. The alteration of space becomes the *agent* by which A and B interact. Furthermore, this alteration could easily be imagined to take a finite time to propagate outward from A, perhaps in a wave-like fashion. If A changes, B responds only when the new alteration of space reaches it. The interaction between B and this alteration of space is a *local* interaction, rather like a contact force.

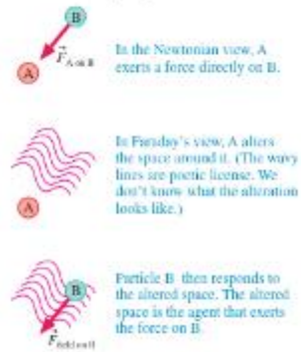
Faraday's idea came to be called a **field.** The term "field," which comes from mathematics, describes a function that assigns a vector to every point in space. When used in physics, a field conveys the idea that the physical entity exists at every point in space. That is, indeed, what Faraday was suggesting about how long-range forces operate. The charge makes an alteration *everywhere* in space. Other charges then respond to the alteration at their position. The alteration of the space around a mass is called the *gravitational field.* Similarly, the space around a charge is altered to create the **electric field.**

> **NOTE** The concept of a field is in sharp contrast to the concept of a particle. A particle exists at *one* point in space. The purpose of Newton's laws of motion is to determine how the particle moves from point to point along a trajectory. A field exists simultaneously at *all* points in space.

Faraday's idea was not taken seriously at first; it seemed too vague and nonmathematical to scientists steeped in the Newtonian tradition of particles and forces. But the significance of the concept of field grew as electromagnetic theory developed during the first half of the 19th century. What seemed at first a pictorial "gimmick" came to be seen as more and more essential for understanding electric and magnetic forces.

FIGURE 22.21 Iron filings sprinkled around the ends of a magnet suggest that the influence of the magnet extends into the space around it.

FIGURE 22.22 Newton's and Faraday's ideas about long-range forces.



Charge as distance and a series of positions

In this model charge refers to the straight Pythagorean Triangle sides, e𝕪 would be the kinetic electric charge and E𝕐 the kinetic displacement force. The e𝕧 length is proportional to e𝕪, a distance can be referred to as a kind of charge here. When this charge becomes a squared force it is a displacement in both cases.

Distances in Roy and Biv are proportional to each other

In Roy electromagnetism charge is like the e𝕙 height and e𝕧 length in Biv space-time. It determines the concept of distance in work as a series of positions. The e𝕙 height is proportional to the e𝕒 altitude or potential electric charge as another kind of distance. When this is a squared force it is the potential displacement force.

Electric charge points like a distance or vector

The e𝕒 altitude points out of a proton as a series of straight Pythagorean Triangle side lines or vectors. Only one can be the +𝕠d and e𝕒 Pythagorean Triangle, this has possible directions while -𝕠d has probably directions.

Straight lines as distances

This is like the straight lines out of the +𝕚d and e𝕙 Pythagorean Triangle, as gravity with the e𝕙 height. The e𝕪 kinetic electric charge points out of it as a straight Pythagorean Triangle side in one direction, this can also appear to be outwards like e𝕒. With the -𝕚d and e𝕧 Pythagorean Triangle as inertia e𝕧 lengths can point out of matter in any direction as well.

Possibilities and probabilities

Only one direction out of the possibilities can result in a displacement and impulse. Only one change in time can become a temporal duration in work.

Roy and Biv displacement with impulse

With Roy electromagnetic forces particles move along these squared lines with impulse. In Biv space-time particles move along the squared lines of e𝕙 height and e𝕧 length also with impulse. Here there is a +𝕚d gravitational time and a -𝕚d inertial time as a clock gauge on which impulse is observed. In Roy electromagnetism there is also time, with impulse there is the +𝕠d potential time and -𝕠d kinetic time.

Roy electromagnetism as a consistent universe

Roy electromagnetism can be regarded as a universe in itself where Biv space-time is not needed. There are distances and time, also work and impulse. Electrons appear mainly as waves inside an atom, however gravity appears mainly as a field in Biv space-time.

Width in Roy electromagnetism

There is no width as is approximated in Biv space-time with height and length. In this model width comes from the neutrino as an orthogonal direction in a neutron. This would give width to Biv space-time as well.

Biv space-time came first as a macro world

In Newtonian physics little was known about Roy electromagnetism, the world was described mainly in Biv space-time. There were distances with a e𝕙 height and e𝕧 length. To this was often added a width to give a right-angled Cartesian coordinate system in 3d. Roy electromagnetism was relatively unknown except there were some forces between charged objects as well as magnets.

Photons and gravis

In between these rival views of the universe there are photons and gravis, according to this model. The photons were known in Biv space-time as light, here they come from Roy electromagnetism. They also affect Biv space-time because Roy and Biv are proportional to each other. If not then one would exert more forces on the other, for example in weaker gravity protons might float rather than having a consistent +𝕚d gravitational mass. Gravis here can be +𝔾D×e𝕓 gravis work as gravitational waves, or e𝔹/+𝕘d gravis impulse being similar to gravitons.

Roy and Biv affect each other with photons and gravis

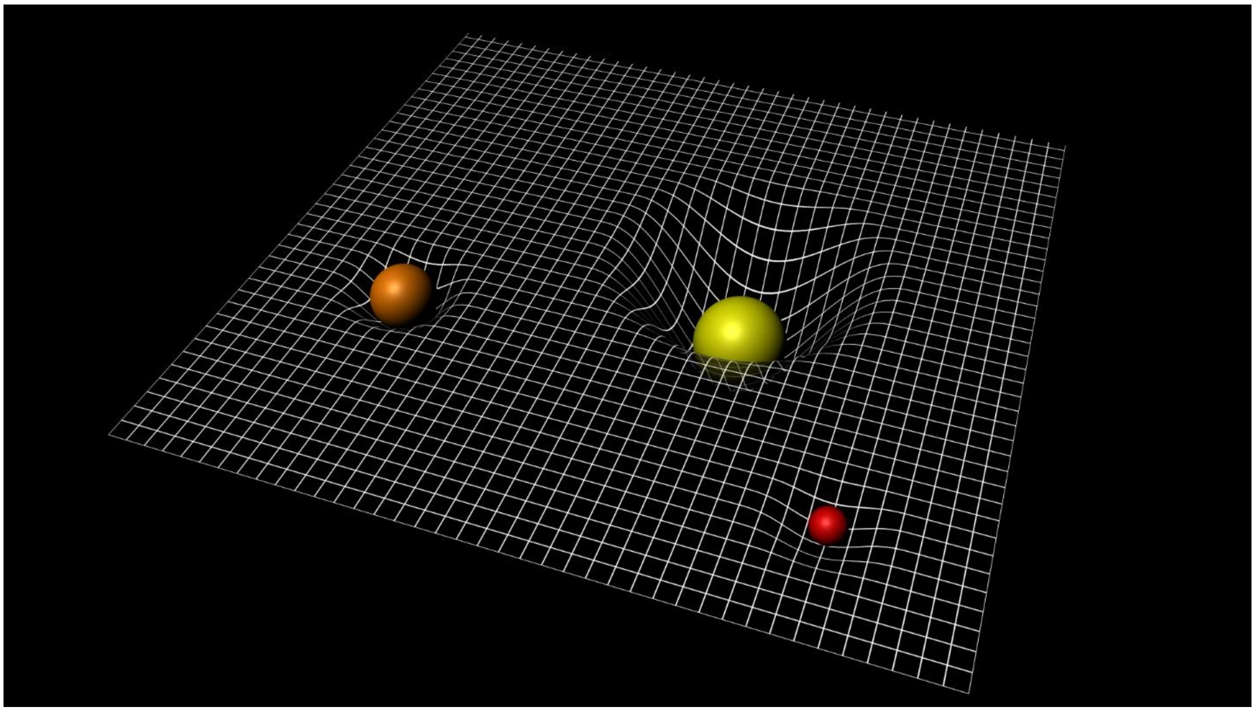
The gravis affect Roy electromagnetism like photon affect Biv space-time, they have active forces onto protons which react against them. This is like active photons colliding with electrons, there is a reaction against them from inertia.

Galaxies as logarithmic spirals

In this model a galaxy can be a logarithmic spiral, this is where the outer rim slows its expansion instead of accelerating with an exponential spiral. This comes from the constant areas of the +𝕚d and e𝕙 Pythagorean Triangle giving gravity and the -𝕚d and e𝕧 Pythagorean Triangle giving the inertia with which the galaxy rotates. These Pythagorean Triangles are also relativistic, they are consistent with the centers approaching c around black holes.

Galaxies as a shallow bowl geodesic

The center of the galaxy has black holes, in this model they form because the whole galaxy has a +𝕚d gravitational mass. That is often modeled by a depression in a grid, as shown below. Here the whole galaxy depresses this grid, from the edges it would appear like a shallow bowl with some quantization from +𝕀D×e𝕙 gravitational work. The diagram shows a deeper bowl shape around sphere represented stars or planets. In a galaxy these bowls overlap, so closer to the center the depression is deeper than it might otherwise be with separated stars.



The center of the bowl is more depressed

That causes the center to be depressed enough to form a larger black hole, in this model the event horizon would be the limit at c. Because the area around the event horizon is already depressed in its +𝕚d gravitational field, then the event horizon is reached at a greater e𝕙 height making the black hole larger. Here the black hole could not exist outside the galaxy or far from the center, the lack of the depressed bowl shape would cause it to shrink or disappear.

Quantized redshifts

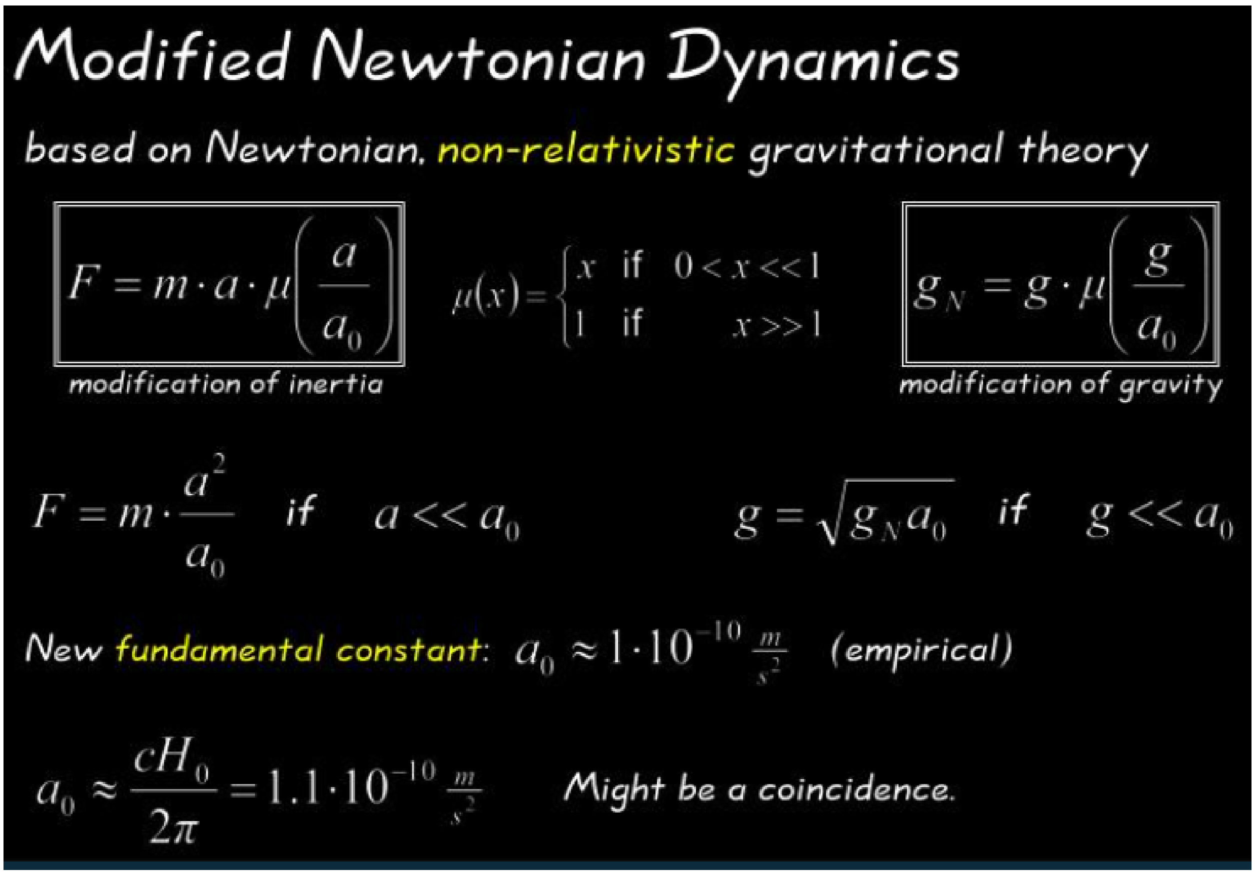
The bowl would also appear to be quantized to some degree, like flatter areas as steps. This is because the +𝕀D×e𝕙 gravitational work is quantized like +𝕆D×e𝕒 potential work in an atom. The Hubble constant multiplies a e𝕙/+𝕚d gravitational speed to make it e𝕙/+𝕀D which is the same as +𝕀D×e𝕙 gravitational work. Stars have a greater +𝕀D gravitational probability of being at these quantized levels.

The limits of c and 1/c

The limit of the e𝕧/-𝕚d inertial velocity at the event horizon is c, the limit at the edge of the galaxy approaches 1/c according to this model. That makes the galaxy have an inverse ratio of its inner and outer inertial velocity giving an overall value that is quantized as 1. In the diagram below the inertial velocity on the rim converges to a fixed value as c at the event horizon. That adds c to the equation, then it is moved to the right-hand side and divides as 1/c.

Rearranging the equation

When the lower equation is rearranged, it becomes $1/2\pi = 1.1\times 10^{-10}$ m/sec^2 or e𝕧/-𝕆D divided by 3×10^8 m/sec or e𝕧/-𝕚d. When divided by the Hubble constant as 1/-𝕚d these are both an inertial acceleration as -𝕀D×e𝕧 inertial work. This gives $\approx 1.1/3 \times 10^{-2}$, H_0 is ≈ 71. 1.1/3 is .367, multiplying this by 2π, then divided by 71 is $\approx .76$. This is close to 1 for approximate values. Some give a value of 1.2×10^{10} which is even closer to 1.



Ionization boundary in Biv spacetime

The galaxy can then be a logarithmic spiral, when an ellipse it averages the same outer rim inertial velocity. This is equivalent to the ionization boundary of an atom in Roy electromagnetism, there the outer orbital reaches a limit where the e𝕪/-𝕠d kinetic velocity is slower before the electron leaves the atom. That would be balanced against the ground state kinetic velocity as α or approximately 1/137.

Inverted Pythagorean Triangles give 1

These are balanced in the atom because the +𝕠d and e𝕒 Pythagorean Triangle is the inverse of the -𝕠d and e𝕪 Pythagorean Triangle. The proton then has an inversely weaker +𝕆D×e𝕒 potential work closer to this boundary, the electron would have a stronger +𝕀D×e𝕙 gravitational work which is a weaker E𝕐/-𝕠d kinetic impulse. and slower e𝕧/-𝕚d inertial velocity.

Galaxies like atoms

Each galaxy would then be like an atom according to this model, they form filaments with other galaxies similar to molecular connections between atoms. These are progressively redshifted according to an increasing e𝕙 height with gravity to the limit of the +𝕚d and e𝕙 Pythagorean Triangle. This would be at c, because past that no photons could be observed or measured, but the Pythagorean Triangle would extend past this. The inertial velocity can also extend past c, that allows for some galaxies moving away to have an inertial velocity greater than 4 times c.

Inertial event horizon

Further out there would be an inertial event horizon, this is where some galaxies cannot be observed and measured because the photons would not have had time to reach us.

Galaxies not gravitationally bound

Because these galaxies are moving forward in -𝕠d kinetic time and -𝕚d inertial time, the photons come from these as the e𝕪 and -𝕘d Pythagorean Triangle. Moving more to one side is like a rocket moving faster than c being observed and measured from the side. The photons are not coming from a rocket moving directly away, if so then they could not be observed or measured according to this model.

Inertial expansion of spacetime

This can also be regarded as an expansion of Biv space-time with the -𝕚d and e𝕧 Pythagorean Triangles. These are in hyperbolic geometry, the universe appears to be expanding forwards in -𝕚d inertial time and be bound in circular geometry with +𝕚d gravitational time. In between is approximately flat space in parabolic geometry which protons and electrons are balanced.

Jets faster than c

Some galaxies have been observed and measured to have jets of matter also around 4 times faster than c. This may be consistent with the model, a jet of matter may be decompressing as it shoots in a straight-line. That would be like the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse of a rocket, with this model it could go past c because it is using -𝕚d inertial mass as a reaction force.

The CMB and light inertial velocity

The CMB is estimated to be about 45 billion light years from us, yet the time elapsed is around 13.8 billion years. That gives a current inertial velocity of about 3 times the speed of light. This would come from a e𝕙 height contraction, seen forward in -𝕚d inertial time as a space expansion. There is also a +𝕚d gravitational time slowing, the photons have taken about 3 times longer to reach us.

Reaction mass and acceleration past c

This is different from accelerating particles in an accelerator. There is no reaction mass being expelled by the particles. To conserve energy the rocket would have to accelerate past c. This would not be observable or measurable from behind, the rocket should disappear as its photons would not do enough -𝔾D×e𝕪 light work to excite an electron to a higher orbital. The rocket would be observable and measurable from the side because the inertial velocity would not be over c from that angle.

Entanglement and c

With entanglement there is an apparently instantaneous change of spin with entangled photons. Because the spins are opposed, the -𝔾D×e𝕪 light work and their -𝔾D light probabilities cancel out. The inertial velocity is consistent with jets and galaxies going faster than c. The entanglement increases this velocity, if the entanglement is slightly distorted then it may be this inertial velocity is slower. For example, one photon might be measured in a gravitational field, the other in free space.

Galaxies are similar at higher redshifts

In the diagrams below, recent results from the James Webb Space Telescope show galaxies similar to local ones at much higher redshifts. That is consistent with this model, the redshift is caused by the increased e𝕙 height towards a limit with the +𝕚d and e𝕙 Pythagorean Triangle. The galaxies here would be quantized as 1 like atoms, being made of atoms with a quantized ionization boundary of 1. These galaxies are approximately the same in an unending universe.

Limits of observation and measurement

The observation and measurement is limited by when the angle θ of the +𝕚d and e𝕙 Pythagorean Triangle corresponds to c. This is the inverse of the -𝕚d and e𝕧 Pythagorean Triangle with the inertia of galaxies, when they don't appear to be moving then the photons are no longer observed and measured like with an event horizon.

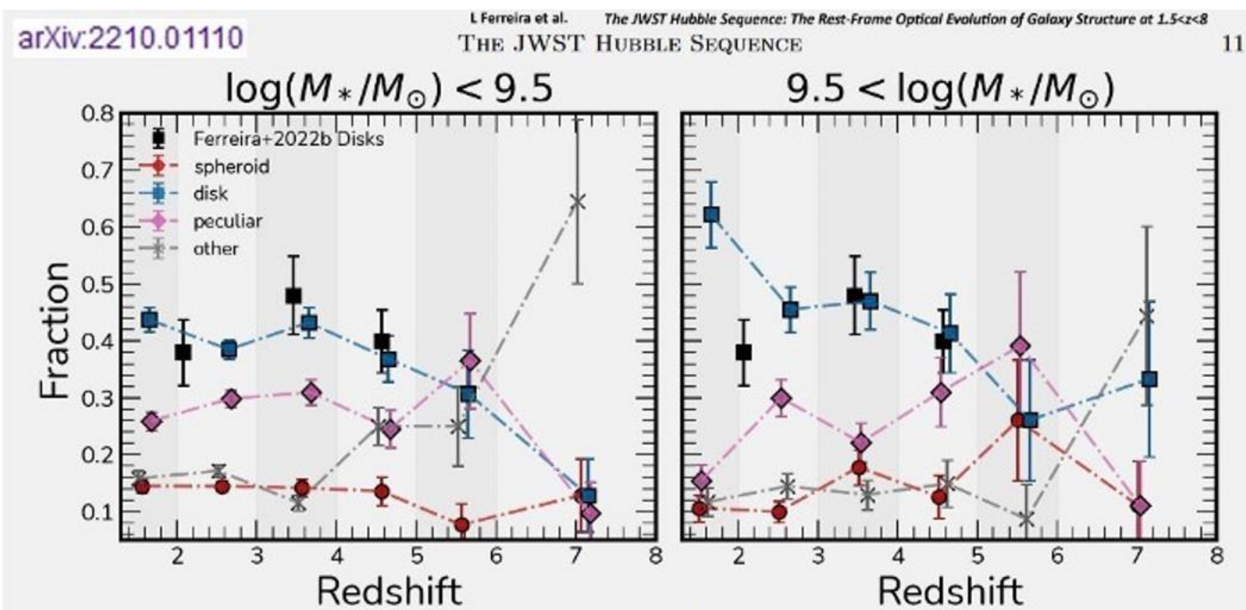


Figure 8. Morphology Fraction vs Redshift. The morphology fraction evolution with redshift for the main morphological classes of our classification framework (Fig. 1) in two mass bins, $\log(M_*/M_\odot) < 9.5$ (**left**) and $\log(M_*/M_\odot) > 9.5$ (**right**). Disks, spheroids, peculiars and other in blue squares, red circles, pink diamonds, and gray crosses, respectively. This other category aggregates the ambiguous, point source and unclassifiable sources. The black squares show the Disk fractions reported in Ferreira et al. (2022).

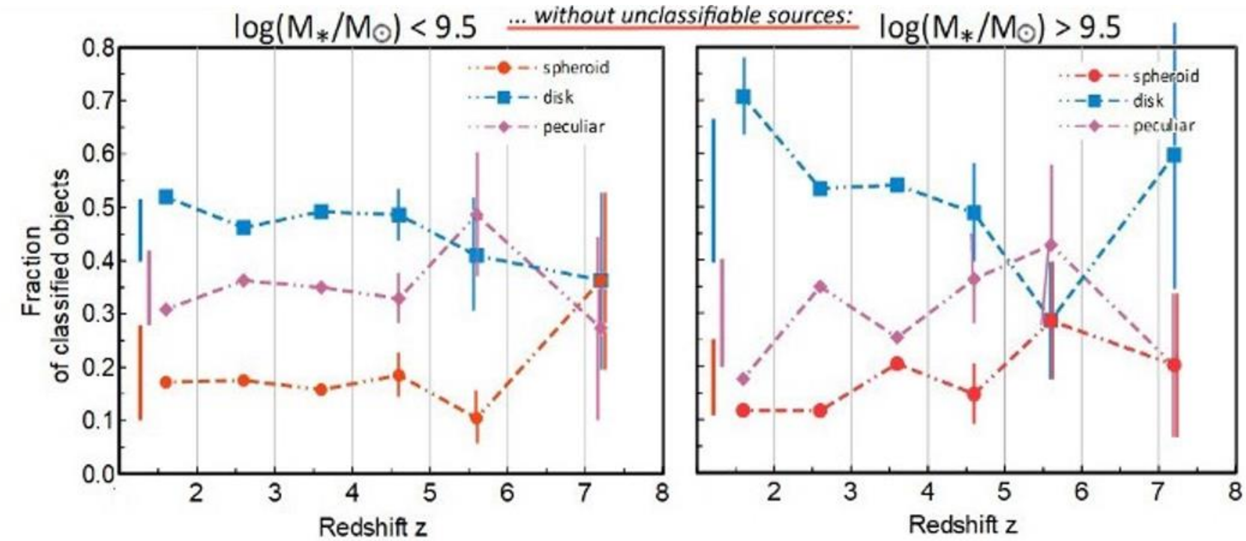


Figure 8 of Ferreira et.al. (2022) modified by Marmet (lower half) to eliminate unclassifiable sources as mentioned above. Data for the smaller galaxies are on the left graph and the data for the larger galaxies are on the right graph.

Galactic constructive and destructive interference

In this model each galaxy would do +𝕀D×eh gravitational work and -𝕀D×e𝕧 inertial work on other galaxies. As with protons and electrons, these can attract each other with Eℍ/+𝕚d gravitational impulse and repel each other with +𝕀D×eh gravitational work. This is a similar process as with protons repelling protons with their +𝕆D potential probability, the potential destructive interference makes them less likely to be close to each other. Electrons also repel like inertial destructive interference, they are less likely to be measured near each other.

Galaxies smaller or larger than 1

When galaxies have more than this quantized value of 1, they would be less able to hold onto extra dust and stars. This is because they would perturb each other, there would also be more gravitational and inertial destructive interference than impulse. Some would then have a higher inertial velocity and leave the galaxy. This is like extra electrons in an atom not fitting into orbitals under the ionization level. Then the stars would have a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse which would move them towards other galaxies.

Galaxies absorbing and emitting stars

If there is room in another galaxy, they would be absorbed like electrons into a positive ion. If not then there would be destructive gravitational and inertial interference, this would be stronger than the Eℍ/+𝕚d gravitational impulse attracting them to the galaxy and they would move away. This tends to give each galaxy about the same inertial velocity on their outer rim. Some might form globular clusters like a molecule.

Forming a cosmic web

This attraction is similar to the Casimir effect with this model, they have a Eℍ/+𝕚d gravitational impulse towards each other. When they get too close there is a +𝕀D gravitational probability that interferes destructively. That causes the galaxies to be less likely to be close together and they move apart. The two forces of impulse and work balance to form the cosmic web. At the CMB these filaments appear like sound waves with a compression of -𝕀D×e𝕧 inertial work. This would be like the galaxies acting as gas molecules, being compressed together in some positions as waves.

Galaxies colliding

With the -𝕀D inertial probability this also interferes destructively, two galaxies can be repelled like two electrons with their -𝕀D inertial probabilities. When two galaxies are on a collision course, then there is an E𝕍/-𝕚d inertial impulse along with the Eℍ/+𝕚d gravitational impulse as they approach each other. When they get close the -𝕀D inertial destructive probability causes them to be repelled. If the two galaxies collide, then there are quantized probabilities where individual stars attract each other with impulse and repel each other with work. This makes it unlikely individual stars would collide, the gravitational and inertial destructive interference would tend to swerve them around each other.

Seyfert galaxies

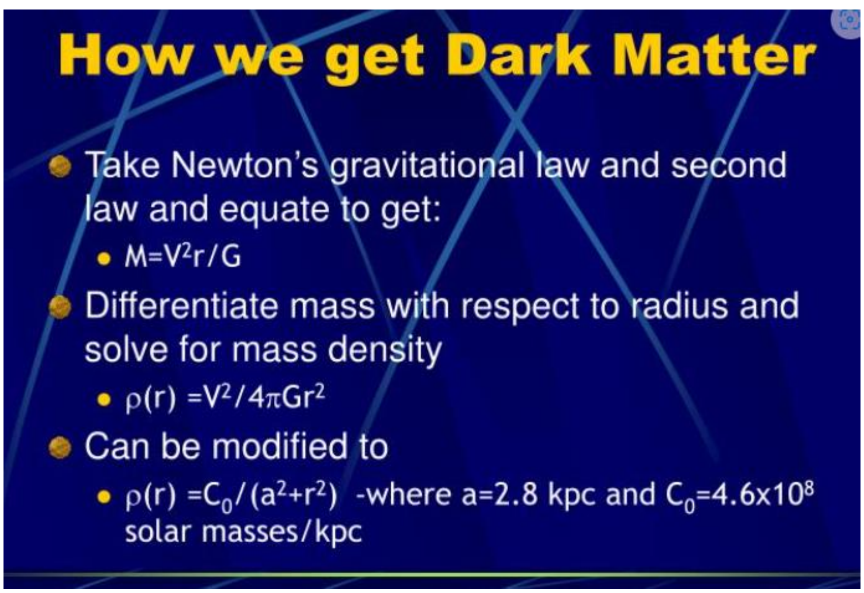
When a galaxy has excess matter it can expel this as a new Seyfert galaxy, that brings its +𝕚d gravitational back to the quantized value of 1. Dust clouds can coalesce into new galaxies up to this quantized level.

Dark matter formula

This formula is similar to that for dark matter below. The ½π term in MOND changes the rotational inertial velocity of the outer rim to a +𝕚d gravitational acceleration, from a circumference to a radius. In the dark matter formula the a^2 value is a e𝕙 height in kiloparsecs. This gives a reduction in the density of dark matter closer to the center of the galaxy. In MOND the opposite occurs, there is a constant a_0 is converged to at the time instead of converging to a radius of a with dark matter.

Dark matter and MOND

Here a is squared, this gives the Eℍ/+𝕚d gravitational impulse downwards which is slowing towards the center with less dark matter being attracted downwards. Further outwards the Eℍ/+𝕚d gravitational impulse downwards is faster from the proposed dark matter, its extra +𝕚d gravitational mass would cause the galaxy to have the same shape as with a_0 in MOND.



Differences between dark matter and MOND

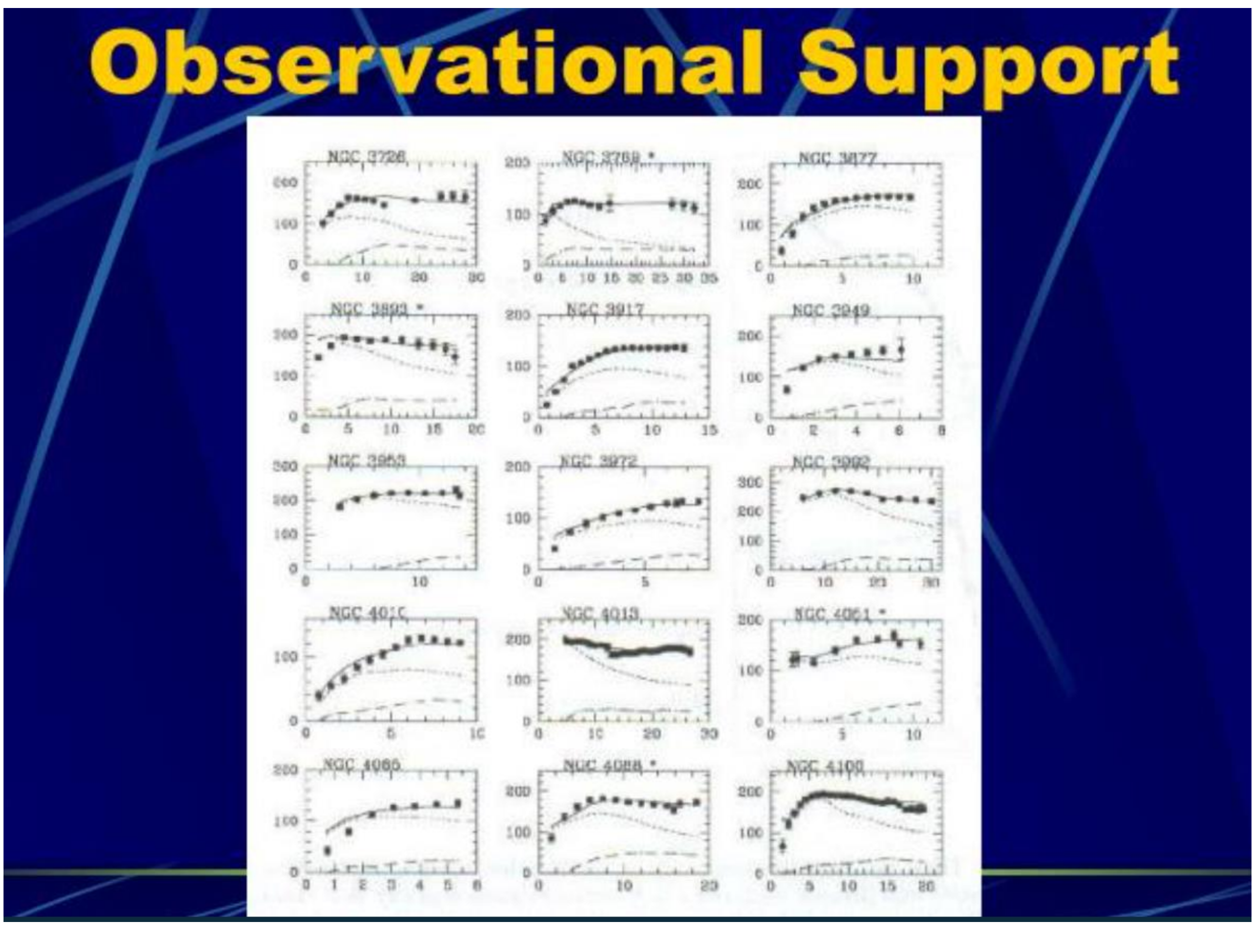
The dark matter formula gives a similar inertial velocity to the outer rim of galaxies. However the two formulae are not exactly the same because MOND is quantized. When a galaxy has less +ȉd gravitational mass it will not reach the same density, its shape is still a logarithmic curve which does not exist in the dark matter formula. That causes some galaxies to have a different density because the outer rim is not decelerating at the same rate relative to the eℍ height from the center in the dark matter formula. This would change the value of a^2 in the dark matter formula.

Dark matter and MOND as inverses

When the galaxy is quantized as 1, then the dark matter formula is the inverse of the MOND formula. When it is smaller then the dark matter formula is not balanced by the inertial formula of MOND. That means the galaxy will be like an atom that is missing electrons, it can attract more dust to form stars and bring its quantization value to 1.

Dark matter and galaxy rotation curves

In the diagrams below, the dark matter formula describes the rotation curves of many galaxies. MOND also describes this because they both use a constant. In this model there is no constant except 1/c, the inverse of the inertial velocity of light.

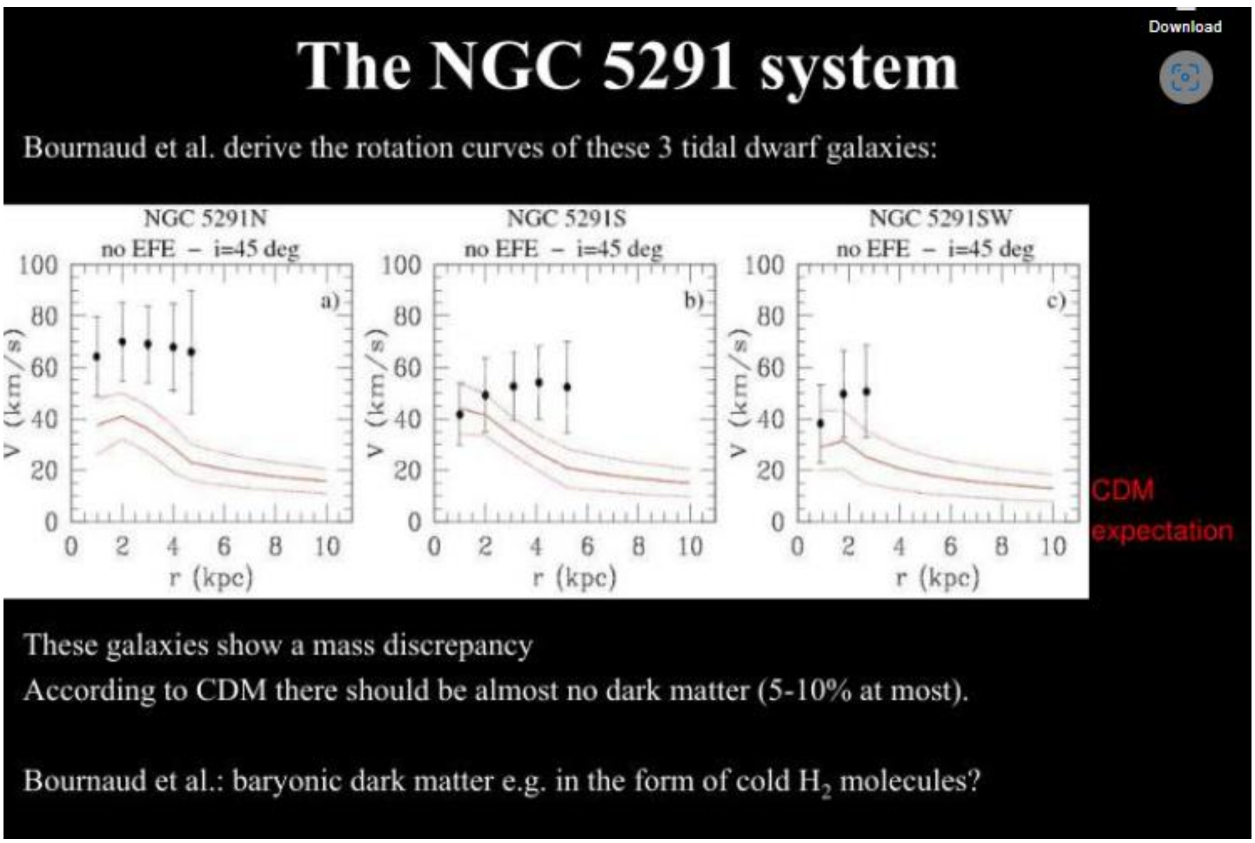


Deviations from dark matter predictions

In the diagrams below, smaller galaxies deviate significantly from dark matter predictions. There should be almost no dark matter, yet the outer rim inertial velocity is slower. In this model that comes from the constant areas of the +ⅈd and eℎ Pythagorean Triangles as gravity, and the -ⅈd and e𝕧 Pythagorean Triangles as inertia. They form a logarithmic spiral, or the gravitational mass is distributed more as a disc. In both cases they act as inverses approaching a quantized value of 1.

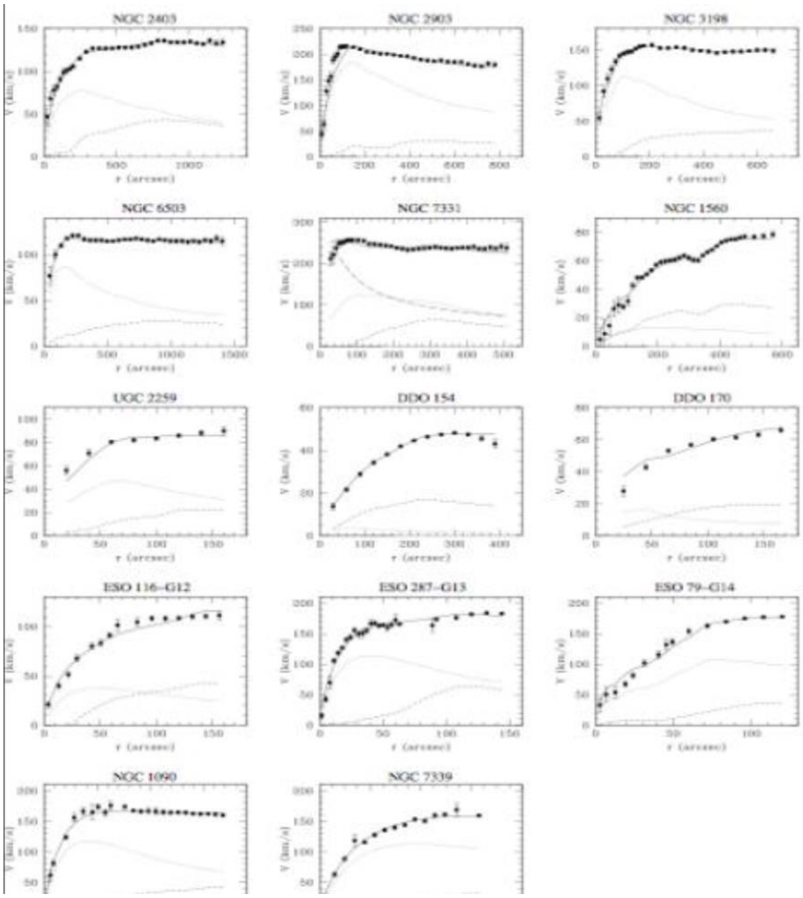
The same logarithmic spiral

This appears as missing dark matter, the galaxy retains the same shape with the logarithmic spiral. Its spiral has more of a +ⅅ gravitational torque and so it has the same inertial velocity on the rim, even though there should be less dark matter there. This is because the galaxy has a smaller eℎ height and the dark matter formula has reduced the dark matter density. The inertial density is not reduced, just the shape of the logarithmic spiral.



Smaller galaxies

This shows the inertial velocities of the galactic rims according to MOND, they converge to the same value with a quantization of 1. When the galaxy has less +ⅈd gravitational mass it converges to a lower figure with the logarithmic spiral. This allows the galaxy to attract more mass, its +ⅅ gravitational destructive interference is smaller and so the dust around larger galaxies can get closer to it. That allows the galaxy to capture more +ⅈd gravitational mass.



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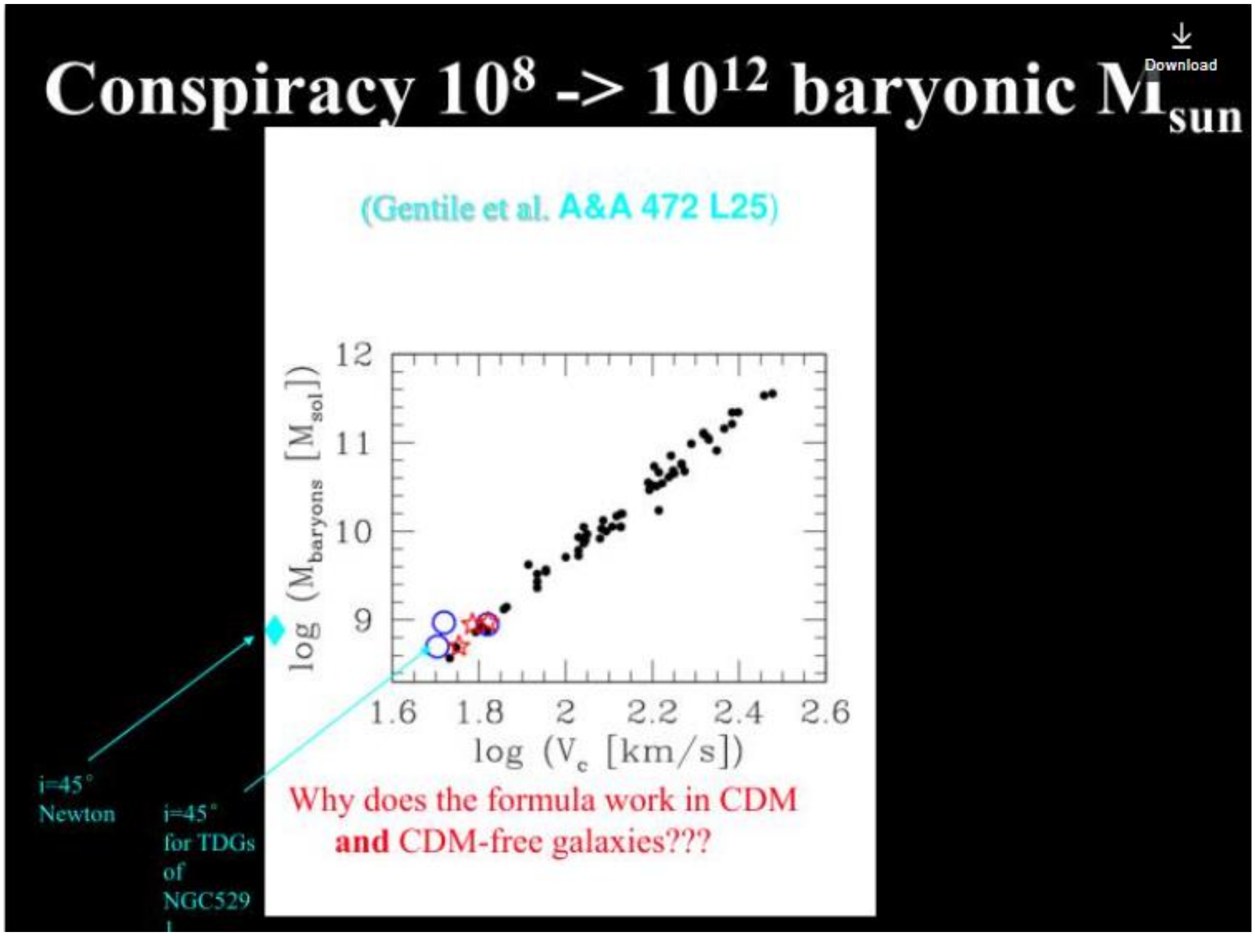
arXiv:astro-ph/0611132

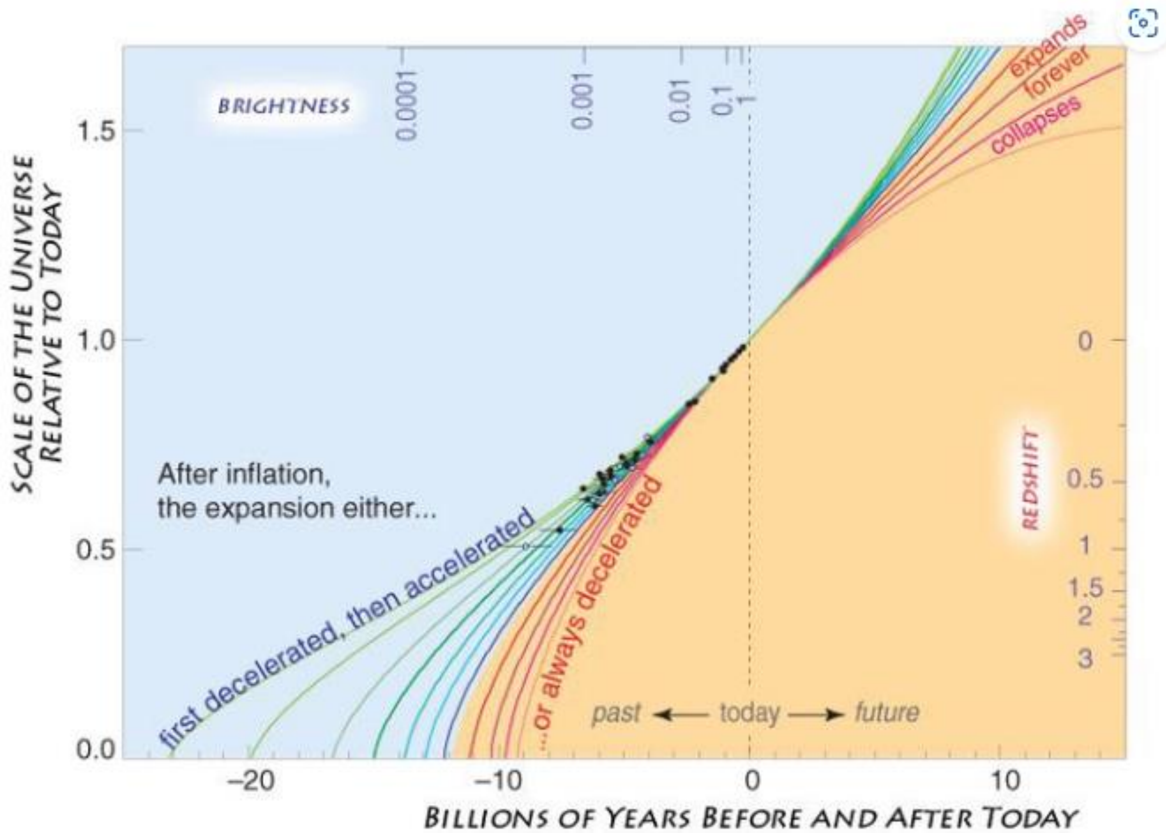
MOND and logarithms

The MOND formula fits many galaxies as shown. This is logarithmic because of the constant areas Pythagorean Triangles. When one Pythagorean Triangle side is squared, and the other remains linear, then the linear side describes an exponential curve. This is seen in radioactive decay for example, as the time doubles the amount of radioactive matter declines by two squared. This also describes the distribution of galaxies from constructive and destructive interference. In this model the +ⅈd gravitational mass also acts as +ⅈd gravitational time. So increases in mass also correspond to increases in the inertial velocity, that would increase as inertial acceleration.



Expansion of the universe

In this model +ⅈd gravitational time goes backwards, this extends to the limit of the +ⅈd and eℍ Pythagorean Triangle. The -ⅈd inertial time goes forward into hyperbolic geometry, this would extend to the limit of the -ⅈd and e𝕧 Pythagorean Triangle. Observing and measuring in the future is limited by whether light from some galaxies can reach us. This comes from this hyperbolic expansion. Observing and measuring in the past would come from the limit of whether light can reach us from beyond the CMB. Each should form a curve from a constant area Pythagorean Triangle.



Measuring back in time and distance (to the left of "today") can inform how the Universe will evolve and accelerate/decelerate far into the future. By linking the expansion rate to the matter-and-energy contents of the Universe and measuring the expansion rate, we can come up with a value for a Hubble time in the Universe, but that value isn't a constant; it evolves as the Universe expands and time flows on. (Credit: Saul Perlmutter/UC Berkeley)

Hubble tension

In this model the light intensity comes from its e𝕐/-𝕘d light impulse, this changes according to general relativity as the e𝕙 height contracts approaching the CMB. The width of galaxies comes from the inertial velocity at the rim, here this comes from the limit of c in the center around black holes. These are balanced by a limit of 1/c on the outer rim giving a quantized value of 1.

Quantized galaxy sizes

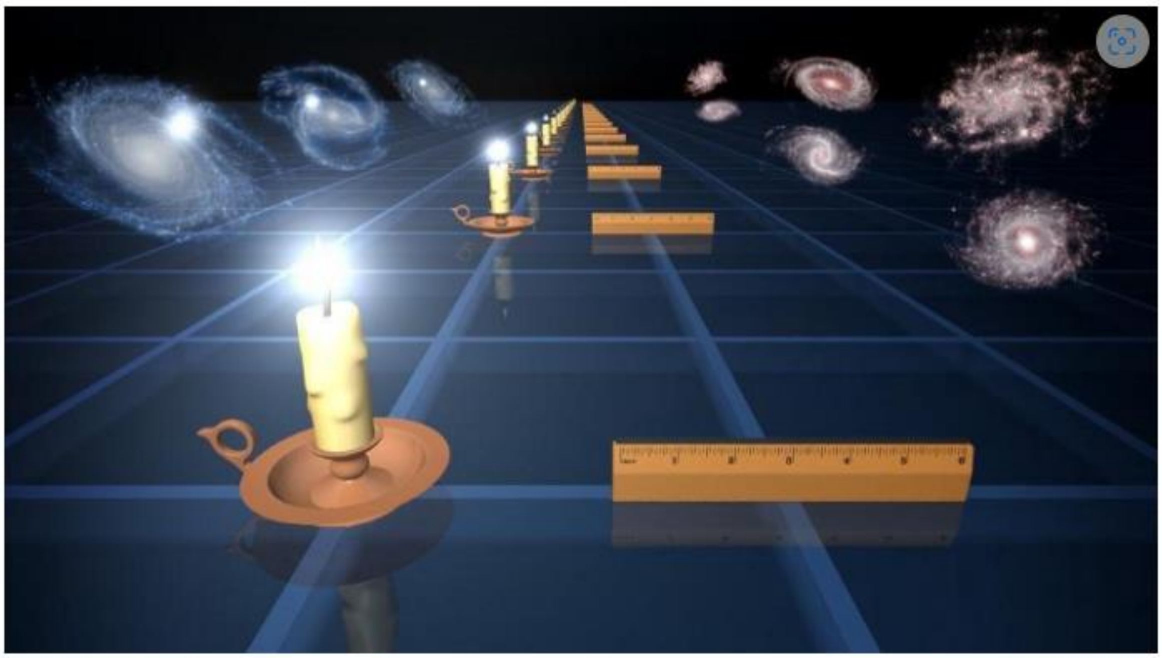
Galaxies then would be expected to be about the same size at extreme redshifts, the width would be smaller because they are further away. If Biv space-time was expanding then galaxies should be getting larger as they get closer, that would also change the width of the galaxies to synchronize with their brightness. In this model there is no space-time expansion, there is a e𝕙 height contraction towards a maximum height.

Galaxy intensity and size

Another way is from the width of galaxies compared to their intensity. Here MOND deviates from the dark matter model, this is because of the quantized size of galaxies. When the light intensity is observed, this can be regarded as being from galaxies of about the same size. This is different from a model of galaxies being formed at higher redshifts, hence they would be smaller. In this model there would also be a +𝕚d gravitational time slowing, that may make the initial Hubble expansion slower. There would also be a e𝕙 height contraction which in reverse would be Biv space-time expansion.

Height contraction not width

In this model the +𝕚d and e𝕙 Pythagorean Triangle has a e𝕙 height contract not a e𝕧 width contraction. Galaxies would then appear flatter but be just as wide. Towards the CMB the +𝕚d and e𝕙 Pythagorean Triangle is not pointing towards a single point or singularity here, the e𝕙 height is the same in any direction. There would then be a deviation between the brightness and the width.



Two of the most successful methods for measuring great cosmic distances are based on either their apparent brightness (L) or their apparent angular size (R), both of which are directly observable. If we can understand the intrinsic physical properties of these objects, we can use them as either standard candles (L) or standard rulers (R) to determine how the Universe has expanded, and therefore what it's made of, over its cosmic history. The geometry of how bright or how large an object appears is not trivial in the expanding Universe. (Credit: NASA/JPL-Caltech)

Quantization of galaxies

In this model there is a quantization value to galaxy sizes, at the event horizon of black holes there would be an inertial velocity of matter approaching c to avoid being pulled inside. On the outer edge of the galaxy the inertial velocity approaches 1/c, this is like +𝕚d×e𝕙 as having a constant Pythagorean Triangle area because the number and sizes of the stars is not changing.

The gravitational speed and inertial velocity

The e𝕙/+𝕚d gravitational speed of matter falling into the black holes approaches c, the e𝕧/-𝕚d inertial velocity of rotation would be its inverse as approaching 1/c. These should remain inverses or the galaxy would gain or lose matter. It is like a solar system where there is a balance between gravity and inertia.

Gravitational lensing

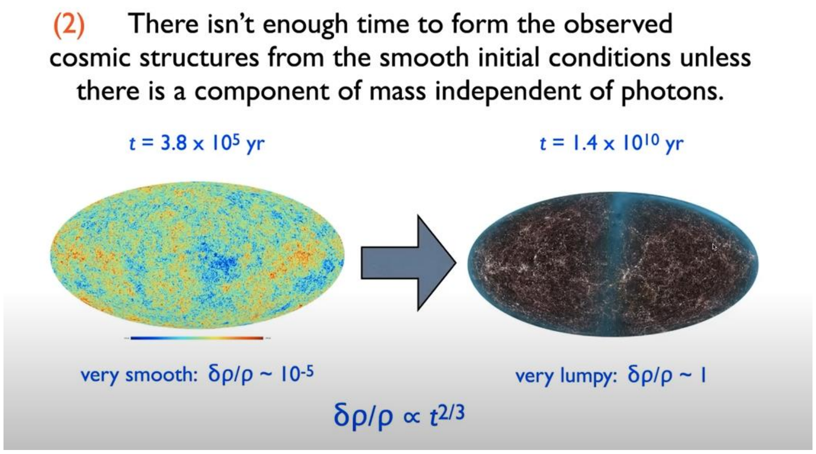
In this model the gravitational lensing of galaxies should also be stronger, there is no expansion of Biv space-time against it. Also light would be moving with a slower inertial velocity, the eℍ height contraction and slower +𝕚d gravitational time is like e𝕪×-𝕘d photons moving upwards from an event horizon. The galaxies have the same height contraction and time slowing as if they were closer, so the photons should appear to curve around them more.

Slower light and gravitational lensing

This can be modeled with closer galaxies having a normal amount of gravitational lensing. Then if these galaxies were flattened in the line of sight of the measurer, the bending around them would appear to be stronger. With stars orbiting close to a black hole, there would also be more lensing around them, the light's inertial velocity would be slower but the attraction to the stars would be the same.

A flattened galactic web

In this model galaxies have the same approximate form to the CMB and beyond, the galactic web is flattened with a eℍ height contraction into the CMB. That makes it appear like sound waves, at a lower height the web would be less flattened and so would appear like an increasingly typical shape.



Stars in the CMB as blackbodies

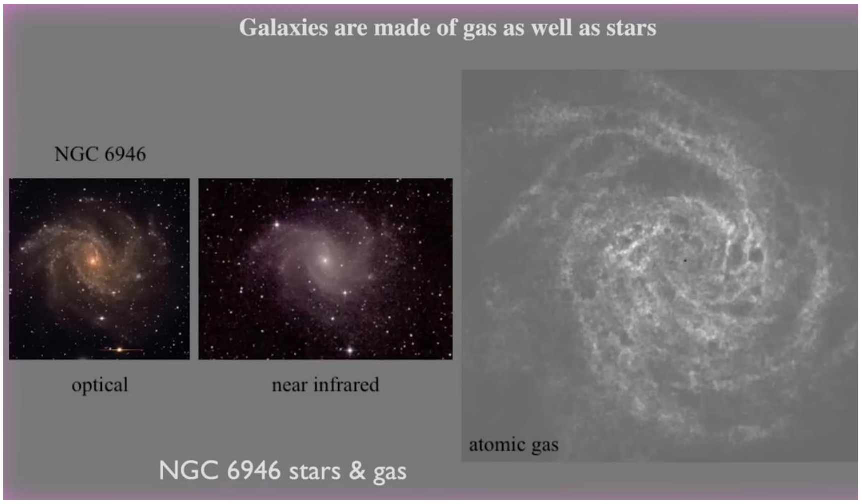
In this model each star emits blackbody radiation, when these are combined together at the CMB they form a surface with the same blackbody radiation. Variations occur from the gravitational forces behind it, when there are more galaxies in some areas these make the CMB appear cooler. The photons lose more -𝔾D×e𝕪 light work in those areas, where it is hotter there are more voids between the galaxies in the galactic web.

Quantization of dust and stars

In this model the quantized levels in a galaxy apply to dust as well as stars. It rotates at the same rate otherwise the stars would have their inertial velocity changed by it the dust's motion. A galaxy forms here by an accumulation of dust up to the quantized levels, when one is filled with dust and stars the next quantized level rotates at a different rate to the one above and below it. This gives the spiral shape, also the logarithmic spiral comes from one Pythagorean Triangle being squared and the other being linear.

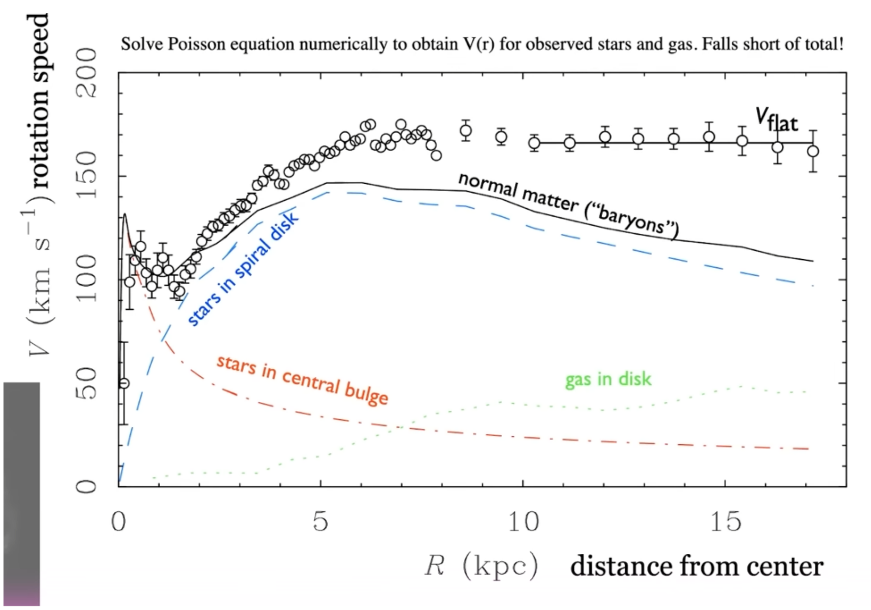
A logarithmic spiral from the constant Pythagorean Triangle areas

A logarithmic spiral forms from the +𝕀D gravitational torque balancing with the -𝕀D inertial torque, that changes inversely to the linear e𝕙 height and e𝕧 length respectively. Because the +𝕚d and e𝕙 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle have constant areas, the +𝕚d gravitational mass and -𝕚d inertial mass of the galaxy does not change. With this spiral stars would form by local gravitational attraction, they also form spirals and disks with the inertia of the dust which becomes the star and planets.



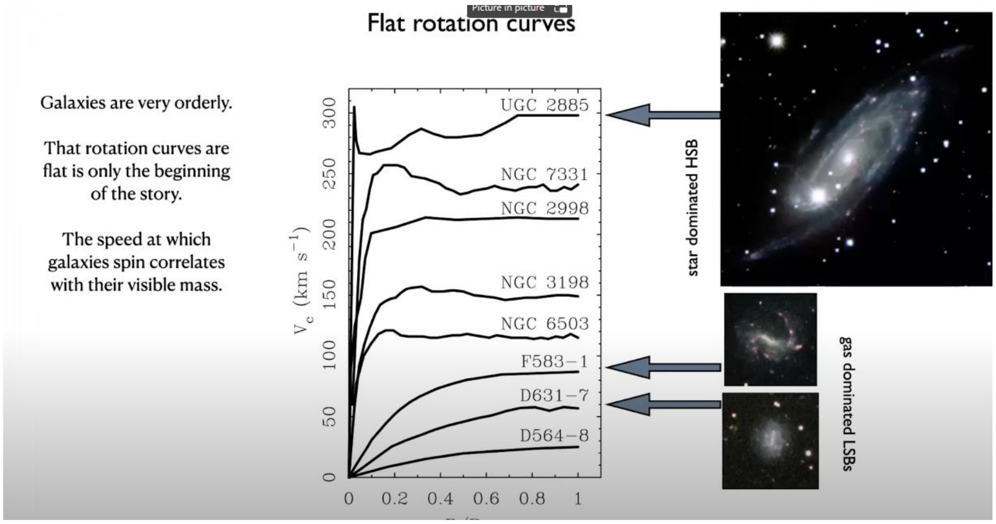
Quantized levels in the galaxy

In the diagram the inertial velocity on the room approaches 1/c according to the logarithmic spiral. There is an approximate quantized level at 100 km/sec and another at ≈ 160 km/sec. This does not follow the amount of rotating matter as shown.



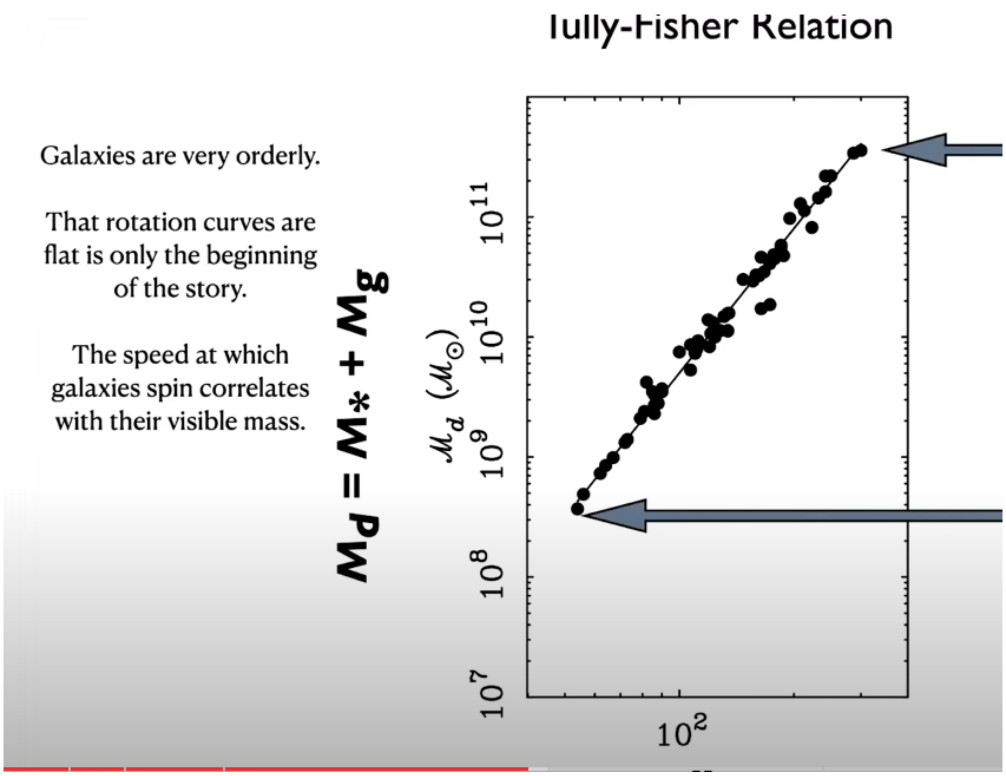
Each galaxy is a logarithmic spiral

In the diagram each galaxy forms a logarithmic spiral, that comes from the constant Pythagorean Triangle areas along with a constant amount of stars and dust. That means the center approaches c around the event horizons and a constant inertial velocity at the rim as a quantized level. Here the difference between the galaxies is approximately 50 km/sec as a quantized step. A larger galaxy would fill up an additional quantized step with a lower inertial velocity.



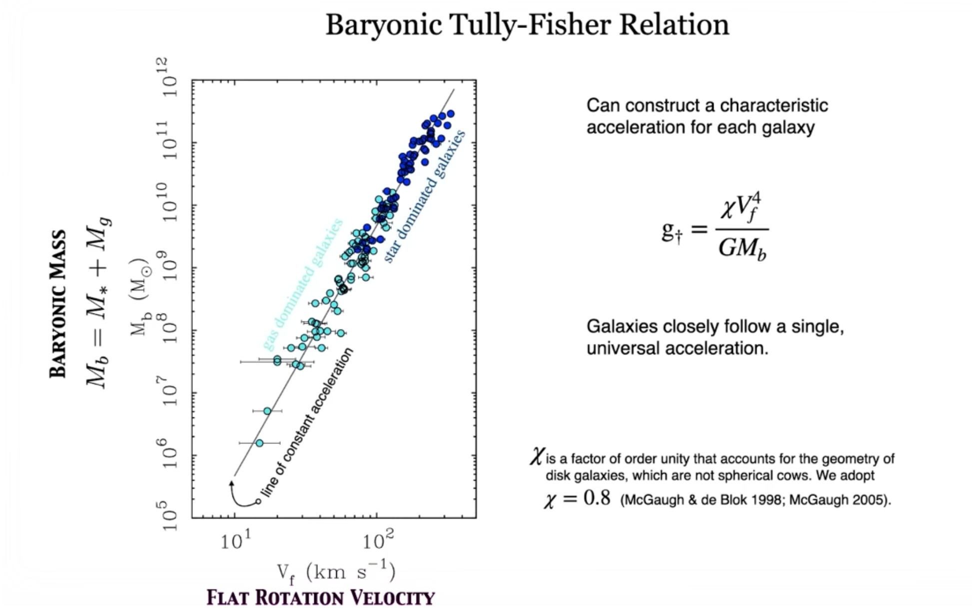
The Tully Fisher relation

In the Tully-Fisher relation, the amount of +ⅈd gravitational mass and the -ⅈd inertial mass are approximately equal. That is because there are about the same numbers of protons and electrons. They tend to bunch together which quantized steps of gravitational mass as shown. The rotational inertial velocity correlates with the gravitational mass because +ⅈd is proportional to the e𝕧 length. As one increases so does the other linearly.



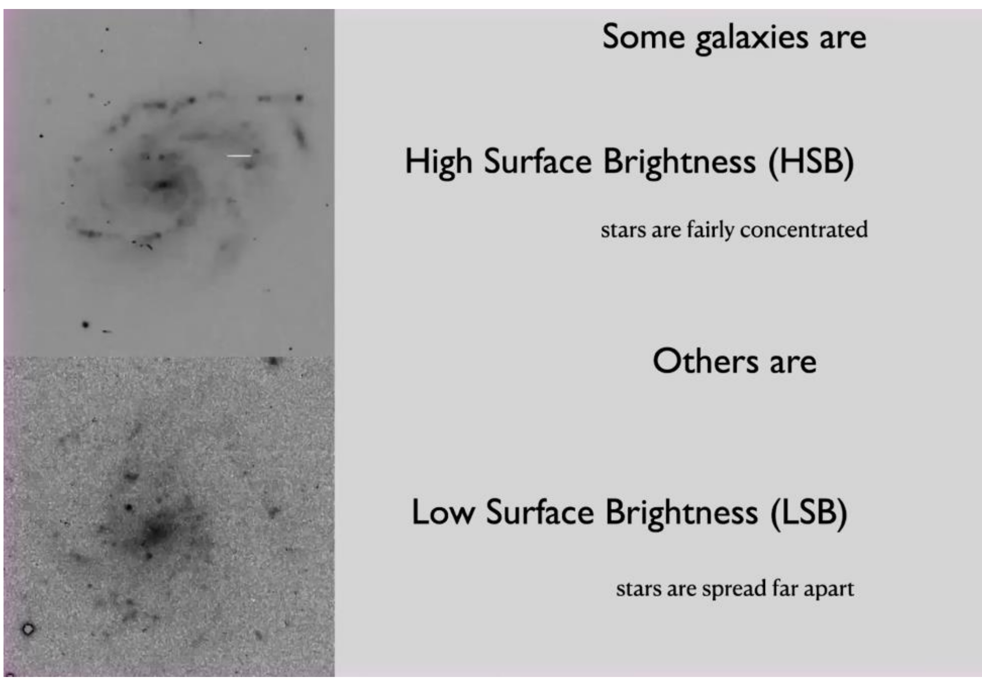
The baryonic Tully Fisher relation

In the diagram the galaxies with more dust have the same relation between the +ⅈd gravitational mass and the e𝕧/-ⅈd inertial velocity. This is because they would form the same logarithmic spiral.



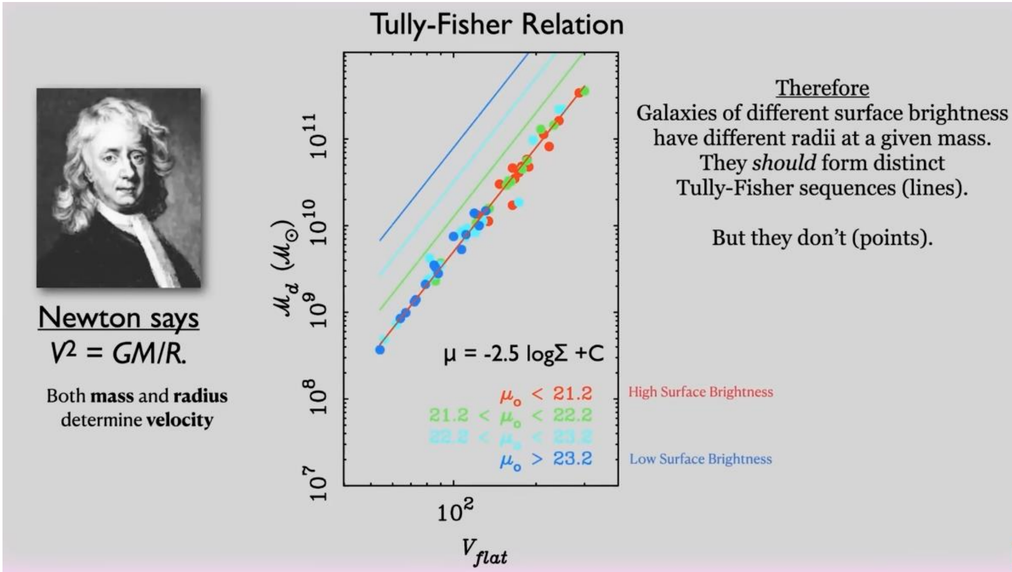
High and low surface brightness

In this model the surface brightness does not affect the logarithmic spiral, there is the same amount of +𝕚d gravitational mass. The inertial velocity would then be the same.



Different galactic radii

In this model a denser galaxy would have a different e𝕙 height for a given +𝕚d gravitational mass of its dust and stars. That would still have the inverse -𝕚d inertial mass, forming a logarithmic spiral. The inertial velocity would again have e𝕧 in e𝕧/-𝕚d proportional to +𝕚d.



Different sized galaxies

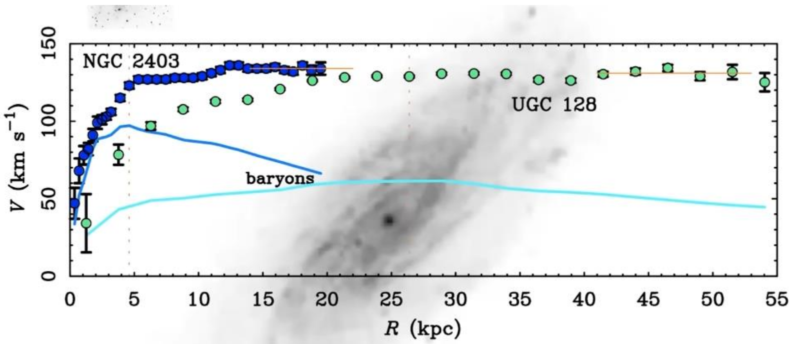
In the first diagram the two galaxies have approximately the same inertial velocity on the rim. They have approximately the same +𝕚d gravitational mass but a different e𝕙 height, so the mass is denser in one. The -𝕚d inertial mass is also denser because that comes from electrons, the +𝕚d gravitational mass from protons. When the gravitational speed e𝕙/+𝕚d points towards the galactic center, that accelerates faster with a Eℍ/+𝕚d gravitational impulse when the galaxy is denser.

Inverse inertial mass

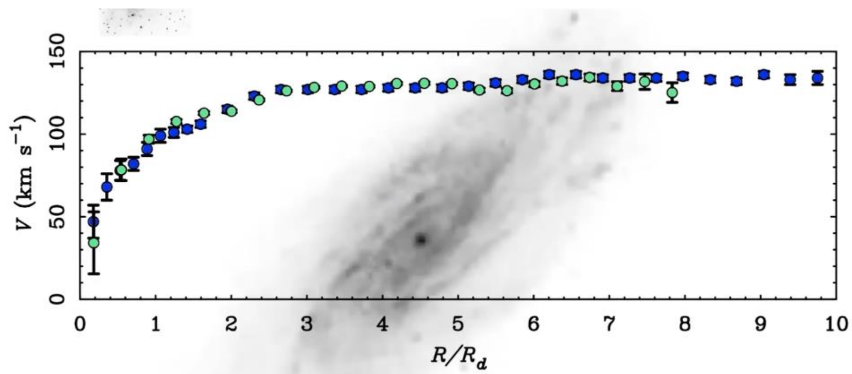
The inertia remains an inverse to this, so the e𝕧/-𝕚d inertial velocity and its E𝕍/-𝕚d inertial impulse is also stronger. In terms of torque the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work also remain inverses. In one galaxy the e𝕙 height is smaller so the -𝕚d inertial mass is also smaller in proportion to it. The +𝕚d gravitational mass does not change so the e𝕧 length in the inertial velocity at the rim does not change. That means with a shorter e𝕙 height that galaxy has a smaller -𝕚d inertial time in e𝕧/-𝕚d.

Different logarithmic spirals

That equates to the same inertial velocity at the rim, e𝕧 as the length is unchanged in proportion to the +𝕚d gravitational mass. Where the e𝕙 height is shorter in a denser region, the inertial velocity is faster so it flattens off more slowly as shown. Because the +𝕚d gravitational mass and -𝕚d inertial mass are equal, then at the rim they both converge to the same inertial velocity.



Radius in physical units (kpc)



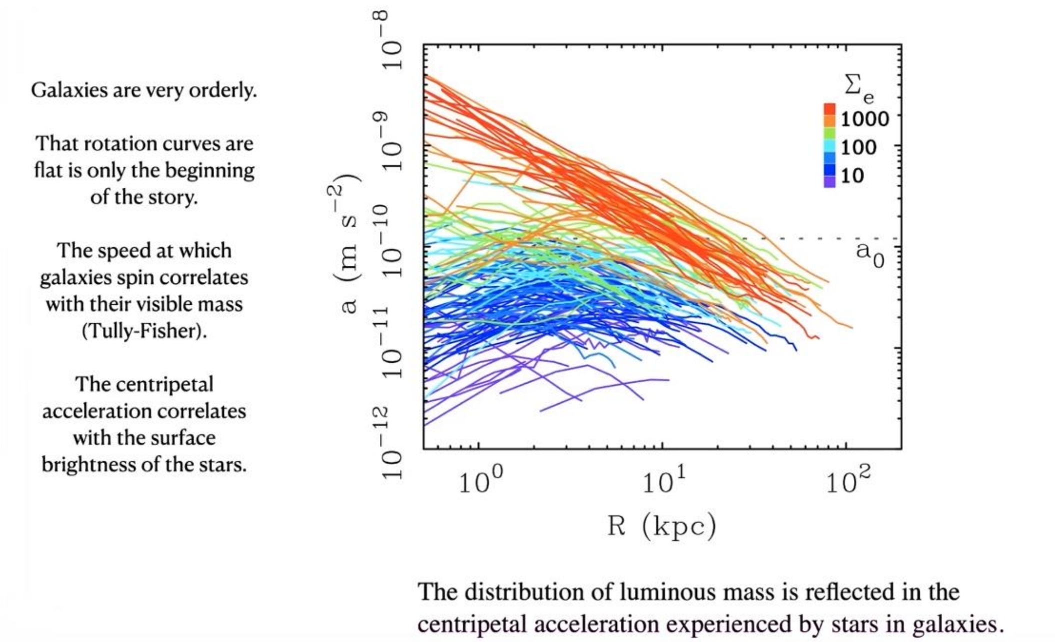
Radius normalized by size of disk.

Denser galaxies

This means that where the surface brightness is larger, that is from a lower e𝕙 height and a denser +𝕚d gravitational mass contained in it. The centripetal acceleration towards the center would be different according to the changed density, that means the logarithmic spiral has a looser or tighter shape from a changing +𝕀D gravitational torque.

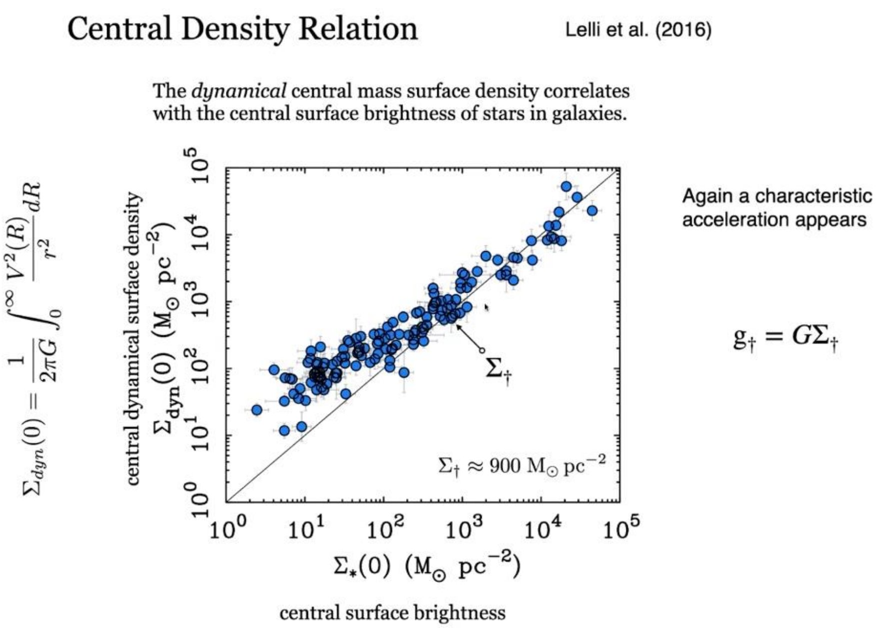
Centripetal acceleration

The centripetal acceleration would be the Eℍ/+𝕚d gravitational impulse pointing towards the center. This also correlates with the rim inertial velocity because +𝕚d is the gravitational time as well as mass.



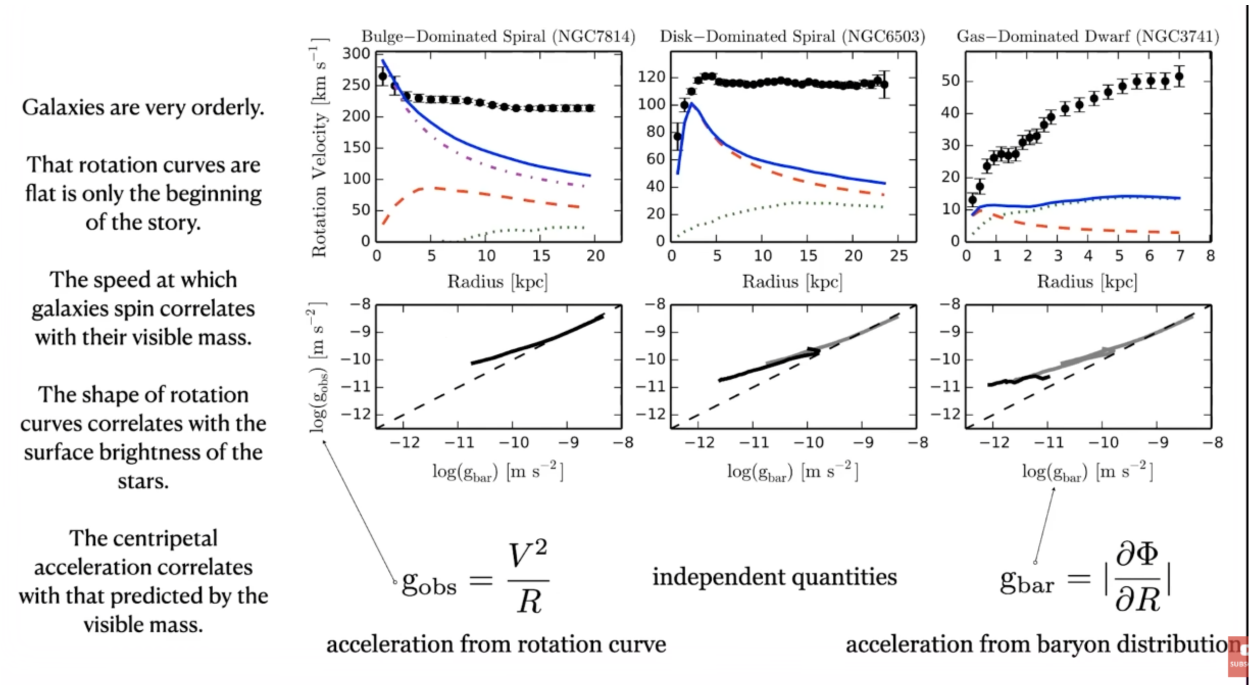
Central density

Here the central density of the galaxies correlates with their surface brightness. They would then also correlate with their +𝕚d gravitational mass and -𝕚d inertial mass.



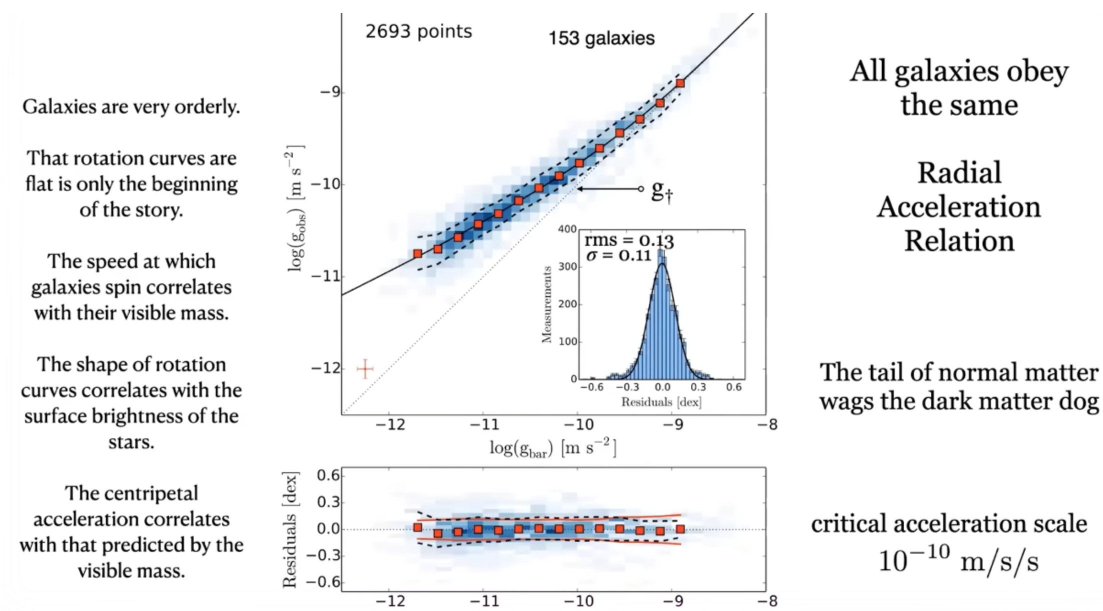
Different shaped galaxies

Different shaped galaxies can have a different density with their +𝕚d gravitational mass in relation to the e𝕙 height from the center. This still approaches the logarithmic spiral where the inertial velocity approaches a minimum. That is because the e𝕙/+𝕚d gravitational speed approaches a maximum at c.



The inertial velocity speed up

In this model the radial acceleration approaches a logarithmic spiral, that has a constant deceleration as a square for all. When the critical acceleration is approached it acts like the inverse of general relativity, the slow inertial velocity approaches 1/c. The e𝕧 length tends to dilate rather than contract, the -𝕚d inertial mass to speed up rather than slow down towards an event horizon. This maintains a minimum inertial velocity, if not then the stars would slow until they stopped and then fall back into the galaxy. This deviates from a parabolic deceleration according to the inverse square rule.



1/c

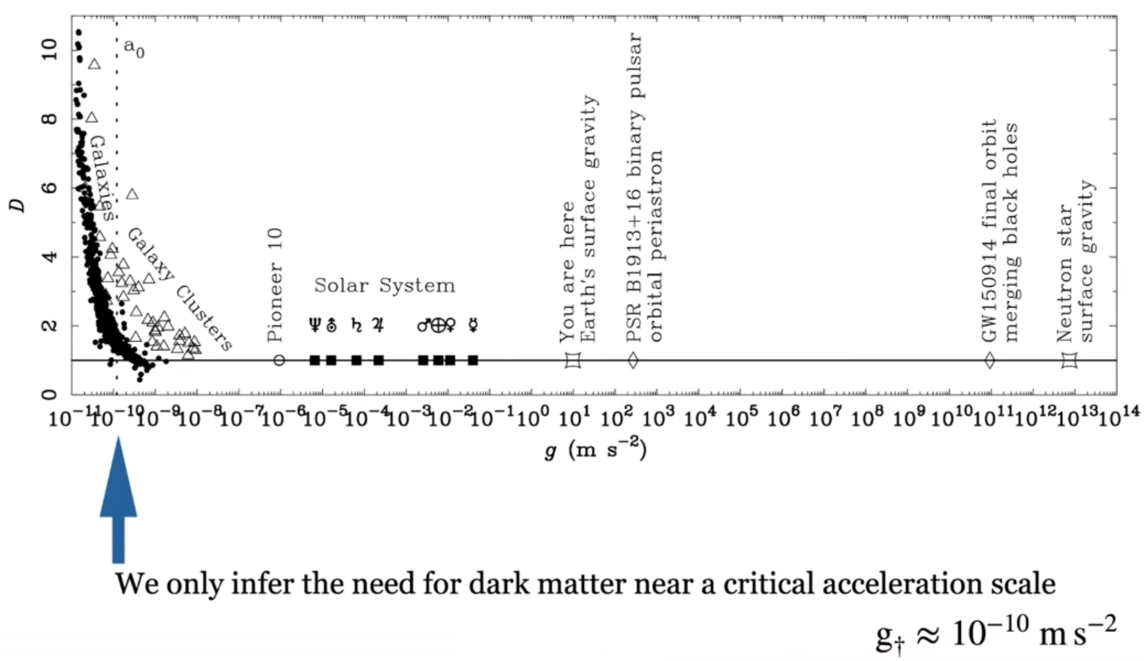
In this model the critical acceleration approaches 1/c, this deviates from an inverse square relationship with squared -𝕀D×e𝕧 inertial work just as +𝕀D×e𝕙 gravitational work deviates towards black holes in the galactic center. That keeps the outer rim moving fast enough to maintain an approximately flat inertial velocity, it acts like dark matter or modified gravity just as general relativity also has modified gravity. Closer to an event horizon, the infalling matter tends to slow down when observed and measured.

Slowing towards an event horizon

A rocket falling towards an event horizon appears to slow down, the +𝕚d gravitational time is slower and the rocket may seem to stop near the event horizon. The -𝕚d and e𝕧 Pythagorean Triangle with inertia is the inverse of this, there is a e𝕧 length contraction of the rocket approaching c and a -𝕚d inertial time slowing.

A minimum gravitational speed

In this model there would also be a minimum e𝕙/+𝕚d gravitational speed as 1/c, when this approaches the e𝕙 height dilates and the +𝕚d gravitational time speeds up. In the nucleus quarks would approach being at rest, that makes them speed up and so they appear to be moving faster there.



Step shaped redshifts

Halton Arp proposed that there are step shaped redshifts in galaxies, that is consistent with this model. The +𝕀D×e𝕙 gravitational work is quantized, there would be redshift values that jump in steps like with electrons in orbitals with +𝕆D×e𝕒 potential work. A continuous change in redshifts would only happen with the Eℍ/+𝕚d gravitational impulse, that can happen outside the atom with a E𝔸/+𝕠d potential impulse. There can be connections between galaxies with a different external redshift, that is like in between molecules of different sizes.

A rubber sheet model of general relativity

General relativity is modeled on a rubber sheet that is depressed with a greater +𝕚d gravitational mass. In an atom there is +𝕆D×e𝕒 potential work so protons are like waves, the electrons do -𝕆D×e𝕪 kinetic work in quantized levels.

Quantized orbitals in an atom

In this model the +𝕀D×e𝕙 gravitational work around a galaxy is like +𝕆D×e𝕒 potential work in an atom, the stars can be confined to galactic steps with a quantized redshift. The +𝕀D gravitational probability is generally whole number based, a galaxy can be elliptical like an electron orbital.

Work and impulse with stars

Just as the electron moves partially as a particle and a wave in an atom with a simple fraction of h, the elliptical galaxy has some Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse so stars can move to some degree through these steps. That allows for some stars to oscillate in galactic areas but also to move around more than the quantization allows.

Galactic steps out to the CMB

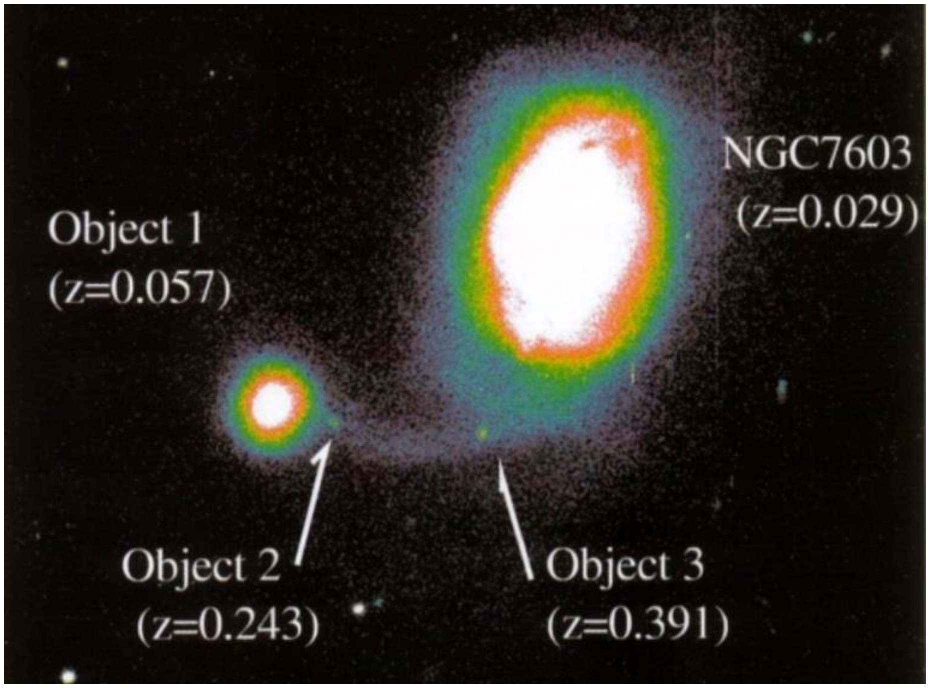
These steps extend out around the galaxies because the e𝕙 height with +𝕀D×e𝕙 gravitational work extends out to the CMB. That makes gravity mainly measurable as waves with a curved geodesic. The graviton as a particle would be very small, it would also be observed outside the CMB or the limit of e𝕙 height for the observer. Trying to find a graviton inside the CMB is like trying to observe an electron in the atom, they are dominated by a quantized wave nature from work.

Satellite galaxies on a galactic step

The galactic steps can be empty, a satellite galaxy would be on one of these steps with a different redshift that is quantized. In between these steps there may be some dust connecting the galaxies, that is like electrons as waves in between atoms in a molecule.

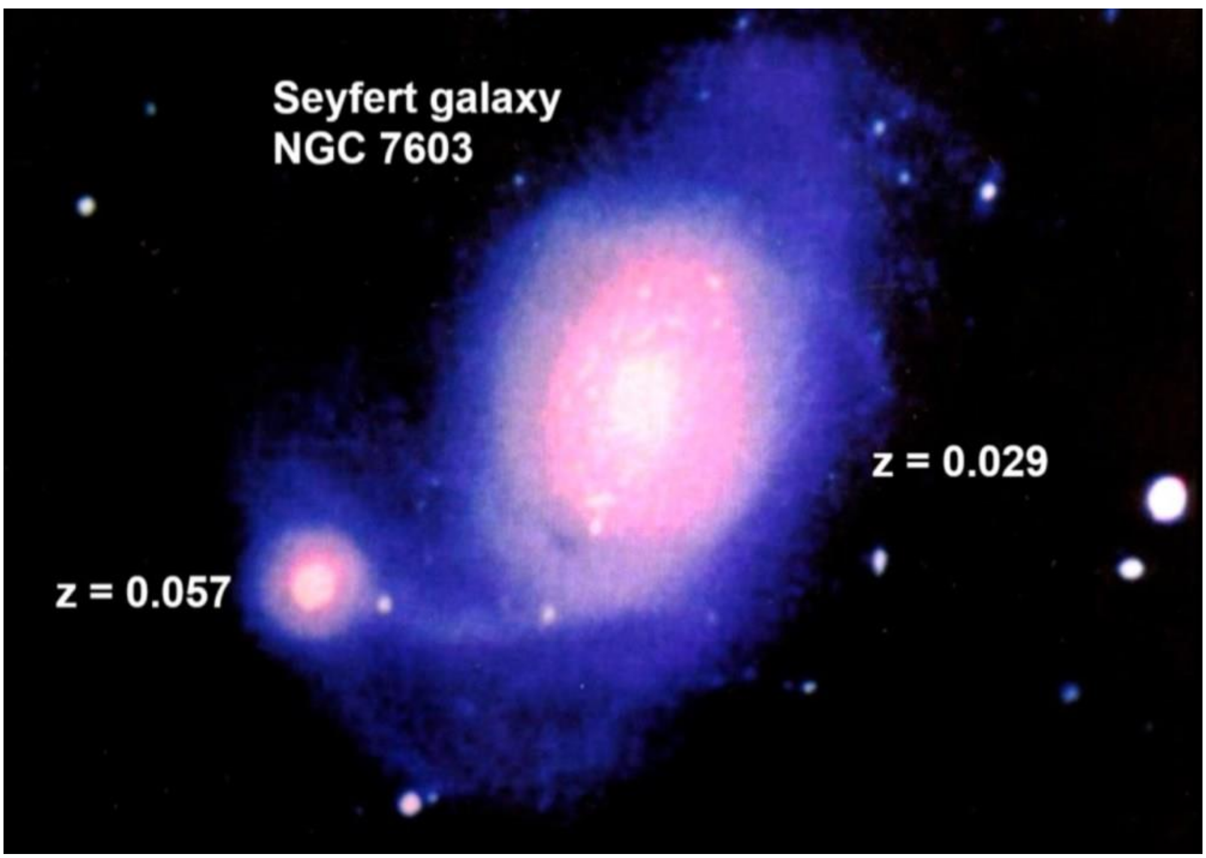
Solids have more work, a gas has more impulse

In this model, molecules are also quantized so the distances between the atoms is bound by quantized resonations like satellite galaxies. A solid does not collapse because of the quantized relationships, a liquid and a gas have more of a E𝕐/-𝕠d kinetic impulse in between the electrons which breaks some of the molecular bonds.



A spiral between galaxies

In this diagram there can be galactic dust around both galaxies, this connection is also a spiral shape because of the +𝕀D×e𝕙 gravitational work being done.



A galaxy emits quasars

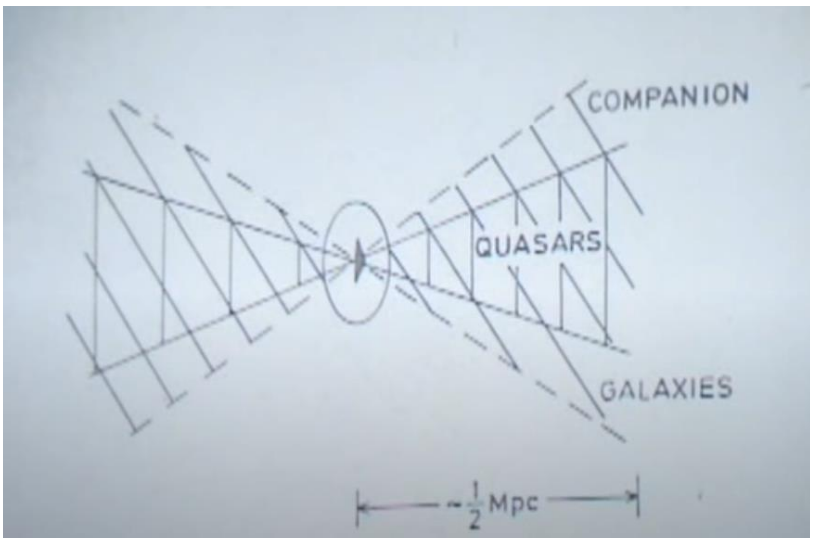
According to Arp a parent galaxy can emit quasars, this come out more in line with the minor axis of the spiral so there can be a non-quantized E𝕍/-𝕚d inertial impulse. In the atoms an elliptical orbital is a combination of -𝕆D×e𝕪 kinetic work and the E𝕐/-𝕠d kinetic impulse of an electron, here the E𝕍/-𝕚d inertial impulse would be stronger in the minor axis direction. That is more of the numerator of the fraction and so there would be more of an E𝕍/-𝕚d inertial impulse there.

Elliptical orbitals

For example an elliptical orbital might be 2/3 of h, 3 would be a quantized value of a circular orbital. The minor axis is the numerator because it is smaller, so this would have more impulse.

Orthogonal to the disk

Orthogonal to the disk would be nearly all E𝕍/-𝕚d inertial impulse and so there would be a continuous jet of material

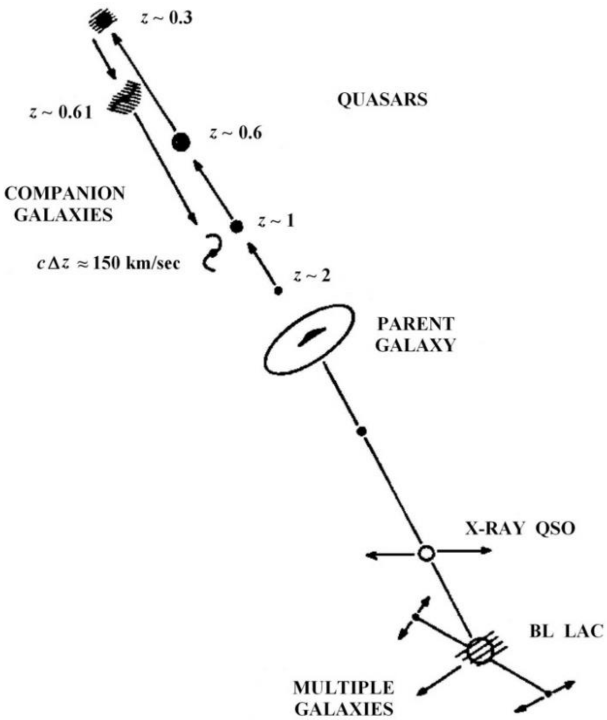


Quasars break up into galaxies

The quasar can then break up into several galaxies that do work on each other, they form galactic steps or orbitals where they can sit in quantized redshift proportions. When the quasars slow they also form more +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, that makes their redshifts become more quantized.

Two quasars opposite each other

There can be two quasars emitted opposite each other, this conserves the E𝕍/-𝕚d inertial impulse so the galaxy does not have its quantized shape distorted. The quasar material has a higher inertial velocity, that comes from a higher e𝕪/-𝕠d kinetic velocity. This can be distributed in the galaxy through quantization, the rigid step structure can cause the quasar material to be ejected with a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse instead.



Arp's hypothesis

Arp's hypothesis was that created matter had a low +ïd gravitational mass, the higher redshift initially comes from this matter being on a lower galactic step. As it is ejected it moves to a higher step so its redshift becomes smaller. The minor axis also has a quantization, so the E𝕍/-ïd inertial impulse forms satellite galaxies like a lower energy state without conflicting with the major axis.

The fundamental assumption: ***Are particle masses constant?***

The photon emitted in an orbital transition of an electron in an atom can only be redshifted if its mass is initially small. As time goes on the electron communicates with more and more matter within a sphere whose limit is expanding at velocity c. If the masses of electrons increase, emitted photons change from an initially high redshift to a lower redshift with time (see Narlikar and Arp, 1993[6])

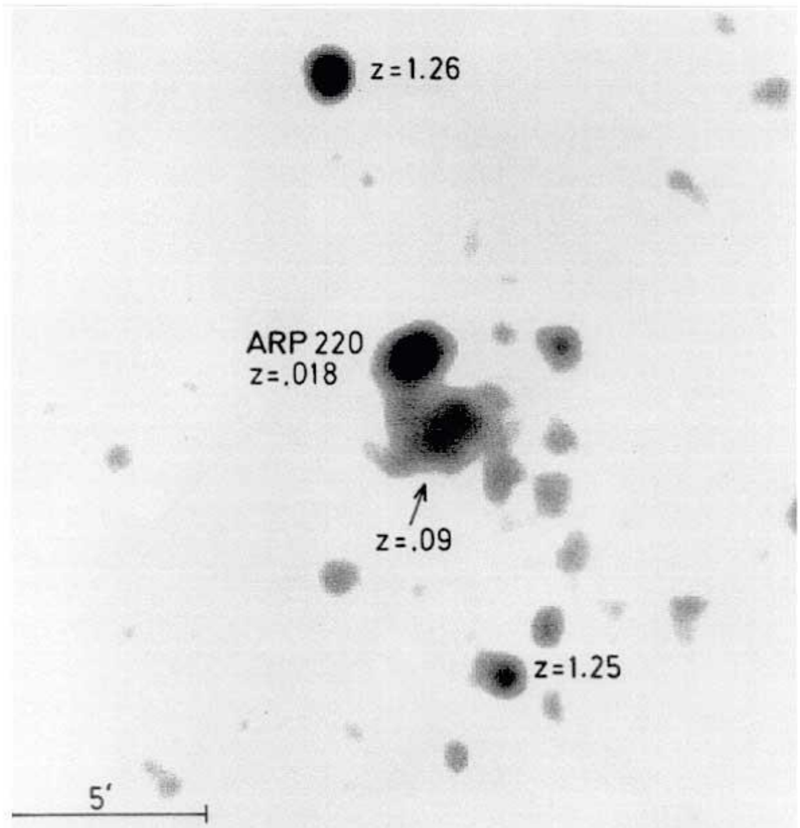
Predicted consequences: ***Quasars are born with high redshift and evolve into galaxies of lower redshift.***

Near zero mass particles evolve from energy conditions in an active nucleus. (If particle masses have to be created sometime, it seems easier to grow things from a low mass state rather than producing them instantaneously in a finished state.)

A spiral between the quasar and the parent galaxy

In this model the two quasars are opposite each other, with the galaxy in between. Here they may have left some dust at quantized intervals. There is also a spiral shape which would be from +𝕀D×e𝕙 gravitational work, that connects to the spiral in the minor axis. Sometimes one quasar can be ejected more towards the measurer with a blueshift, then the redshift of the second quasar is higher moving away with the same proportion.

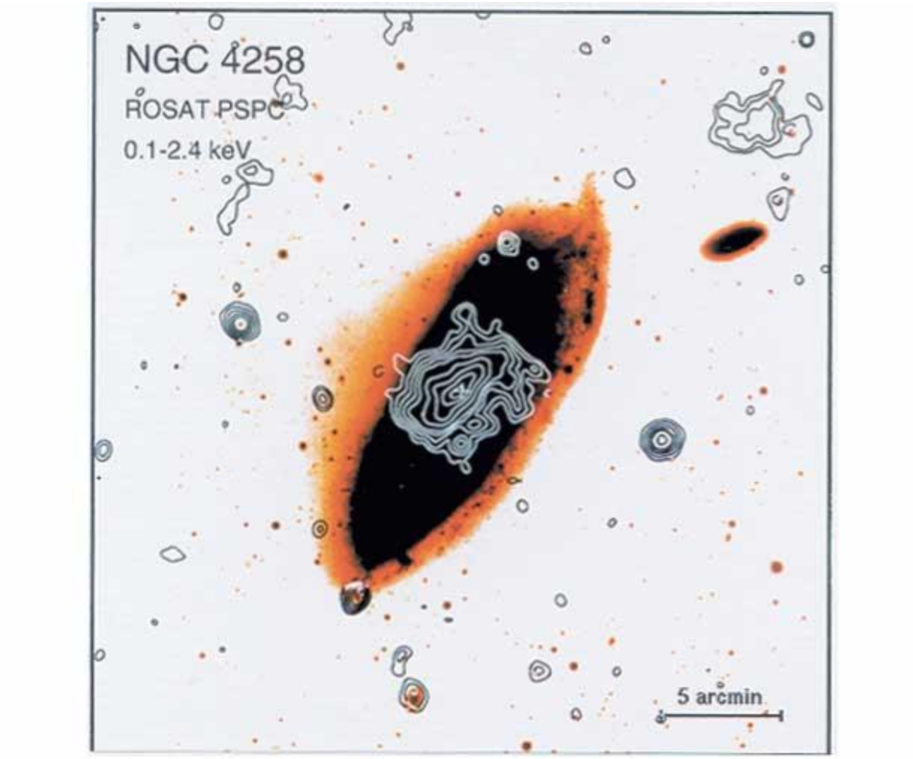
ULIRG's



2000 - INNER REGION OF ULIRG ARP 220. X-RAY QUASARS EXACTLY ALIGNED WITH ALMOST IDENTICAL SPECTRA. TRAIL OF X-RAY SPOTS LEADING DOWN TO z=1.25 QSO. GROUP OF Z=.09 GALAXIES CONNECTED BY X-RAYS AND LOW z=.018 HYDROGEN.

Two quasars ejected

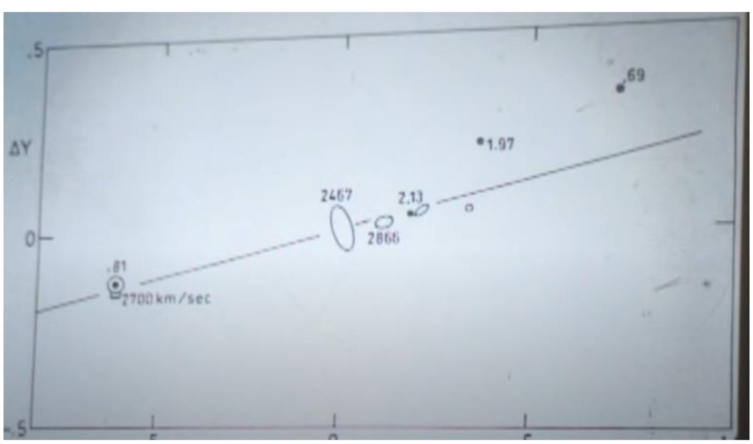
In the diagram two quasars may have been ejected with an E𝕍/-𝕚d inertial impulse along the minor axis.



1994 - X-RAY QUASARS NEAR ACTIVE GALAXIES. THIS PAIR AT Z = .40 AND .65 FALL ACROSS A BRIGHT SEYFERT 2 GALAXY KNOWN TO BE EJECTING RADIO AND X-RAY MATERIAL

Quantized satellite galaxies from quasars

According to Arp the quasars are emitted on opposites sides of the galaxy along the minor axis. The E𝕍/-𝕚d inertial impulse slows with the Eℍ/+𝕚d gravitational impulse pulling them back towards the parent galaxy. According to this model, some galaxies can fall back onto a quantized redshift step.

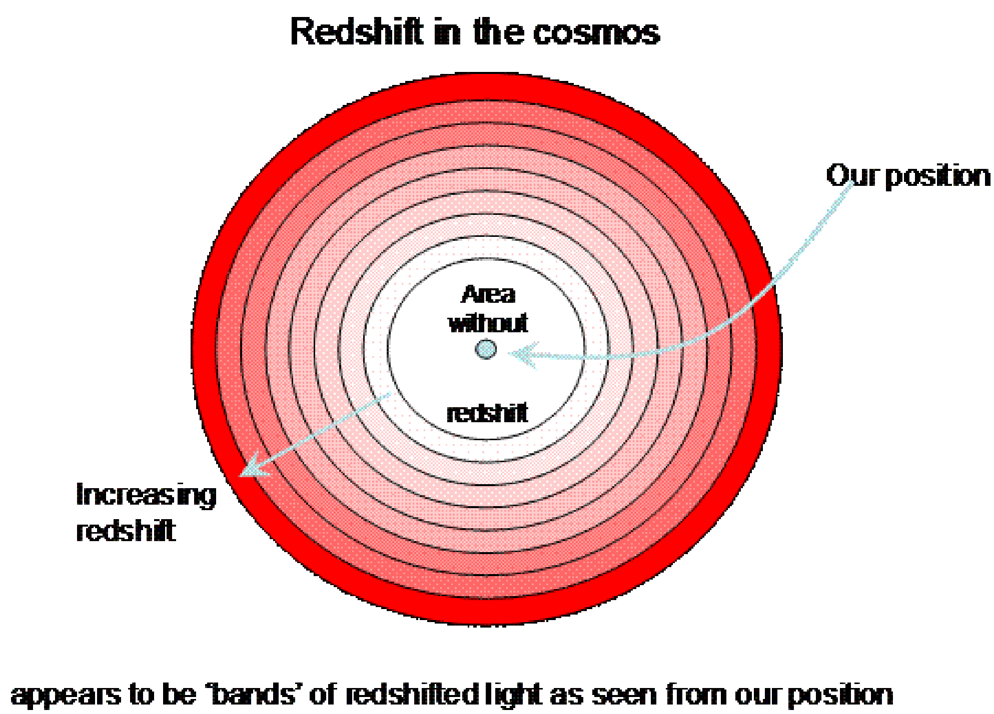


Quantized redshifts in all directions

There appears to be a quantized redshift in all directions from the measurer with an increasing e𝕙 height. In this model the +𝕀D×e𝕙 gravitational work from the +𝕚d and e𝕙 Pythagorean Triangle means galaxies would have their redshifts arranged this way. The e𝕙 height to the galaxies need not be quantized, it is the redshift as the photons in effect climb up a quantized gravitational well.

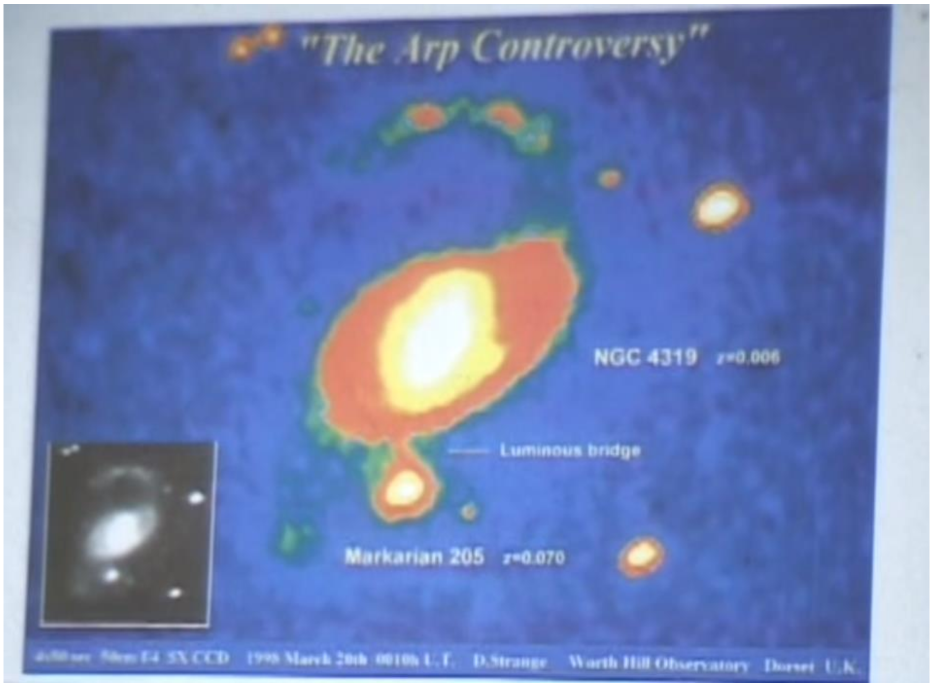
Quantized kinetic redshift

This is like in an atom, from the nucleus the electrons would be measured in quantized orbitals as steps. The e𝕒 altitude is proportional to the e𝕙 height of gravity outside the atom, in Biv space-time +Id×e𝕓 gravitational work should have quantized redshifts like the -𝕆D×e𝕪 kinetic work of electrons is kinetically redshifted.



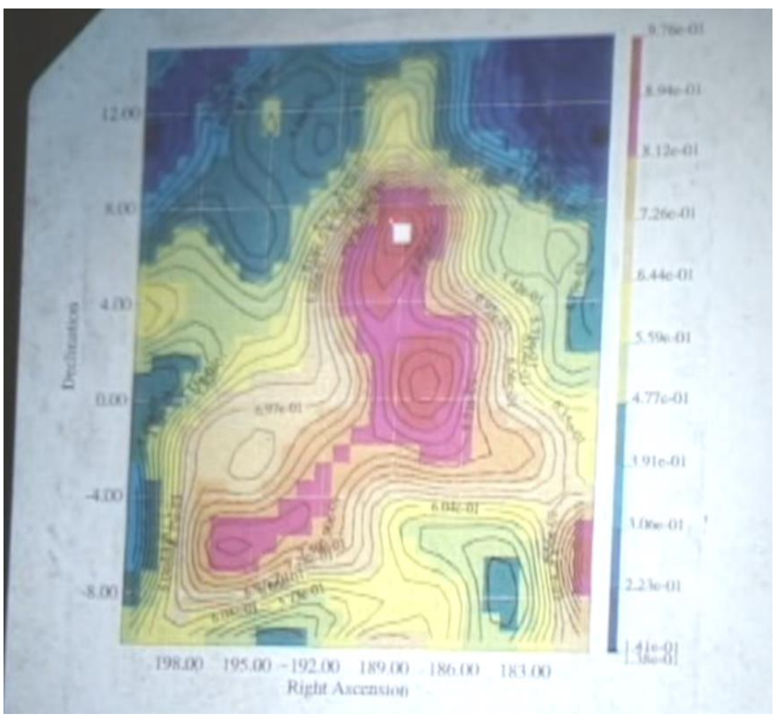
Connections between galaxies

Here Arp shows a connection between a satellite galaxy and the parent galaxy which is degraded. This can be like a molecular bond between the galactic steps, dust can be transferred between them.



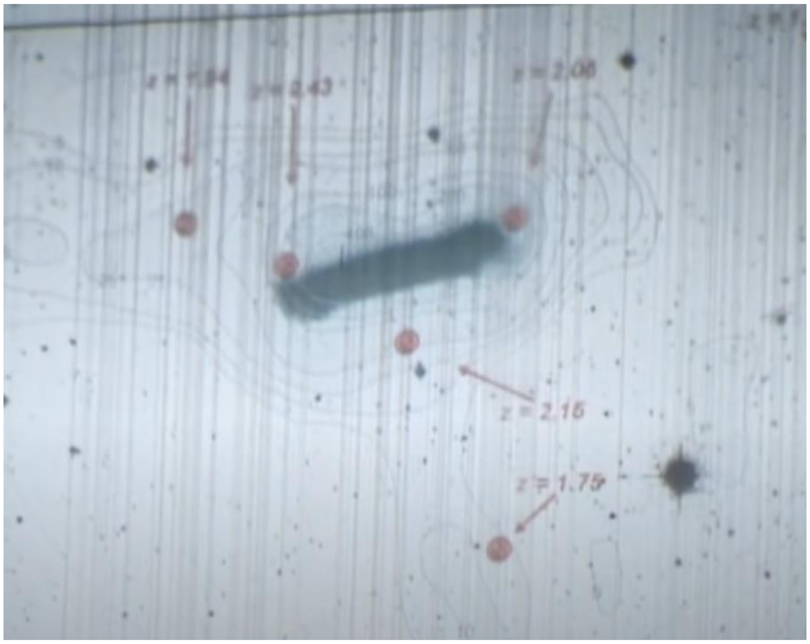
Step like contours

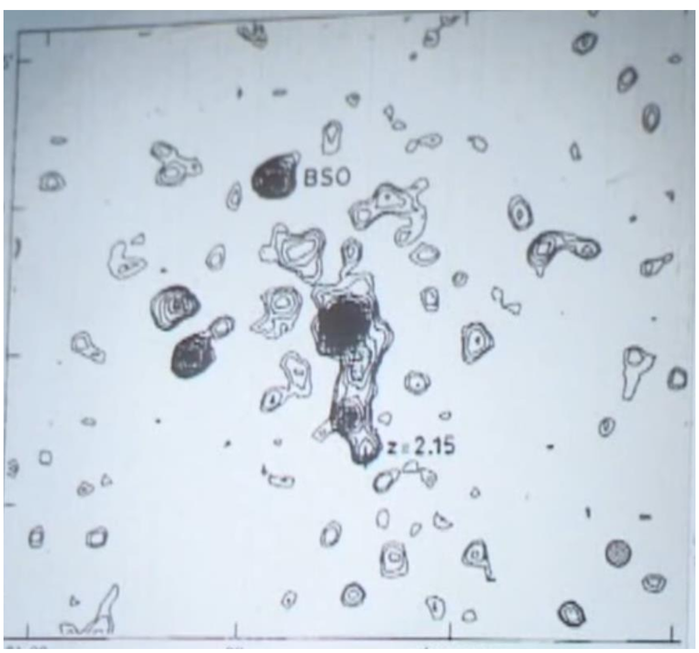
In this image there are several connections, the step like contours can be related to a quantized redshift. There would be similar quantized connections in between atoms in a molecule.



Intrinsic redshift lecture

This is from Halton Arp's intrinsic redshift lecture. There are quasars with different redshifts, perhaps ejected from the minor galaxy of the galaxy. These can be on the galactic steps from +𝕀D×e𝕙 gravitational work.





Probe charges

When a probe charge is placed at a e𝕒 or e𝕪 position it measures the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, not an electric field. This is measured as Newtons/Coulomb, in this model Newtons are a measurement of work because the spin Pythagorean Triangle sides are squared.

The probe charge is a scale

Coulombs have no forces, they are the +𝕠d×e𝕒/+𝕠d potential momentum and -𝕠d×e𝕪/-𝕠d kinetic momentum. According to this model the change in the momentum is measured by work by the probe. The charge used to probe is like a ruler or scale, it has no affect on the charge. This is because the size of a ruler used to measure positions does not affect those positions.

1. Some set of charges, which we call the **source charges,** alters the space around them by creating an electric field $\vec{E}$ at all points in space.
2. A separate charge q *in* the electric field experiences force $\vec{F} = q\vec{E}$ exerted *by the field*. The force on a positive charge is in the direction of $\vec{E}$; the force on a negative charge is directed opposite to $\vec{E}$.

Thus the source charges exert an electric force on q through the electric field that they've created.

We can learn about the electric field by measuring the force on a *probe charge q*. If, as in FIGURE 22.23a, we place a probe charge at position (x, y, z) and measure force $\vec{F}_{\text{on } q}$, then the electric field at that point is

$$\vec{E}(x, y, z) = \frac{\vec{F}_{\text{on } q} \text{ at } (x, y, z)}{q} \qquad (22.5)$$

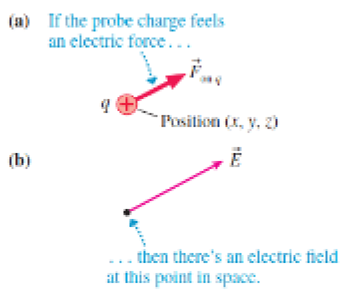
We're *defining* the electric field as a force-to-charge ratio; hence the units of electric field are newtons per coulomb, or N/C. The magnitude E of the electric field is called the **electric field strength.**

It is important to recognize that probe charge q allows us to *observe* the field, but q is not responsible for creating the field. The field was already there, created by the source charges. FIGURE 22.23b shows the field at this point in space after probe charge q has been removed. You could imagine "mapping out" the field by moving charge q all through space.

Because q appears in Equation 22.5, you might think that the electric field depends on the size of the charge used to probe it. It doesn't. Coulomb's law tells us that $\vec{F}_{\text{on } q}$ is proportional to q, so the electric field defined in Equation 22.5 is *independent* of the charge that probes it. The electric field depends only on the source charges that create it.

We can summarize these important ideas with the **field model** of charge interactions:

FIGURE 22.23 Charge q is a probe of the electric field.



A series of points is not a field

In this model there are vectors in all positions, but these come from work and the magnetic field. A charge moves to a higher +𝕆D potential probability or -𝕆D kinetic probability that is larger with work. It can collide with other charges with a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. Points in space are not a field, an integral area such as -𝕠d×e𝕪 has not points which would be derivatives as e𝕪/-𝕠d. A point e𝕪 needs to be defined by when it was there at a kinetic time -𝕠d.

Summing columns as an integral

When individual columns are summed in an integral, these can go to an infinitesimal width in calculus. Here this infinitesimal can only come from work, the displacement from one column to the next can describe the changes in slope of the curve as impulse. With an integral of work this is measured over a series of infinitesimal positions so the torque of the integral causes the curve shape to be created.

A curve from torque or probability

The other axis would measure this torque as a square, it can also be a probability density of where the curve is likely to go. These probabilities can constructively and destructively interfere, this gives probable integral sizes as an area as with Fourier analysis.

Constructive and destructive possibilities

When these columns observe displacements as a series of impulses, the same curve can be made with some uncertainty. These are differentiated with time, then the positions would become displacements from one column to the next and the other axis would be of time. The possible impulse have a kind of interference as collisions, a constructive collision is when the slope or speed/velocity increases and a destructive collision is when the slope or speed/velocity decreases.

Possibilities and probabilities are inverses

A constructive collision is the inverse of a constructive interference, the first has a larger impulse and the second does more work. In a gas the collisions have constructive and destructive possibilities, with the constructive and destructive interference these approach a normal curve integral with the Boltzmann constant -𝕠d ×e𝕪/-𝕆d. When the pressure of a gas is observed on the surface of a container, this increases with constructive collisions or possibilities. This increases with e𝕪 temperature and a continuous spectrum from the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse of the gas.

Limits of work

The limit of -𝕆D×e𝕪 kinetic work is generally the ionization level in an atom, outside it the electrons has a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse as a particle. This can also do some -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work, for example when there is a constructive and destructive interference around the slits in a double slit experiment. There is also a diffraction around the slits where the -𝕆D kinetic torque curves the electrons away from a straight-line through it.

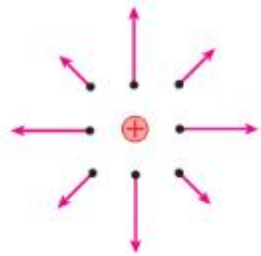
A gravitational limit of work

With the +𝕚d and e𝕙 Pythagorean Triangle and gravity there is a limit to +𝕀D×e𝕙 gravitational work, generally past this gravity would come mainly from the Eℍ/+𝕚d gravitational impulse as particles. That gives a limit like a ground state from where gravis and photons can be emitted, that appears like an event horizon.

Electric field

Charges interact via the electric field.

- The electric force on a charge is exerted by the electric field.
- The electric field is created by other charges, the **source charges.**
  - The electric force is a vector.
  - The field exists at all points in space.
  - A charge does not feel its own field.
- If the electric field at a point in space is $\vec{E}$, a particle with charge q experiences an electric force $\vec{F}_{\text{on } q} = q\vec{E}$.
  - The force on a positive charge is in the direction of the field.
  - The force on a negative charge is opposite the direction of the field.



The electric charge is the inverse of the magnetic field

In this model using a probe charge does +𝕆D×e𝕒 potential work or -𝕆D×e𝕪 kinetic work according to Coulomb's Law. Here there is a single charge in (22.7), that gives (-𝕠d×e𝕪/-𝕠d)/E𝕐 which is 1/e𝕪. That is multiplied by -𝕠d×e𝕪/-𝕆D in Newtons to give 1/-𝕠d. The electric charge here would be the inverse of the -𝕠d kinetic magnetic field, so 1/-𝕠d is e𝕪 as the kinetic electric charge.

The Electric Field of a Point Charge

We will begin to put the definition of the electric field to full use in the next chapter. For now, to develop the ideas, we will determine the electric field of a single point charge q. FIGURE 22.24a shows charge q and a point in space at which we would like to know the electric field. To do so, we use a second charge q' as a probe of the electric field.

For the moment, assume both charges are positive. The force on q', which is repulsive and directed straight away from q, is given by Coulomb's law:

$$\vec{F}_{\text{on } q'} = \left(\frac{1}{4\pi\epsilon_0} \frac{qq'}{r^2}, \text{ away from } q \right) \tag{22.6}$$

It's customary to use $1/4\pi\epsilon_0$ rather than K for field calculations. Equation 22.5 defined the electric field in terms of the force on a probe charge; thus the electric field at this point is

$$\vec{E} = \frac{\vec{F}_{\text{on } q'}}{q'} = \left(\frac{1}{4\pi\epsilon_0} \frac{q}{r^2}, \text{ away from } q \right) \tag{22.7}$$

The electric field is shown in FIGURE 22.24b.

NOTE The expression for the electric field is similar to Coulomb's law. To distinguish the two, remember that Coulomb's law has a product of two charges in the numerator. It describes the force between *two* charges. The electric field has a single charge in the numerator. It is the field of *a* charge.

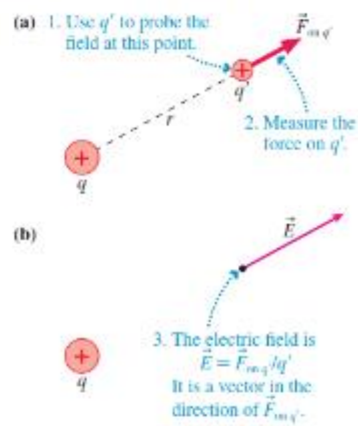


FIGURE 22.24 Charge q' is used to probe the electric field of point charge q.

Force vectors

Here the vectors pointing away from the positive charge, or proton would come from the +𝕠d and e𝕒 Pythagorean Triangle. They are represented here as shorter when further away from the proton according to the inverse square law. In this model the vectors would extend outwards from the proton as an e𝕒 altitude. When this is squared it gives the E𝔸/+𝕠d potential impulse. This is a reactive force, proportionally to the Eℍ/+𝕚d gravitational impulse this would be in meters^2/second. This means the attraction at higher e𝕙 heights and e𝕒 altitudes decreases accoridng to the inverse square law.

Potential probability of negative charges being attracted

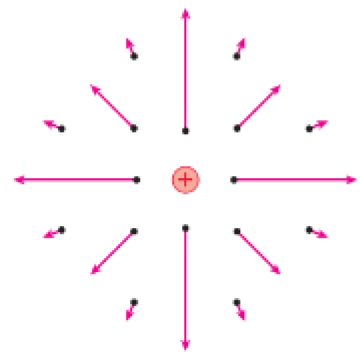
Inverse to this is the +𝕆D×e𝕒 potential work, there is a stronger +𝕆D potential probability of electrons or negative charges being found at lower e𝕒 altitudes. Further out this probability drops as a square, according to the diagram. That would mean electrons would move inwards with a stronger E𝕐/-𝕠d kinetic impulse, also consistent with the inverse square rule.

If we calculate the field at a sufficient number of points in space, we can draw a **field diagram** such as the one shown in FIGURE 22.25. Notice that the field vectors all point straight away from charge *q*. Also notice how quickly the arrows decrease in length due to the inverse-square dependence on *r*.

Keep these three important points in mind when using field diagrams:

1. The diagram is just a representative sample of electric field vectors. The field exists at all the other points. A well-drawn diagram can tell you fairly well what the field would be like at a neighboring point.
2. The arrow indicates the direction and the strength of the electric field *at the point to which it is attached*—that is, at the point where the *tail* of the vector is placed. In this chapter, we indicate the point at which the electric field is measured with a dot. The length of any vector is significant only relative to the lengths of other vectors.
3. Although we have to draw a vector across the page, from one point to another, an electric field vector is *not* a spatial quantity. It does not "stretch" from one point to another. Each vector represents the electric field at *one point* in space.

FIGURE 22.25 The electric field of a positive point charge.



In this model away from a charge can be in circular geometry with the +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity. This gives the direction from the nature of the Pythagorean Triangle. With the -𝕠d and e𝕪 Pythagorean Triangle as the electron, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia, these also have a direction from the Pythagorean Triangle itself. That means they don't need to have direction imposed externally. When this direction is added then it comes from an observation or measurement which adds uncertainty.

Unit Vector Notation

Equation 22.7 is precise, but it's not terribly convenient. Furthermore, what happens if the source charge *q* is negative? We need a more concise notation to write the electric field, a notation that will allow *q* to be either positive or negative.

The basic need is to express "away from *q*" in mathematical notation. "Away from *q*" is a *direction* in space. To guide us, recall that we already have a notation for

Orthogonals Pythagorean Triangles

Here iotas can be modeled as orthogonal Pythagorean Triangles, this can be regarded as having a direction as î, ĵ, and k̂. The size of the straight Pythagorean Triangle sides can be regarded as an infinitesimal, such as e𝕒^0 and e𝕪^0. These Pythagorean Triangle sides cannot be added or subtracted here except as vectors. They would have no positive and negative signs.

Orthogonal spin Pythagorean Triangle sides

They would have spin Pythagorean Triangle sides at right angles to each straight one, here +𝕠d is the positive square root of -1 and -𝕠d is the negative square root of -1.

The neutron

In this model there can be three orthogonal Pythagorean Triangles, this enables a model of the hadrons, leptons, quarks, gluons, bosons, etc. The basis of this model is the neutron, this has a balance between going -𝕠d forward in kinetic time and +𝕠d going backwards in potential time. It has three different spins, that prevents it from spinning like a rolling wheel as the proton, electron, and photon do here.

Balancing forward and backward time

The neutron is represented here by an +𝕠d and e𝕒 Pythagorean Triangle as +𝕠2/3, the other two orthogonal -𝕠d and e𝕪 Pythagorean Triangles are -𝕠1/3 which adds to zero. Here +𝕠2/3 is the up quark, -𝕠1/3 is the down quark. This balance the -𝕠d forwards and +𝕠d backwards time. Proportionally it also balances the +𝕚d backwards gravitational time, and the -𝕚d forwards inertial time. The three Pythagorean Triangles overall have a half spin, two of them cancel each other leaving one to be able to be clockwise or counterclockwise.

Fractional magnetic fields

The model works in a similar way to atomic orbitals, here the magnetic fields are fractional because there are three orthogonal Pythagorean Triangles. That allows for an +𝕠2/3 up quark to act as a field or integral square, the -𝕠1/3 down quark as a single time value. In between +𝕠2/3 and -𝕠1/3 there is 1, this acts as a boson like the e𝕪×-𝕘d photon. With the +𝕚2/3 and -𝕚1/3 in Biv space-time the difference is also a quantized 1.

Quantized bosons

These 1s can act as gluons, also W bosons and pions. Here this has a mass because it comes between +𝕚2/3 and -𝕚1/3, this gives the pion in between protons and neutron with the strong force. They have mass as the difference between a gravitational and inertial mass. The W boson also has a mass because it is where a +𝕚2/3 up quark flips to a -𝕚1/3 in Biv space-time.

Quantized change from a neutron to a proton

The neutron can change into a proton, that happens by one of the -𝕠1/3 down quarks changing to an +𝕠2/3 quark. That represents 1 as a quantized value like in orbitals, the change is mediated by a pion. Now there are two +𝕠2/3 up quarks and one -𝕠1/3 down quark. The difference of 1 is negative because the Pythagorean Triangles are now positive as +1.

The proton as a rolling wheel

The proton also has a single degree of freedom, this enables it to spin like a rolling wheel. In this model this spin is like a planet, also the +𝕚d gravitational mass spins proportionally to the +𝕠d potential mass or potential magnetic field. This degree of freedom dominates because the -𝕠1/3 is subtracted from the two +𝕠2/3 up quarks, it is extinguished but is conserved for if the proton becomes a neutron again.

Two degrees of freedom expelled

The two degrees of freedom are expelled as a W^- boson as -1, this is also quantized. That decays into an electron as -𝕠1 with a quantized value of -1 opposite the proton. The other degree of freedom is orthogonal to both the proton and electron, here this is the neutrino from the 𝕠d and 𝕞 Pythagorean Triangle.

Forming a neutron with a positron

If that happens then the positron +𝕠1 and the neutrino as 𝕠d+ combine into a W^- boson as -1, this adds the other two degree of freedom to the proton returning it to becoming a neutron. The W^+ boson is positive when a +𝕠1 positron and 𝕠d neutrino are emitted to form a neutron. This is sending the positron backwards in time, that balances the time directions of the neutron.

Three colors as three degrees of freedom

These Pythagorean Triangles can be ordered in three different ways, that gives the gluon colors of red, green, and blue. For example if one Pythagorean Triangle was vertical, this could be either red, green, or blue.

Three generations from torque

Here a quark has three generations, this occurs from an +𝕠2/3 being twisted with a +𝕆D potential torque to an orthogonal direction. A third torque would change this to the last orthogonal direction giving only three generations.

A higher generation as a probability

These can still combine with other quarks, it acts like a single Pythagorean Triangle that has been twisted once or twice to a higher generation. That torque is conserved as a probability, that gives the likelihood it will decay.

A higher generation as impulse

The -𝕠1/3 down quark can also be twisted once or twice into a second and third generation. In both quarks these twists increase the mass, with the +𝕠2/3 this is a +𝕚d gravitational mass as -𝕚1/3, the -𝕠1/3 has a -𝕚d inertial mass as -𝕚1/3.

The first three quark changes as work

When an +𝕚2/3 up quark is flipped into a -𝕚1/3 down quark, then up to an +𝕚2/3 up quark, this gives three masses. When these are individually squared as probabilities, they can be divided by the sum which is squared. That is adding their individual probabilities, then dividing by the sum of their total probabilities. The three are squared as work measurements, then divided by the three acting as time observations on a clock gauge. When these are squared it gives the probability of their being measured as work or observed as impulse.

The next three quark changes as impulse

This gives a mass fraction of 4/9, normally expressed from the Koide formula as the square root 2/3. Here it is a square because it is done from work. The next three go from a -𝕚1/3 strange quark to a +𝕚2/3 top quark, then to a -𝕚1/3 bottom quark. This gives a mass fraction of 5/9 with a total of 1 as a quantization. These are not squared because they go from a -𝕚1/3 to a -𝕚1/3 which is impulse using these as time.

Times and probabilities of decaying

Because the down, strange, and bottom quarks are not squared they connect to impulse. This gives the decay times of higher quark generations. With the up, charm, and strange quarks this gives the probabilities of their decaying.

The three generations of leptons as work

The leptons as the electron, muon, and τ electron also have their squared mass being added up. Here they are -𝕀D inertial probabilities, these are divided by the three inertial masses added then squared. That also gives 4/9 like the first three quarks. Because there are no additional degrees of freedom this ends at 4/9, the neutrinos may account for the additional 5/9 to give a quantized 1.

Energy as an approximation

In (22.8) the $\hat{r}$ symbol has a direction because this is expressed as energy, for example the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. This has E𝔸 squared in the numerator and +𝕆D squared in the denominator, in this model that is an approximation because it would be observing as a particle and measuring as a wave in the same position and time.

Measuring momentum in a direction

Q is -𝕠d×e𝕪/-𝕠d as a Coulomb as well as being the kinetic momentum. This varies according to r^2 or E𝕐 which is a force vector from the E𝕍/-𝕚d inertial impulse, that is measured as a change in Newtons as work. That gives it a direction on a scale or ruler as positions. This can also be referred to here as a vector, it has direction but no forces.

FIGURE 22.26 Using the unit vector $\hat{r}$.

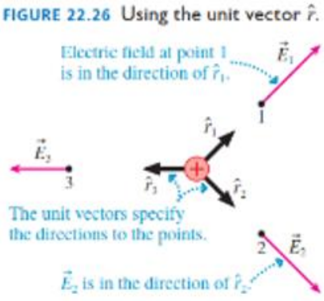


FIGURE 22.27 The electric field of a negative point charge.

expressing certain directions—namely, the unit vectors $\hat{\imath}$, $\hat{\jmath}$, and $\hat{k}$. For example, unit vector $\hat{\imath}$ means "in the direction of the positive *x*-axis." With a minus sign, $-\hat{\imath}$ means "in the direction of the negative *x*-axis." Unit vectors, with a magnitude of 1 and no units, provide purely directional information.

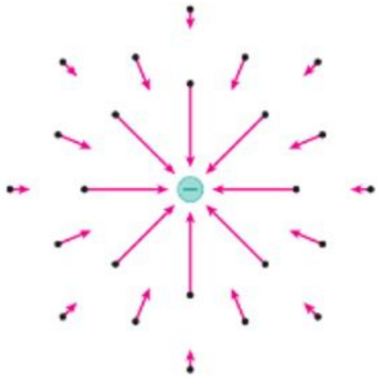
With this in mind, let's define the unit vector $\hat{r}$ to be a vector of length 1 that points from the origin to a point of interest. Unit vector $\hat{r}$ provides no information at all about the distance to the point; it merely specifies the direction.

FIGURE 22.26 shows unit vectors $\hat{r}_1$, $\hat{r}_2$, and $\hat{r}_3$ pointing toward points 1, 2, and 3. Unlike $\hat{\imath}$ and $\hat{\jmath}$, unit vector $\hat{r}$ does not have a fixed direction. Instead, unit vector $\hat{r}$ specifies the direction "straight outward from this point." But that's just what we need to describe the electric field vector, which is shown at points 1, 2, and 3 due to a positive charge at the origin. No matter which point you choose, the electric field at that point is "straight outward" from the charge. In other words, the electric field $\vec{E}$ points in the direction of the unit vector $\hat{r}$.

With this notation, the electric field at distance *r* from a point charge *q* is

Vectors have no sign

Here there is a kinetic electric charge, this is represented as E𝕐 force vectors from the E𝕐/-𝕠d kinetic impulse. In this model it is being measured in Newtons as a magnetic field, the r^2 can be observed as electrically charged particles with the inverse square law. Here vectors have no positive or negative sign, instead they are added and subtracted according to their directions and magnitudes. The direction of a vector comes from its associated Pythagorean Triangle, the derivative slope would be a speed or velocity in a direction from this.



$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r} \quad \text{(electric field of a point charge)} \qquad (22.8)$$

where $\hat{r}$ is the unit vector from the charge toward the point at which we want to know the field. Equation 22.8 is identical to Equation 22.7, but written in a notation in which the unit vector $\hat{r}$ expresses the idea "away from q."

Equation 22.8 works equally well if q is negative. A negative sign in front of a vector simply reverses its direction, so the unit vector $-\hat{r}$ points *toward* charge q. **FIGURE 22.27** shows the electric field of a negative point charge. It looks like the electric field of a positive point charge except that the vectors point inward, toward the charge, instead of outward.

We'll end this chapter with three examples of the electric field of a point charge. Chapter 23 will expand these ideas to the electric fields of multiple charges and of extended objects.

A point charge

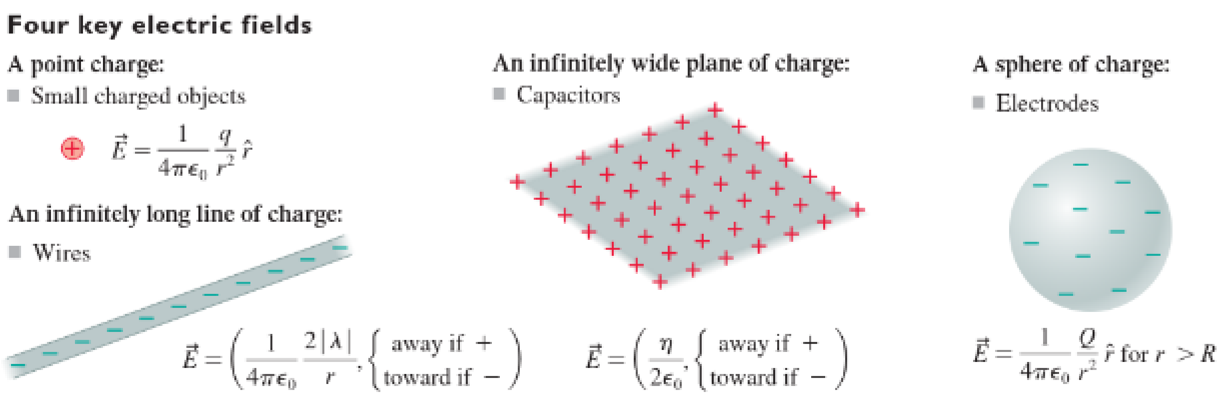
Here there is a point charge, being positive this would be an e𝕒 position. This implies the +𝕆D×e𝕒 potential work is being measured with e𝕒 positions, if an electric force that would be the E𝔸/+𝕠d potential impulse as a displacement between positions. With r not squared this would be measuring +𝕆D×e𝕒 potential work as a change in e𝕒 position.

A plane of charge

In this model there is no plane of charge, there is an integral field from magnetism. This can be measured by positions as points of charge.

A sphere of charge

This can be measured as -𝕆D×e𝕪 kinetic work on the surface, for example with a magnetic flux going through it. It can also be observed as a E𝕐/-𝕠d kinetic impulse, this would be the kinetic displacement forces from electrons as particles.



Charge as points or particles

In this model the e𝕒 potential electric charge and the e𝕪 kinetic electric charge are points when measuring +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. When they are observing points there is a displacement from one end of a force vector to the other. That would represent a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse where a particle moved from the start of the force vector to the end.

Time as instants not a duration

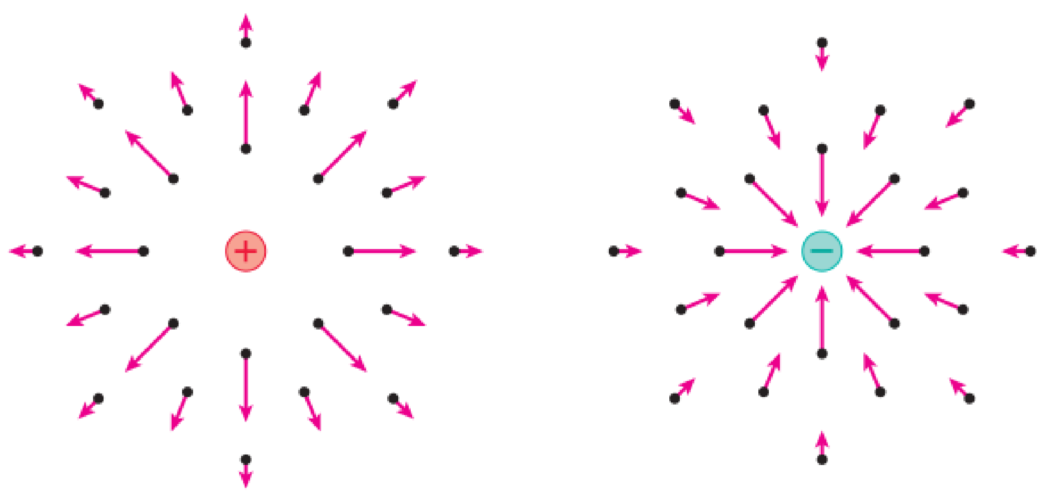
This uses +𝕚d potential time and -𝕠d kinetic time, but not as a temporal duration. Instead it means that there is a displacement observed at a temporal instant. A previous observation at a different instant is compared to observe the displacement, with the inverse square law a particle would move further towards a charge in a given time period.

23.2 The Electric Field of Point Charges

Our starting point, from « Section 22.5, is the electric field of a point charge q:

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r} \qquad \text{(electric field of a point charge)} \qquad (23.1)$$

where $\hat{r}$ is a unit vector pointing away from q and $\epsilon_0 = 8.85 \times 10^{-12}$ $C^2/N\,m^2$ is tl permittivity constant. **FIGURE 23.1** reminds you of the electric fields of point charge Although we have to give each vector we draw a length, keep in mind that each arro represents the electric field *at a point*. The electric field is not a spatial quantity th "stretches" from one end of the arrow to the other.



Electric charge and magnetic fields from different reference frames

Here vectors are added together, in this model they use vector addition and subtraction depending on their direction. When these are point charges they are points or positions on a straight scale or ruler, then the +𝕆D×e𝕒 potential work or -𝕆D×e𝕪 kinetic work is being measured not an electric field. In conventional physics electric charges appear as magnetic fields by changing the reference frame, so this does not give different results overall.

Electric charge and magnetic fields are orthogonal

These are orthogonal because the reference frame has a spin Pythagorean Triangle side and a straight Pythagorean Triangle side, for example -𝕚d inertial time and a e𝕧 length. The impulse is observed on the -𝕚d inertial time axis, the same phenomena can be measured as work on the e𝕧 length axis. This would be why changing the reference frame turns electric charge into a magnetic field, it changes the frame from time to positions.

A field cannot be measured with time, a particle cannot be observed with positions

A magnetic field cannot be measured with time, there are no particles to observe what time they were at a location. It can only be measured with probability densities or forces. Electric charges cannot be observed with positions, they are at a position and if they go to another position this says nothing about the forces involved. This might happen quickly or slowly and so it can only be observed with time.

Constructive and destructive possibilities and probabilities

The vectors are added but not as superpositions. Instead the work is being measured, their +𝕆D potential and -𝕆D kinetic probabilities can superpose with constructive and destructive interference. Here there can also be constructive and destructive possibilities, this is where vectors can add or subtract respectively like interference.

Energy as work and impulse combined

When energy, for example the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, is used this combines both work and impulse. That means overall there appears to be an electric field, the E𝕐/-𝕠d kinetic impulse is combined with -𝕆D×e𝕪 kinetic work. The uncertainty principle says these cannot be observed and measured simultaneously in the same position, according to this model. These are then separated here, but they can be combined to give an approximate electric field or magnetic particles.

Multiple Point Charges

What happens if there is more than one charge? The electric field was defined as $\vec{E} = \vec{F}_{\text{on } q}/q$, where $\vec{F}_{\text{on } q}$ is the electric force on charge q. Forces add as vectors, so the net force on q due to a group of point charges is the vector sum

$$\vec{F}_{\text{on } q} = \vec{F}_{1 \text{ on } q} + \vec{F}_{2 \text{ on } q} + \cdots$$

Consequently, the net electric field due to a group of point charges is

$$\vec{E}_{\text{net}} = \frac{\vec{F}_{\text{on } q}}{q} = \frac{\vec{F}_{1 \text{ on } q}}{q} + \frac{\vec{F}_{2 \text{ on } q}}{q} + \cdots = \vec{E}_1 + \vec{E}_2 + \cdots = \sum_i \vec{E}_i \qquad (23.2)$$

where $\vec{E}_i$ is the field from point charge i. That is, **the net electric field is the *vector sum* of the electric fields due to each charge.** In other words, electric fields obey the *principle of superposition*.

Thus vector addition is the key to electric field calculations.

Straight displacements

In this model there are no curved electric field lines, these can only be straight displacements observed as force vectors. The field vectors shown would be these displacement vectors when particles are observed. When there is a charged particle it can only move in a straight-line with impulse, a negative ion can move directly towards a positive ion.

Charges radiate as straight lines

This is shown below where the e𝕒 altitudes radiate as straight lines out of a positive charge, the e𝕪 kinetic electric charge radiates also as straight lines. The electric field lines would be composed of small straight-line vectors, that can be observed and mapped by using smaller charged ions at different points. When these displace from a starting to a final position, over a time on a clock gauge, that gives the impulse as the strength of the charge there.

Gravitational and inertial impulse as straight lines

These positive charges are like Eℍ/+𝕚d gravitational impulse around a planet, where a change in e𝕙 height points directly down to the center of the planet. A moon would also have a Eℍ/+𝕚d gravitational impulse, its E𝕍/-𝕚d inertial impulse would represent the negative charge in Roy electromagnetism. A rocket launched from the moon would have this straight-line E𝕍/-𝕚d inertial impulse, then that is influenced by the straight-line Eℍ/+𝕚d gravitational impulse from the planet, ignoring the moon's smaller gravity.

No smooth curve with impulse

This gives a series of E𝕍 inertial force vectors and Eℍ gravitational force vectors. They cannot be a smooth curve because that would mean time would infinitely divisible. That is not the same as instants on a clock gauge, like Zeno's points on a line there can always be instants in between them without it becoming a smooth curve of time around the clock. Also an -𝕚d and e𝕧 Pythagorean Triangle has a constant area, if e𝕧 went to zero with a smooth curve then the area would also go to zero. Conversely work cannot have a force in a straight-line, then there can be no torque.

A curved impulse becomes work

If impulse has a curved force then, it becomes work. It can no longer by observed over time because it becomes a temporal force. If work as a straight-line force it becomes impulse, that cannot be measured over a distance. That is because it would be measuring a displacement over a distance. If so, then different displacement forces would be all the same if they all went over the same distance. Only by observing it over time would the difference displacements be conserved.

Energy is torque and displacement

To move between instants there is a torque as the clock hand spins. That is a force not a smooth curve. To resolve this energy uses both a torque and a displacement together, such as in the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation. But this is not allowed here because of the uncertainty principle.

Time evolution and Schrodinger's equation

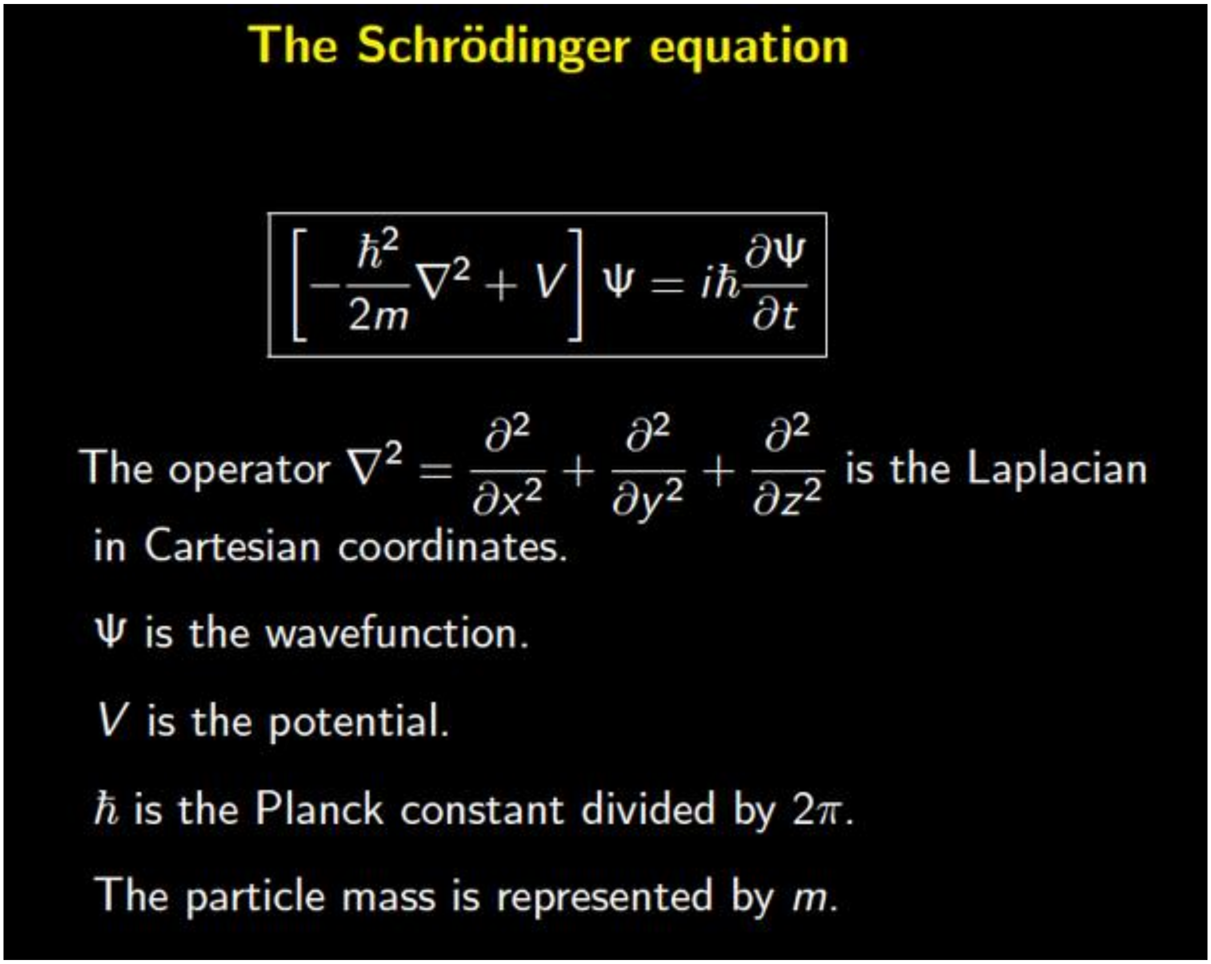
In Schrodinger's equation there is a deterministic time evolution, in this model that would be impulse. Then it can be measured as a wave function, here that would come from work. There is a collapse in this wave function of work to observing a particle with impulse, that gives rise to the wave/particle duality. This time evolution comes from h as -𝕠d ×e𝕐/-𝕠d, that is observing the E𝕐/-𝕠d kinetic impulse. This is not the equation for energy, instead it takes energy as Joules and multiplies it by seconds.

Schrodinger's equation is based on energy

In this model Schrodinger's equation is based on energy, here the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy on the right-hand side comes from the electron and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia on the left-hand side comes from inertia. This gives the two sides of Schrodinger's equation. In the equation below the left-hand side of the equation is in Biv space-time, the right-hand side in Roy electromagnetism.

Inertia in one direction

Here ∇^2 is in three orthogonal directions, for the -𝕠d and e𝕪 Pythagorean Triangle on the right-hand side and the -𝕚d and e𝕧 Pythagorean Triangle on the left-hand side this would use one direction as e𝕧. The -𝕚d and e𝕧 Pythagorean Triangle as inertia only acts in one direction.



The Laplacian comes from impulse

When e𝕧 is squared it is E𝕍 as the inertial displacement force, this can be written as ∂^2/∂e𝕧^2 because the first derivative of the -𝕚d and e𝕧 Pythagorean Triangle is ∂/∂e𝕧. This is always with respect to e𝕧 because the straight Pythagorean Triangle side is only used with derivatives and the spin Pythagorean Triangle side only with integrals. The first derivative would be an inertial velocity -𝕚d/e𝕧 and the second derivative is the E𝕍/-𝕚d inertial impulse. Here this can be written as -𝕚d/E𝕍 for the convention of derivatives changing the denominator. That makes it seconds/meter^2 instead of meters^2/second which is the same.

Kinetic energy from Planck's constant

Both sides of the equation represent energy, here h squared is (-𝕠d ×e𝕐/-𝕠d)(-𝕠d ×e𝕐/-𝕠d), when divided by 2×-𝕠d as double the kinetic mass that gives ½×E𝕐×E𝕐/-𝕆D. Then this is divided by

∂/∂E𝕍 which is proportional to E𝕐 to give the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. Writing this as Biv space-time it would become (-𝕚d×E𝕍/-𝕚d)(-𝕚d×E𝕍/-𝕚d)(1/2× 1/-𝕚d)(1/E𝕍) as the ½×e𝕍/-𝕀d ×-𝕚d linear inertia.

Dimensional analysis

On the right-hand side this would reduce to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy so the dimensional analysis is consistent. That is because the -𝕠d and e𝕪 Pythagorean Triangle as the electron is proportional to the -𝕚d and e𝕧 Pythagorean Triangle as inertia.

ℏ converts a tangential force to a radial force

Schrodinger's equation uses -𝕠d ×e𝕐/-𝕠d as h, here this is divided by 2π. π is not used here, it is commonly in ℏ because that takes the E𝕐/-𝕠d kinetic impulse as a tangential force and converts it into a radial force. Instead this model uses the E𝔸/+𝕠d potential impulse going directly out from a proton, that also gives the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy which in the equation is V. With this model the left-hand side would also use the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation which is proportional to the rotational potential energy. In this instance it is usually ignored.

Partial derivatives and impulse

The term ∂ψ/∂-𝕠d should then be the same as in this model as 1/-𝕠d, i here represents the square root of -1. Here the spin Pythagorean Triangle side would not be a derivative, it is used in the E𝕐/-𝕠d kinetic impulse because the e𝕪 kinetic electric charge is the second derivative not -𝕠d.

Obscure and intangible numbers

That is the negative square root -𝕠d, this model has -𝕚d as the negative square root of +1. In this model +𝕠d and -𝕠d are called Obscure numbers, this is a memory aid as they start with O. +𝕚d and -𝕚d are called Intangible numbers as a memory aid, also to avoid confusion with imaginary numbers.

Using ψ

Schrodinger's equation has no value for ψ in it, instead it represents that this is also a wave equation from the particle/wave duality. In this model that is because the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy for example has E𝕐/-𝕆D. That is both observing a particle and measuring a wave function.

Mixing inertia and the potential

On the left-hand side there is the ½×e𝕍/-𝕀d ×-𝕚d linear inertia, the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy is added to it. This is mixing together Roy electromagnetism and Biv space-time, in this model it is allowed because they are proportional to each other. Here this can also be brought to the right-hand side so that is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy minus the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy.

Reversing the signs

In this model the signs would be reversed, the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy would be positive as +𝕠d and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy would be negative as -𝕠d.

The difference between the potential and kinetic energies

It represents the difference between the potential and kinetic energies here. When subtracted, the remainder would be proportional to the ½×e𝕍/-𝕀d ×-𝕚d linear inertia on the left-hand side. This leaves out the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation on the left, but this is assumed to be negligible in the equation. Here it would be the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation minus the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. This would be positive overall when the electrons are in orbitals, the gravity would be stronger than the inertia.

Kinetic energy and inertia are proportional

Schrodinger's equation, according to this model, gives the proportionality of the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. The Hamiltonian is used here to model inertia.

The kinetic impulse and inertial impulse are proportional

This is the same as in this model, the E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse being proportional. Inversely also the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work being proportional. It implies the Eℍ/+𝕚d gravitational impulse and E𝔸/+𝕠d potential impulse are proportional, the +𝕀D×e𝕙 gravitational work and +𝕆D×e𝕒 potential work are also proportional. That comes from the constant Pythagorean Triangle areas.

Time evolution from impulse

The time evolution comes from the E𝕍/-𝕚d inertial impulse and E𝕐/-𝕠d kinetic impulse, this is deterministic and changes over time. That is because impulse has no probabilities, the particles are not waves and move with possibilities instead. The added ψ symbol has no dimensions, that means it is used to represent work and a wave duality to the impulse.

Uncertainty from energy

This duality comes from E𝕍/-𝕀D in the ½×e𝕍/-𝕀d ×-𝕚d linear inertia and E𝕐/-𝕆D in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. In this model that leads to uncertainty because it is observing a particle at the same time as measuring a wave in the same position.

Including uncertainty

To include this uncertainty -𝕠d ×e𝕐/-𝕠d as h is used, this is observing the change in orbital of an electron. That happens with a E𝕐/-𝕠d kinetic impulse because it is an observation, hence the E𝕐 kinetic displacement force. Here h has a minimum value, that makes it impossible for energy to become infinitely divisible as time or position. In Newton physics there was no quantization, mass and light were not known to be a minimum size. With blackbody radiation Planck showed that quantized levels of light must exist, from that came h as Planck's constant.

Quantum jumps as work and impulse

The quantum jump between orbitals is -𝕆D×e𝕪 kinetic work in this model, that is not measurable here except that a e𝕪×-𝕘d photon is emitted or absorbed. The electron in this model is like a rolling wheel and standing wave, to change this to make an observation the electron must act as a particle with a E𝕐/-𝕠d kinetic impulse.

Collapsing the wave function

By using h the electron can be a direct observation, here that is called the collapse of the -𝕆D×e𝕪 kinetic work wave function into a E𝕐/-𝕠d kinetic impulse particle. The work of electrons in positions is collapsed by the photon into a particle, which is observed at a time.

Deriving h from energy

Here h is observing the change in the -𝕠d and e𝕪 Pythagorean Triangle from one orbital to the next, for example dropping an orbital and emitting a e𝕪×-𝕘d photons. Because the e𝕪 and -𝕘d Pythagorean Triangle as the photon has a constant area this is a constant. It is observed in joule seconds as Planck's constant, it is derived from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. That is multiplied by -𝕠d as kinetic time and the ½ factor removed to give -𝕠d ×e𝕐/-𝕠d.

Deriving h from momentum

In this model that is from the constant area of the -𝕠d and e𝕪 Pythagorean Triangle as the electron, it can also be derived from the -𝕠d×e𝕪/-𝕠d kinetic momentum of an electron in an orbital, that is observed by squaring E𝕐 to give h as -𝕠d ×e𝕐/-𝕠d. In Schrodinger's equation energy is modeled as momentum.

Observing an orbital number

It is a constant because it is observing the values from one spherical orbital to the next, with elliptical orbitals it can be a fraction. When n as d is the orbital number, n^2 as D, then +𝕚d×e𝕙/+𝕀D is observing this change as an orbital. Here n is a linear variable as an integer, it is squared to observe it as a particle with impulse.

1 as a constant

Because the difference between each orbital is 1 this gives a constant. The photon itself is not squared as the e𝕐/-𝕘d light impulse unless it is observed. It can also be measured as -𝔾D×e𝕪 light work when n is not squared. When emitted it has a rotational frequency -𝕘d and a wavelength e𝕪 or e𝕧 which are also not squared unless they are observed or measured as impulse or work. So this gives a constant when the photons are emitted, for example from a blackbody where Planck's constant originated.

Separating the variables of work and impulse

According to this model Schrodinger's equation is two forces combined, that of work and impulse. Because of this a separation of variables can give two equations, here that would separate work and impulse.

Collapsing work into impulse

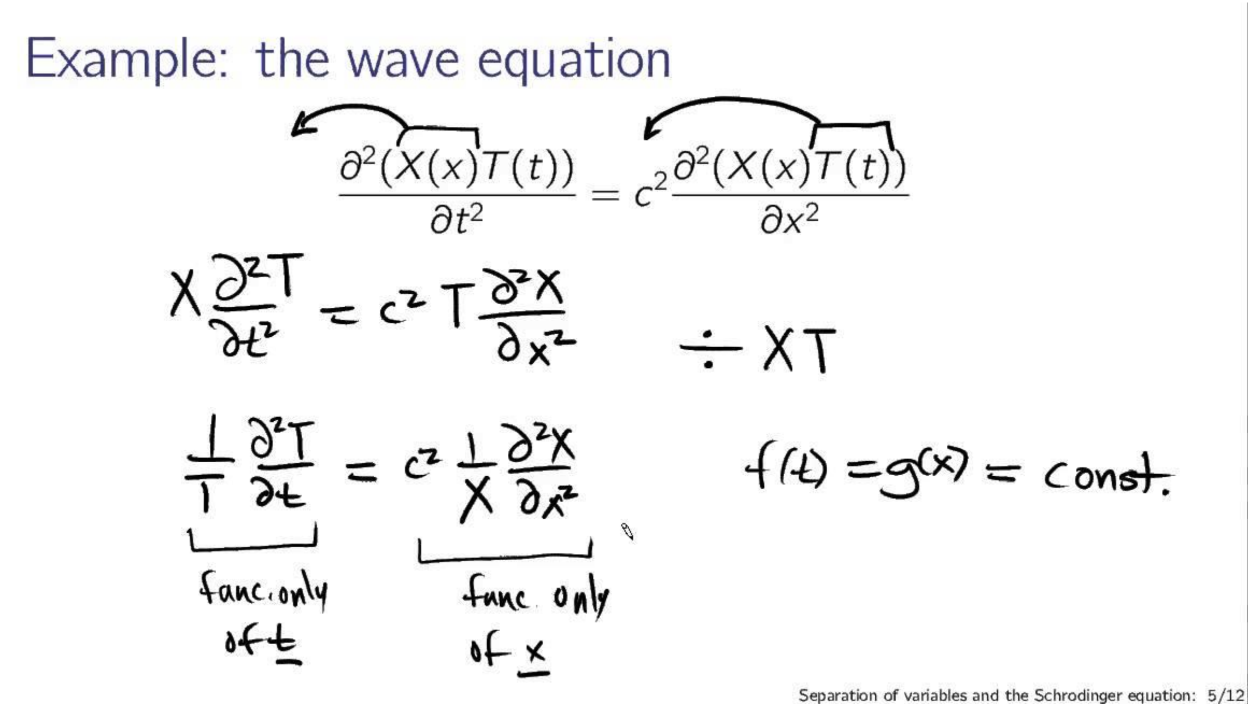
The ½×e𝕍/-𝕀d ×-𝕚d linear inertia = the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy when there is no change in energy, taking the right-hand side as a constant k, 1/2 and the -𝕚d inertial mass as constants this becomes E𝕍≈k×-𝕀D. In this model that means the E𝕍/-𝕚d inertial impulse is approximately the inverse of the -𝕆D×e𝕪 kinetic work, this can be written as E𝕍/-𝕀D ≈ k. Because they are approximately equal, then collapsing the -𝕆D×e𝕪 kinetic work wave function into E𝕐/-𝕠d kinetic impulse as a particle can occur.

Separating the variables of the wave equation

When the variables are separated below the left-hand side is a function of t^2 as -𝕀D, the right-hand side is a function of x^2 as E𝕍. This uses the wave equation, in this model that is a combination of work and impulse. The wave moves with a rotation as work, also with a back-and-forth motion as impulse.

A wave with work and impulse

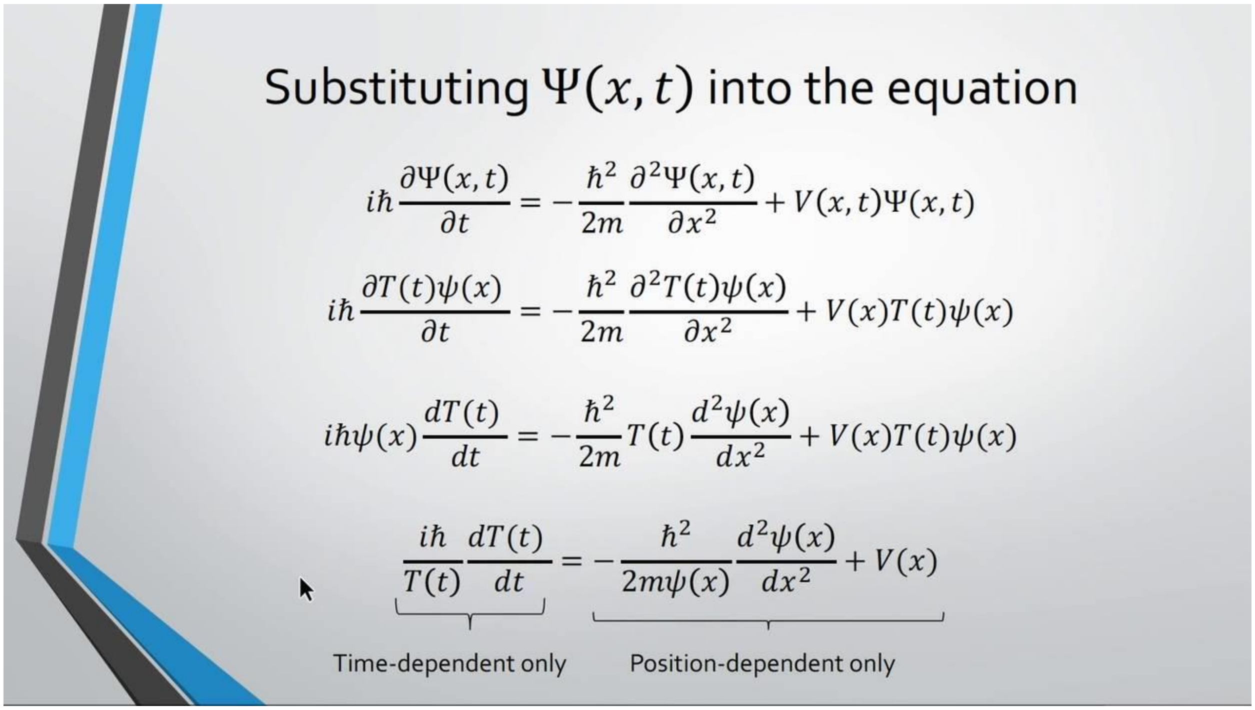
This is divided by xt below, here this is -𝕚d×e𝕧 as an integral and ½ the constant area of the -𝕚d and e𝕧 Pythagorean Triangle. Without dividing by xt this has -𝕀D×e𝕧 inertial work on the left-hand side as x/t^2, also the E𝕍/-𝕚d inertial impulse on the right-hand side as t/x^2. This is for a constant wave, the -𝕀D×e𝕧 inertial work and E𝕍/-𝕚d inertial impulse do not equal each other if this changes but xt as -𝕚d×e𝕧 is a constant. The combination of work and impulse give the wave a particle duality, according to this model.



Schrodinger's equation below is separated with its variables. The left-hand side still contains h as -𝕠d ×e𝕐/-𝕠d, this still has E𝕐 in it as the E𝕐/-𝕠d kinetic impulse so some variables are not separated. Here time refers to a deterministic impulse in Schrodinger's equation. On the right-hand side it becomes position dependent which comes from -𝕀D×e𝕧 inertial work. This is still x squared here because h has a square in it, separating the variables is still used for observation of impulse.

No ψ on the left-hand side

The left-hand side has no ψ symbol because it is a deterministic evolution over time. The right-hand side has a ψ symbol because the probability changes with different positions. When the position changes with work this can be observed as a particle, that change is the wave function collapse.



Separating variables on the right-hand side

The same can be done with the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy on the right-hand side of Schrodinger's equation, this separates into the -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse using -𝕠d×e𝕪 like xt was earlier. The right-hand side reduces then to the proportionality of the ½×e𝕍/-𝕀d ×-𝕚d linear inertia and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, also the proportionalities of work and impulse. When these are separated impulse is the observed collapse of the ψ wave function from work.

Mass energy equivalence

In this model they also give the mass energy equivalence where the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is E in $E=mc^2$. Then the ½×e𝕍/-𝕀d ×-𝕚d linear inertia is -𝕚d as m and E𝕍/-𝕀D is c^2 for that inertial velocity.

Schrodinger's equation and special relativity

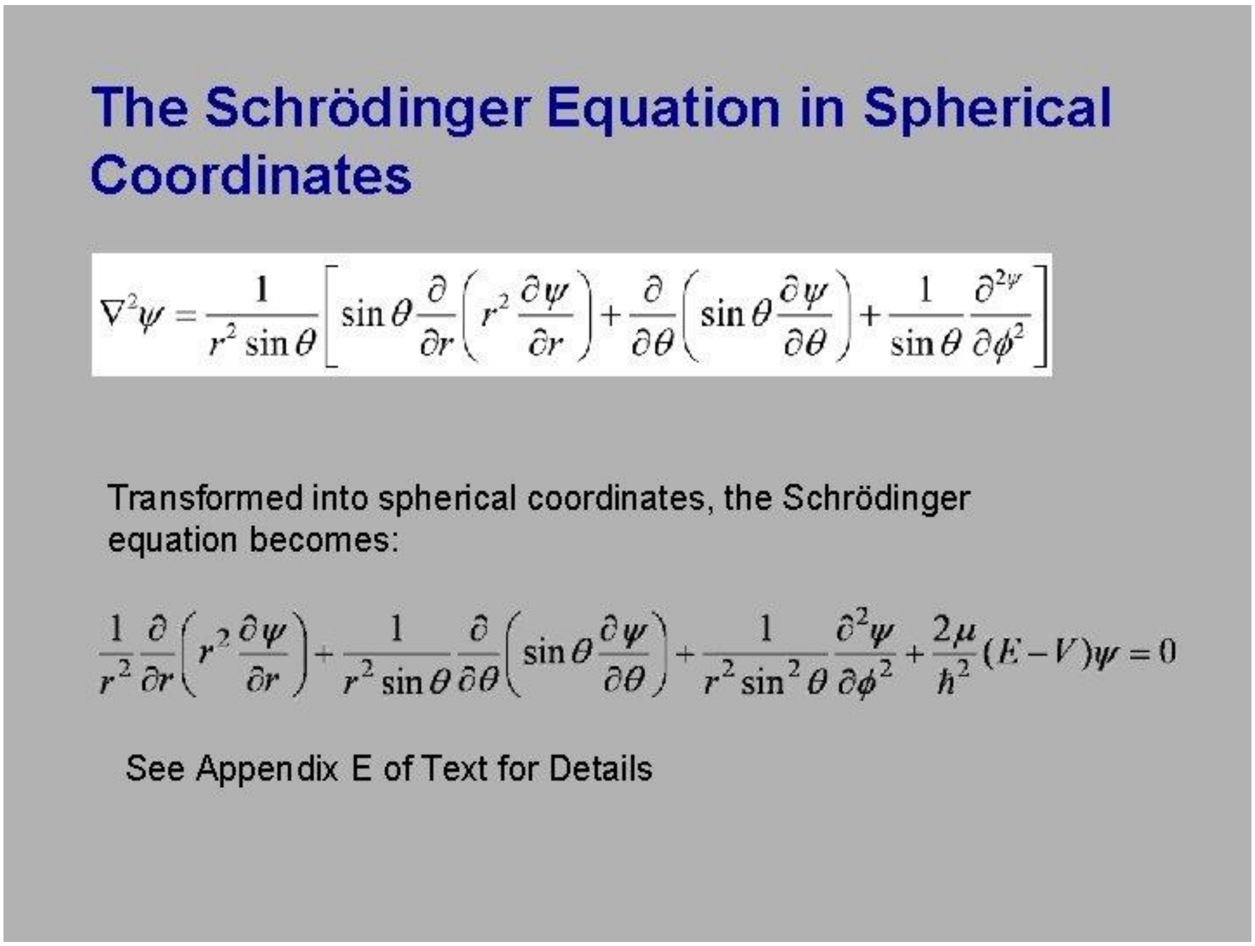
In this model Schrodinger's equation also becomes consistent with general and special relativity. This is because the constant Pythagorean Triangle changes the straight Pythagorean Triangle side of distance inversely, with the spin Pythagorean Triangle side of time. With higher e𝕧/-𝕚d inertial velocities the h observations would have a -𝕠d kinetic and -𝕚d inertial time slowing. The wave function would have a e𝕪 kinetic and e𝕧 length contraction.

Schrodinger's equation and general relativity

The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy in this model is also relativistic, with the E𝔸/+𝕠d potential impulse there is a +𝕠d potential time slowing. That is proportional to with the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation where the Eℍ/+𝕚d gravitational impulse has the +𝕚d gravitational time slowing. The +𝕆D×e𝕒 potential work has e𝕒 contracting as an altitude or distance, this is proportional to the e𝕙 height contracting with +𝕀D×e𝕙 gravitational work.

Circular geometry

When Schrodinger’s equation is transformed into circular geometry, this works with the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation which is proportional to the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. Then the electron with its ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy would be subtracted from the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, the Hamiltonian would be expressed in terms of changes in gravity. The electron is bound to the +𝕠d potential mass or magnetic field of the proton, also to its +𝕚d gravitational mass. Orbitals are also circular or elliptical, the equation can then be expressed in circular geometry.



Functions as impulse

A function f(x) according to this model is deterministic, because of this it would come from impulse. When x is a position, this would change this with a displacement or acceleration to a new position. Here a probability would not be a function, this would use Fourier Analysis which would have interferences in waves also as probabilities.

A position operator

The diagram below shows the -𝕠d×e𝕪/-𝕠d kinetic momentum for example, this can be observed with h as -𝕠d ×e𝕐/-𝕠d. Using a ∂e𝕪 operator here would change this from an impulse observation of a particle back to momentum. This can happen after an electron is observed, it could return to a kinetic momentum.

The time independent Hamiltonian

Here the energy E can be the ½×e𝕍/-𝕀d ×-𝕚d linear inertia for example, this is modeled as the square of the inertial momentum (-𝕚d×e𝕧/-𝕚d)(-𝕚d×e𝕧/-𝕚d). Then it is divided by 2m as ½×1/-𝕚d to give the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. This is time independent below.

In this model momentum is shown as a combination of momentum and velocity, -𝕚d×e𝕧 would contain enough information for the inertial momentum. That is because the momentum would be the same with different angles θ of the -𝕚d and e𝕧 Pythagorean Triangle.

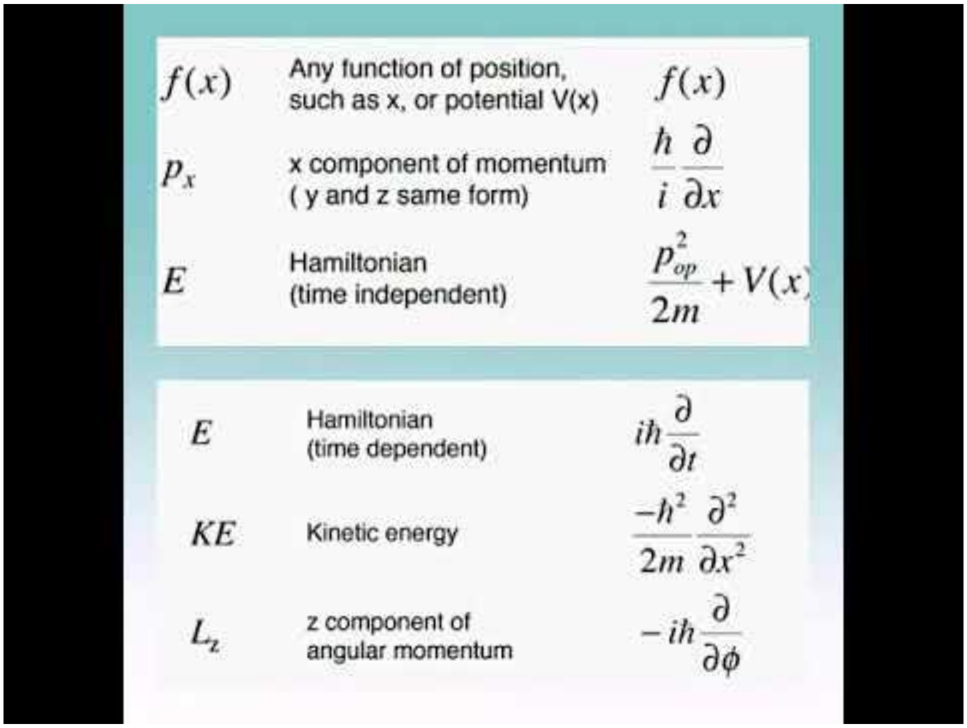
For example if -𝕚d doubles then e𝕧 would halve. That can be written as -𝕚d×e𝕧/-𝕚d, the inertial mass doubled which by itself would double the inertial momentum. But e𝕧 halves and the denominator as the -𝕚d inertial time also doubles, this decreases the inertial velocity 4 times. The inertial momentum would overall decrease by ½.

The time dependent Hamiltonian

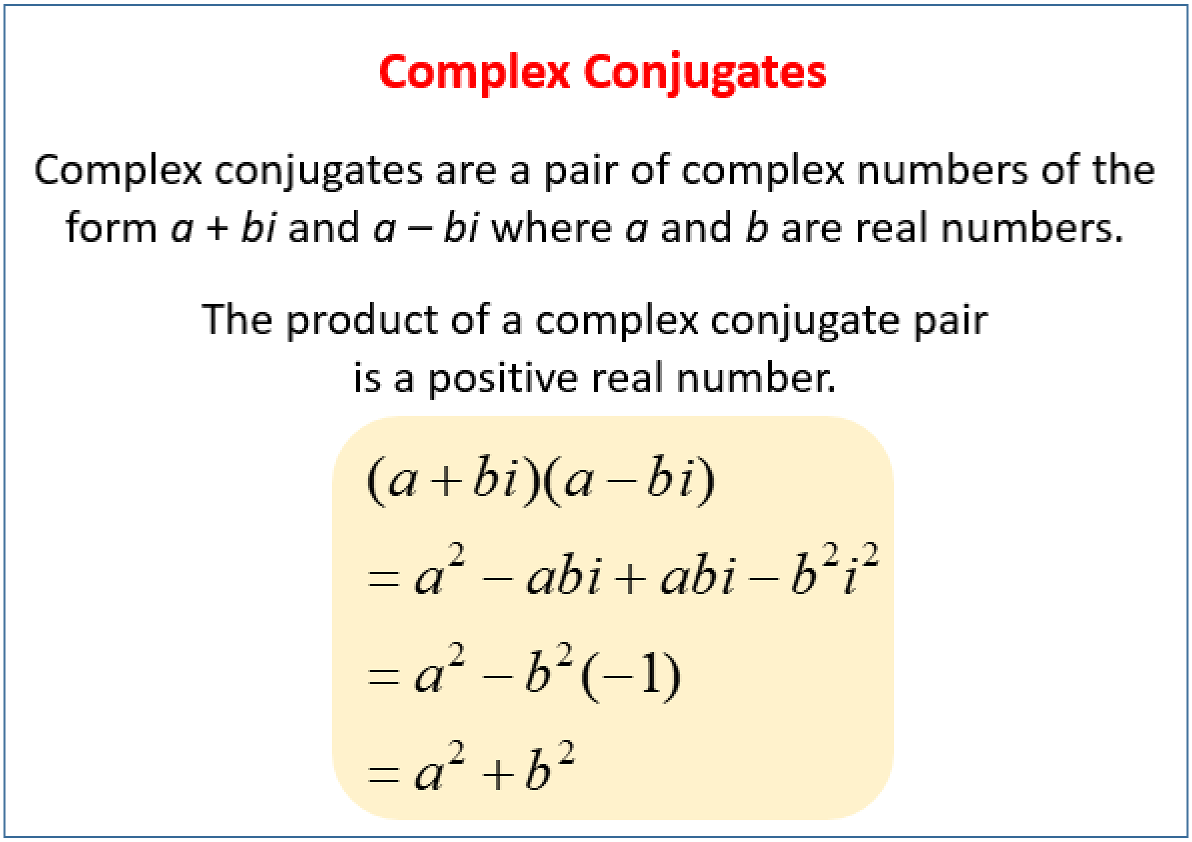
Here this begins with h as -𝕠d ×e𝕐/-𝕠d, the i is not needed because -𝕠d is already the square root of -1. Then a derivative operator ∂t would return it to being the -𝕠d×e𝕪/-𝕠d kinetic momentum. This would not be a valid operation in this model, except as an approximation because h already includes the Pythagorean Triangle area as an uncertainty.

The ½×e𝕍/-𝕀d ×-𝕚d linear inertia as kinetic energy below is given as -𝕠d ×e𝕐/-𝕠d squared or (-𝕠d ×e𝕐/-𝕠d)(-𝕠d ×e𝕐/-𝕠d), that would not be allowed in this model because -𝕠d ×e𝕐/-𝕠d is already a square as an observation. Then it is divided by 2×-𝕠d where -𝕚d is the kinetic mass. To reduce E𝕐×E𝕐 here a second derivative operator is ∂^2/∂E𝕐 is used.

L_z below give an angular momentum or torque, the -𝕠d ×e𝕐/-𝕠d h value here only has one direction as e𝕪 proportionally a e𝕧 length. So this is where work is done causing an observed particle with h to be turned as a wave to a new e𝕧 direction.



In this model complex conjugation comes from the +𝕠d and e𝕒 Pythagorean Triangle as the proton and -𝕠d and e𝕪 Pythagorean Triangle as the electron. It also comes from the +𝕚d and e𝕙 Pythagorean Triangle as gravity and the -𝕚d and e𝕧 Pythagorean Triangle as inertia. These for pairs of complex conjugates.



When these are multiplied together they give the Pythagorean Equation, according to this model. (e𝕒+𝕠d)(e𝕪-𝕠d) gives e𝕒×e𝕪 -𝕠d×+𝕠d. These are pairs of Pythagorean Triangle inverses so the product is a constant, for example if the e𝕒 altitude doubles then e𝕪 halves. When e𝕒 doubles then +𝕠d halves so -𝕠d doubles, that makes e𝕒×e𝕪 -𝕠d×+𝕠d a constant from the constant Pythagorean Triangle areas. Instead of a complex conjugate this can be referred to as an obscure conjugate, because +𝕠d and -𝕠d are obscure numbers here.

When (e𝕙+𝕚d)(e𝕧-𝕚d) in Biv space-time are multiplied together this is also a constant for the same reasons, these are proportional to the Roy electromagnetic Pythagorean Triangles. e𝕙×e𝕧 is a constant, is e𝕙 doubles then e𝕧 halves. If e𝕙 doubles then +𝕚d halves, then -𝕚d doubles. This becomes e𝕙×e𝕧 +𝕚d×-𝕚d. Instead of a complex conjugate this can be referred to as an intangible conjugate, because +𝕚d and -𝕚d are intangible numbers here.

e𝕒×e𝕪 -𝕠d×+𝕠d is the subtraction of two squares, as a constant that gives a hyperbola. Because the -𝕠d and e𝕪 Pythagorean Triangle is active here this changes in hyperbolic geometry, the +𝕠d and e𝕒 Pythagorean Triangle is reactive against this. +𝕠d and -𝕠d are the square roots of -1, so here multiplying them together gives a negative value.

e𝕙×e𝕧 +𝕚d×-𝕚d is the addition of two squares equaling a constant, that gives the equation for a circle so this is in circular geometry. +𝕚d and -𝕚d are the square roots of +1 so multiplying them together gives a positive value.

Using the obscure and intangible numbers gives two sides of a Pythagorean Triangle overall, this changes by the angles θ of these sub–Pythagorean Triangles. While the pairs do not change, the two bottom +𝕠d and e𝕒 Pythagorean Triangle as the proton and the +𝕚d and e𝕙 Pythagorean Triangle as gravity can become larger for example. With a lower e𝕒 altitude and lower e𝕙 height there is a stronger +𝕠d potential magnetic field and +𝕚d gravitational field.

The two upper -𝕠d and e𝕪 Pythagorean Triangle as the electron, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia, would change inversely to this. The overall Pythagorean Triangle does not change, but below $a^2 + b^2$ can have different factors. When a^2 is e𝕙×e𝕧 then e might double in e𝕙 and halve in e𝕧 for example.

In this diagram Biv space-time would be c, here a can be Roy electromagnetism and b would be the central Pythagorean Triangles for photons and gravis. These would be (e𝕪×-𝕘d)(+𝕘d×e𝕓), these are inverses and so it is the same as doubling it in the Pythagorean Equation. It would be e𝕪×e𝕙 using the height instead of the e𝕓 depth as an inverse, e𝕓 is used as a color convention here to represent green blue as +𝕘d×e𝕓. The -𝕘d×+𝕘d value is a constant as an inverse, the same as +𝕠d×-𝕠d and +𝕚d×-𝕚d are.

Then (e𝕒×e𝕪 -𝕠d×+𝕠d)^2 +(e𝕪×e𝕙×-𝕘d×+𝕘d)^2=(e𝕙×e𝕧 +𝕚d×-𝕚d)^2 as a constant overall. The internal factors can change, then the photons and gravis transmit the change in between Roy electromagnetism and Biv space-time. For example if the -𝕠d and e𝕪 Pythagorean Triangle electron in a Hydrogen atom drops an orbital, then e𝕪 increases and -𝕠d decreases, its e𝕪/-𝕠d kinetic velocity increases. The e𝕒/+𝕠d potential speed decreases inversely to this.

The central factors as positive or negative

The +(e𝕪×e𝕙×-𝕘d×+𝕘d)^2 term by itself has no sign, when positive it is the overall changes from Roy electromagnetism to Biv space-time. When negative it can be moved to the right-hand side, then it mediates the changes from Biv space-time to Roy electromagnetism. There is no sign from it overall. This can also be regarded as a constant so addition or subtraction are the same with the inverses of -𝕘d light time forward and +𝕘d gravis time backward. A change in the lower Pythagorean Triangle pair can be regarded as occurring backwards in time, the change in the upper Pythagorean Triangle pair occurs forward in time.

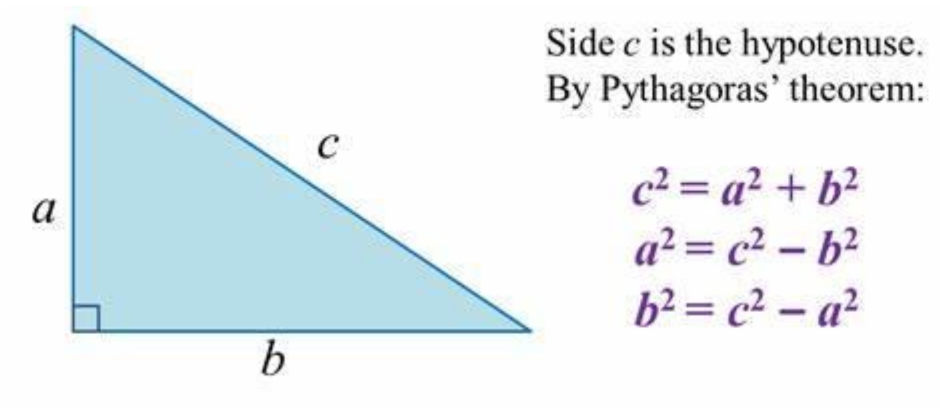
This need not happen at the same time because changes between many atoms can be transmitting and receiving in circles, the photons moving forward in time and the gravis moving backwards in time.

That is transmitted by a change in e𝕪×e𝕙×-𝕘d×+𝕘d, the e𝕪×-𝕘d photon is emitted which mediates the change to the -𝕚d and e𝕧 Pythagorean Triangle. Then e𝕧 increases as -𝕚d decreases, the electron's inertial velocity increases. The gravis transmit this change backwards in time, the e𝕙 height decreased so the +𝕚d gravitational field increased. That is the inverse of the inertial change. This transmits the change to the proton, its e𝕒 altitude decreases and its +𝕠d potential time increases so its e𝕒/+𝕠d potential speed decreases.

This can model the changes between Hydrogen atoms for example, the e𝕪×-𝕘d photons might be emitted and absorbed with temperature changes or collisions. These move forward in -𝕘d light time, the +𝕘d gravis time moves backwards as the Hydrogen atoms change their gravity and inertial inversely to the photon.

This is then another inverse according to this model, the e𝕪×-𝕘d photon transmits changes forward in time, the +𝕘d×e𝕓 gravis transmits the inverse of these changes backwards in time. This is because the photon transmits changes to the upper Pythagorean Triangle pair, the gravis transmits changes to the lower Pythagorean Triangle pair.

Larger atoms follow the same Pythagorean Equation, more protons can combine in the nucleus and more electrons can orbit it. Neutrons act like a compact Hydrogen atom in this model, with the addition of the neutrino. When the neutron decays this is mediated forward in time by e𝕪×-𝕘d photons, when it reforms it is mediated backwards in time by gravis.



Dirac notation

In this model the |> ket notation would be negative, as e𝕪-𝕠d and e𝕧-𝕠d. It also uses the bra symbol as <|, that is the complex conjugate so that (e𝕪-𝕠d)(e𝕒+𝕠d)=e𝕒e𝕪-𝕠d×+𝕠d or <|>. Here the complex conjugation is not needed because -𝕠d×-𝕠d=-𝕆D, so it remains negative. The inner product works differently here because the E𝕐/-𝕠d kinetic impulse and -𝕀D×e𝕧 inertial work cannot be observed and measured in the same position and time. Instead of this the (e𝕪-𝕠d) Pythagorean Triangle would be observed as the E𝕐/-𝕠d kinetic impulse, also measured as -𝕀D×e𝕧 inertial work.

In the diagrams below conventional physics converts this into a column and row vector with linear algebra. In this model the ket |> would be vectors as a list of e𝕪 with different e values. The <| bra would not be vectors, instead they would represent spin here.

$$|\Psi\rangle = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_n \end{pmatrix}. \qquad \langle\Psi| = (a_1^* a_2^* \cdots a_n^*).$$

That is converted into a Hermitian matrix in conventional physics, there would be a sum Σ of the inner product. The integrals would be where these are multiplied together as $-𝕠d_1 \times e𝕪_1$, $-𝕠d_2 \times e𝕪_2$, …

Being integrals they can be regarded as |ψ>. That can also be written as derivative fractions of separate -𝕠d and e𝕪 Pythagorean Triangles or other Pythagorean Triangles. The b terms would be d terms here, for example 1/-𝕠d$_1$, 1/-𝕠d$_2$… so that there are kinetic velocities of e𝕧$_1$/-𝕠d$_1$, e𝕧$_2$/-𝕠d$_2$, … To differentiate these from ψ this could be written as <χ| so that ψ would be associated with a spin Pythagorean Triangle side and χ like x would be a straight Pythagorean Triangle side. This might become confusing with its similarities to conventional Dirac notation, however.

$$(\Psi_a, \Psi_b) = (a_1^* a_2^* \cdots a_n^*) \begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix} = \sum_{i=1}^{n} a_i^* b_i,$$

A matrix similar to the Hermitian format could be used where the complex conjugates would be replaced by integral multiplication on the upper right, and derivative slopes on the lower left. This might be used to convert this model into some applications using linear algebra.

Unitary and Hermitian matrices

Normal: $M = \begin{bmatrix} \lambda_1 & 0 & \cdots & 0 \\ 0 & \lambda_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \lambda_d \end{bmatrix}$ with respect to some orthonormal basis

Unitary: $M^\dagger M = I$ which implies $|\lambda_k|^2 = 1$, for all k

Hermitian: $M = M^\dagger$ which implies $\lambda_k \in \mathbf{R}$, for all k

In 4. Below the |> bra would refer to the -𝕠d values, for example <e𝕪|𝕠d>. The squaring here as <e𝕪|-𝕆D> would give -𝕆D×e𝕪 kinetic work and probabilities, e𝕪 would be the e𝕪 scale on which the -𝕆D×e𝕪 kinetic work is measured as a series of positions. To make an observation it could be written as <e𝕪|𝕠d>, the square <E𝕐|-𝕠d> would be the E𝕐/-𝕠d kinetic impulse. In 6. Below that can be written with Schrodinger's equation as h|1/-𝕚d>=H(-𝕠d)|1/-𝕠d>, here 1/-𝕚d and 1/-𝕠d are fractions to make h as -𝕠d ×e𝕐/-𝕠d into -𝕠d×E𝕐/-𝕆D. Combing the notation like this may be confusing, it is used here to illustrate that this model gives the same answers.

Postulates of Quantum Mechanics

1. Normalized **ket vector** $|\Psi\rangle$ contains all the information about the state of a quantum mechanical system.

2. **Operator *A*** describes a physical observable and acts on kets.

3. One of the **eigenvalues *a_n*** of *A* is the only possible result of a measurement.

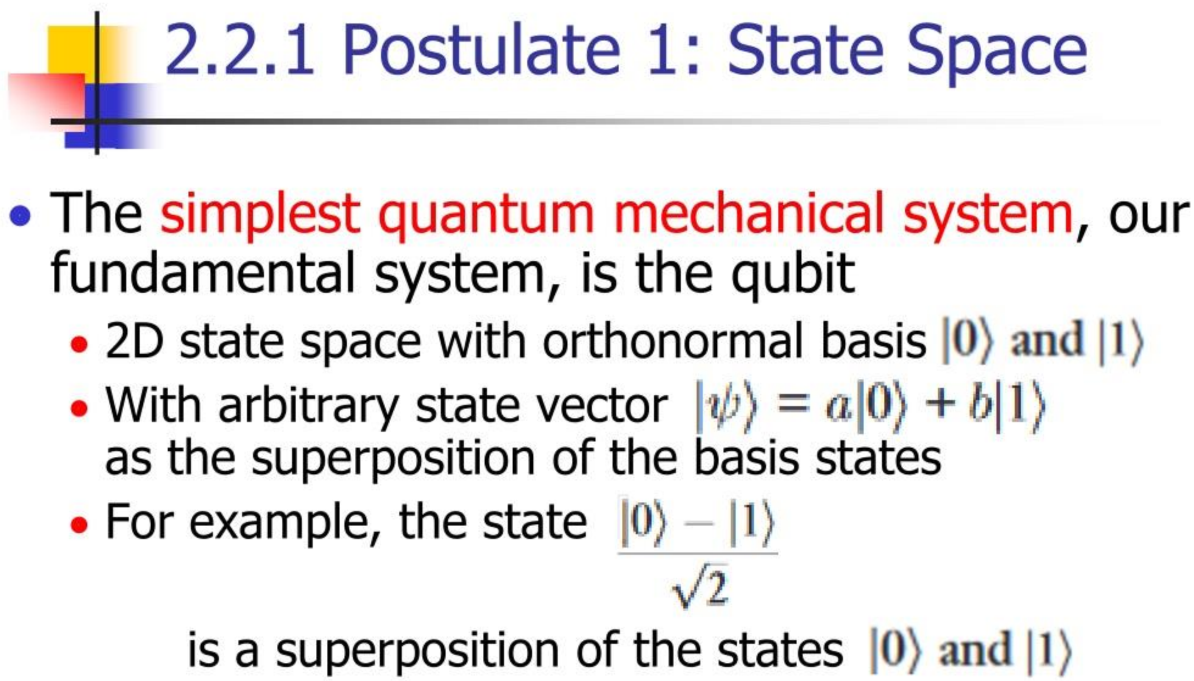
4. The **probability** of obtaining the eigenvalue a_n : $P = \left|\langle a_n | \psi \rangle\right|^2$

5. **State vector collapse** : $|\psi'\rangle = \dfrac{P_n|\psi\rangle}{\sqrt{\langle\psi|P_n|\psi\rangle}}$

6. **Schrödinger Equation** : $i\hbar \dfrac{d}{dt}|\psi(t)\rangle = H(t)|\psi(t)\rangle$

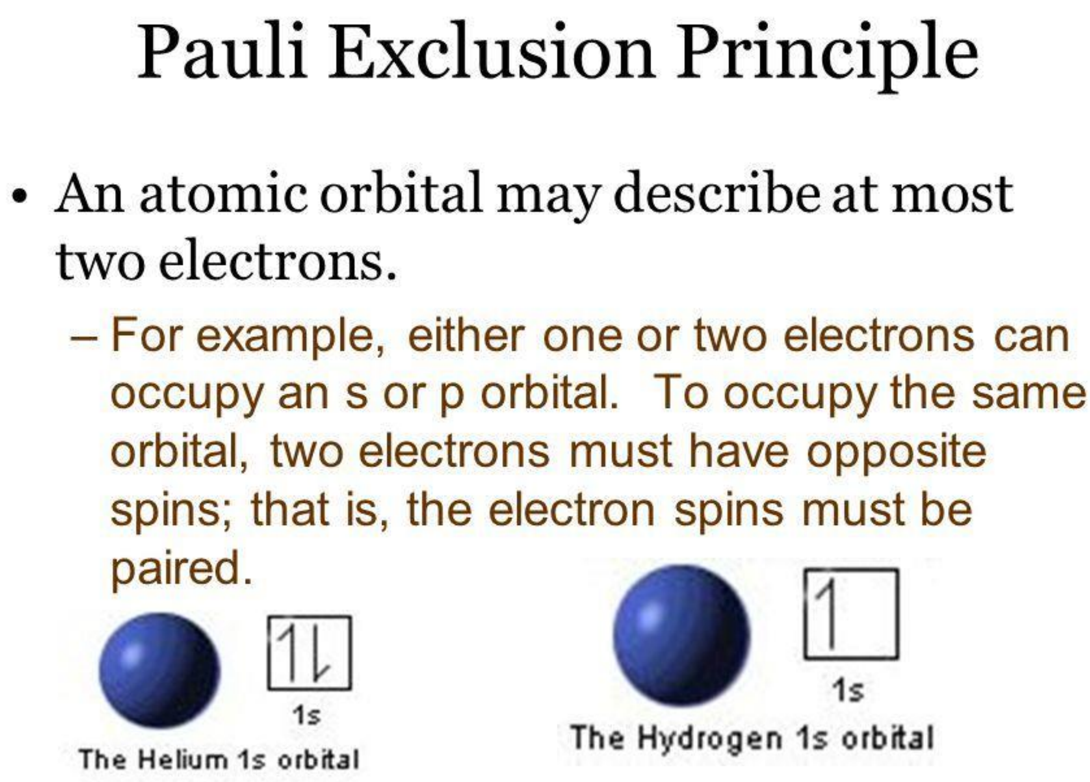
   Time evolution of a quantum system

Here the cubits would be |-𝕠d>= d_1|-𝕠> + d_2|-𝕠>. That represents a superposition of two spin Pythagorean Triangle sides. When this is measured as -𝕆D×e𝕪 kinetic work the two probabilities would be constructive or destructive interference.



Pauli Exclusion Principle

In this model fermions do -𝕆D×e𝕪 kinetic work in atomic orbitals. They interfere destructively with other electrons with too close a e𝕪 position, this prevents them from having the same spin directions.



Electron pairs and spin

In the diagram there are pairs of electrons, one would have its spin flipped. For example as a rolling wheel the axle is the -𝕠d kinetic magnetic field, this can create a -𝕆D kinetic torque and probability causing a destructive interference with other fermions. The e𝕪 kinetic spoke might be regarded as spinning clockwise as the wheel moves.

Asymmetrical rolling wheel

This spoke comes out of one side of the rolling wheel, for example when clockwise it might connect to the edge of the -𝕠d axle, that points out away from the viewer. When counterclockwise the spoke would protrude out towards the viewer.

Torque and displacement from a wheel

To view this -𝕆D×e𝕪 kinetic work or a E𝕐/-𝕠d kinetic impulse is needed, -𝕆D×e𝕪 kinetic work measures the -𝕆D kinetic torque of the axle. To observe this the spoke is displaced from one position at its end to another, this would have an E𝕐 squared force. An example would be a spoke pointing out from a horizontal spinning wheel, when a barrier is brought to the spoke it is struck and decelerated with a displacement force.

Constructive interference brings two electrons together

When the spin is flipped the kinetic spoke would turn counterclockwise, the -𝕆D kinetic torque tends to neutralize the torque from an unflipped electron rolling wheel. This is also a -𝕆D constructive interference, the clockwise spin moves downwards on its leading edge on an unflipped electrons. The counterclockwise spin moves downward on its trailing edge, these interfere constructively making it more likely the two electrons are close to each other.

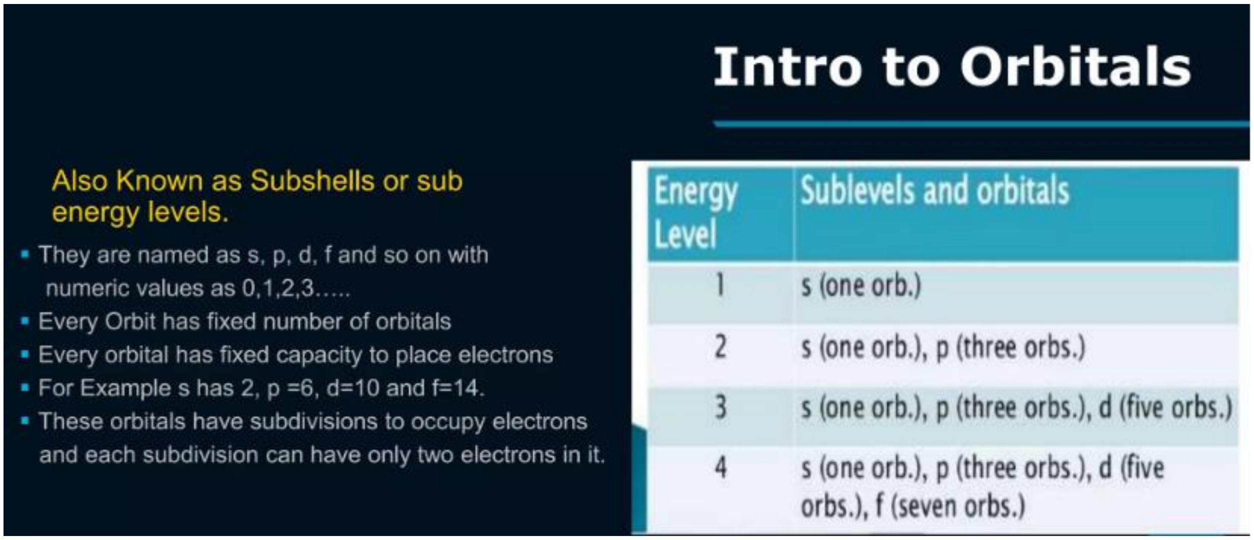
Electron shells

In the diagram the electron shells fill up with pairs of electrons with constructive interference. These also have some constructive and destructive interference with other pairs. That causes the other pairs to be closer but still separated.

Element	Configuration notation	Orbital notation	Noble gas notation
Lithium	$1s^2 2s^1$	1s: ↑↓ 2s: ↑ 2p: __ __ __	$[He]2s^1$
Beryllium	$1s^2 2s^2$	1s: ↑↓ 2s: ↑↓ 2p: __ __ __	$[He]2s^2$
Boron	$1s^2 2s^2 p^1$	1s: ↑↓ 2s: ↑↓ 2p: ↑ __ __	$[He]2s^2 p^1$
Carbon	$1s^2 2s^2 p^2$	1s: ↑↓ 2s: ↑↓ 2p: ↑ ↑ __	$[He]2s^2 p^2$
Nitrogen	$1s^2 2s^2 p^3$	1s: ↑↓ 2s: ↑↓ 2p: ↑ ↑ ↑	$[He]2s^2 p^3$
Oxygen	$1s^2 2s^2 p^4$	1s: ↑↓ 2s: ↑↓ 2p: ↑↓ ↑ ↑	$[He]2s^2 p^4$
Fluorine	$1s^2 2s^2 p^5$	1s: ↑↓ 2s: ↑↓ 2p: ↑↓ ↑↓ ↑	$[He]2s^2 p^5$
Neon	$1s^2 2s^2 p^6$	1s: ↑↓ 2s: ↑↓ 2p: ↑↓ ↑↓ ↑↓	$[He]2s^2 p^6$

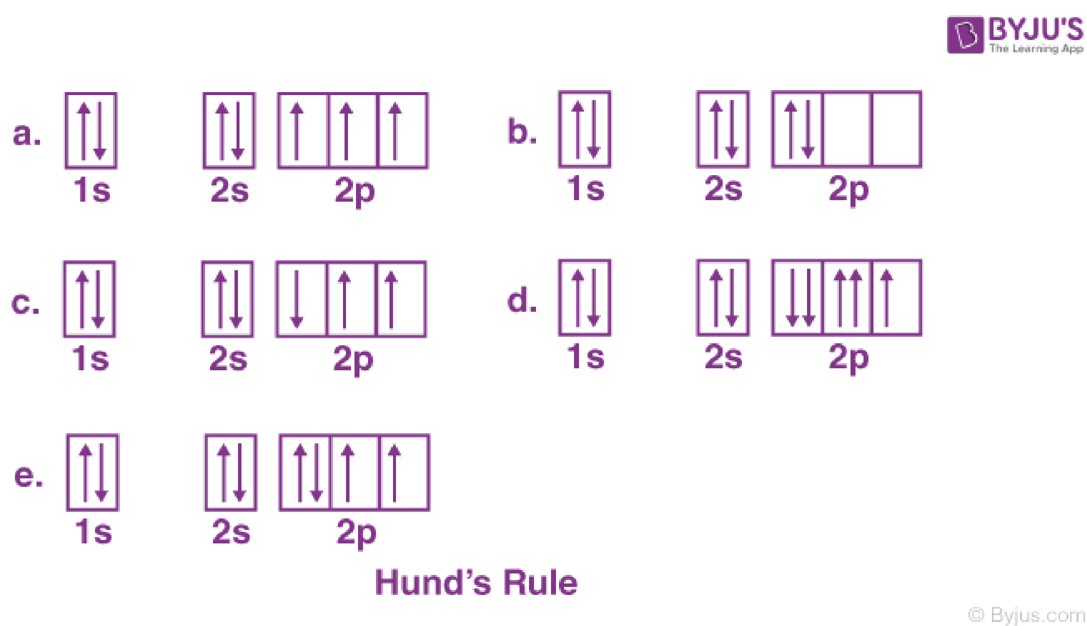
Electron pairs and entanglement

Each orbital has subshells with pairs of electrons in constructive interference. When electrons leave the atoms they move mainly with a E𝕐/-ⓞd kinetic impulse, they can form a kind of boson pair as entangled electrons. Because the probability remains in destructive interference, this is because the -𝕆D kinetic probabilities pass through other fields, measuring one electron means the other must have the opposing spin. They could not entangle with the same spin, they would remain fermions with a destructive interference between them.



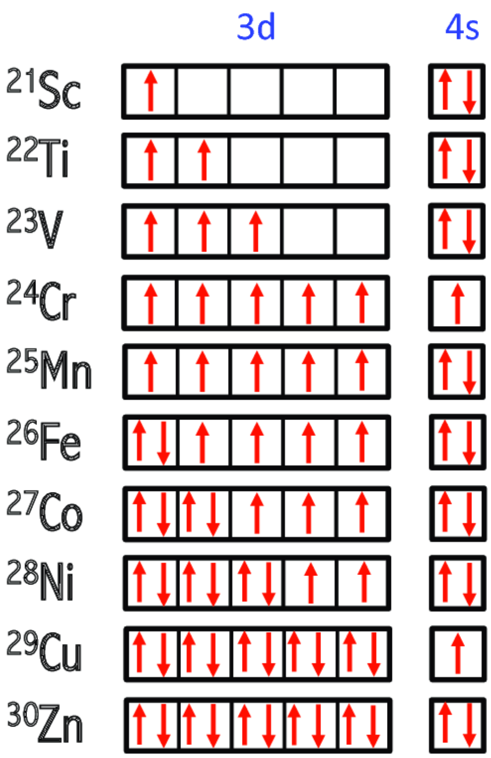
Hund's rule

In this model electron spins have a destructive interference between fermions, and a constructive interference between boson pairs. There is a greater probability for bosons to pair up, but if spins are not flipped the most probable configuration is away from the destructive interference between fermions. In c there are two electrons in constructive interference in 2p, another two have destructive interference and remain separated. In d there are still 2 electrons in constructive interference, the others in 2p remain more separated with destructive interference. This is the most -𝕆D kinetically probable arrangement.



3d and 4s orbitals

This also occurs in the 3d and 4 s orbitals below, the most -𝕆D kinetically probable outcome is that electrons are more separated.



The Aufbau Principle

Electrons have a -𝕆D kinetic probability, this is subtracted from the +𝕆D potential probability from the nucleus. When an electron is an a higher orbitals, its -𝕆D kinetic torque must be larger so its does more -𝕆D×e𝕪 kinetic work. If orbitals are available below it, then the electron has a higher -𝕆D kinetic probability of emitting -𝔾D light probability and moving lower down.

Potential probability

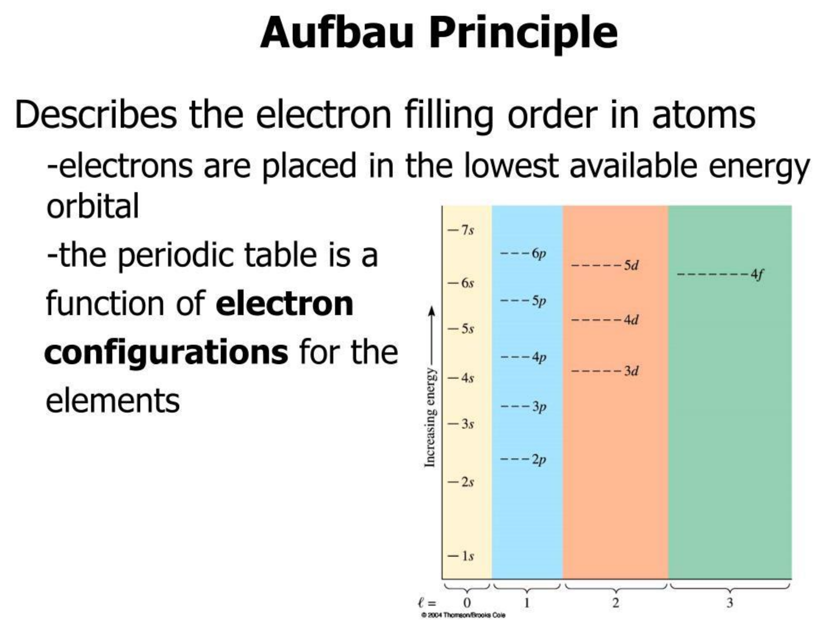
This is because the +𝕆D potential probability is higher as a square with a lower e𝕒 altitude above the nucleus. That means an electron is more -𝕆D kinetically probable to be added to this higher +𝕆D value, it then moves downward into the lowest orbital. To counter this the electron must retain its -𝕆D kinetic probability in the higher orbital, the +𝕆D potential probability reacts against this causing the electron to emit a photon and move to a lower e𝕒 altitude.

The electron has an active probability

That is because the electron has active forces, it can actively do -𝕆D×e𝕪 kinetic work in emitting a photon as the most probable outcome. The photons does -𝔾D×e𝕪 light work and so this is separated from the electron as the most probable outcome for it as well.

Gravitational probability

This is like +𝕀D×e𝕙 gravitational work, iotas are more +𝕀D gravitationally probable to move to a e𝕙 height that is lower. This is because the +𝕀D gravitational probability increases as a square as the e𝕙 height decreases linearly. Countering this is the -𝕀D inertial probability of a satellite for example, if there is no friction then the inertia remains and the satellite stays in orbit. This is because inertia is reactive, it cannot do the equivalent of emitting a photon to lose inertia.



The wave function and the double slit experiment

In this model the wave/particle duality also occurs in the double slit experiment. A photon approaches the slits, if there is an attempt to observe which slit the photon rolling wheel goes through it is observed as a particle. This e𝕐/-𝕘𝕕 light impulse has no interference pattern because the -𝕘𝕕 as light time is not squared as a probability.

Not a wave function collapse

This is not a collapse, instead a different aspect of the photon rolling wheel is observed. The wheel is a rotating e𝕪 and -𝕘𝕕 Pythagorean Triangle, the area of the Pythagorean Triangle is not measured so it is not a wave. If the wheel is observed this is by an acceleration of its e𝕪/-𝕘𝕕 ratio. For example if the photon collides with an electron particle, the change in its -𝕘𝕕 rotational frequency and e𝕪 or e𝕧 wavelength defines it as a particle.

Reflecting a photon

A single photon can be measured with -𝔾𝔻×e𝕪 light work or observed as a e𝕐/-𝕘𝕕 light impulse, when a photon cannot be absorbed by an atom it can be reflected as a wave doing -𝕆𝔻×e𝕪 kinetic work. This does not turn the photon into a wave function here, instead it does -𝔾𝔻×e𝕪 light work on the atom, is reflected, and then it returns to being a e𝕪 and -𝕘𝕕 Pythagorean Triangle with no forces.

Changing the photon’s frequency

This might change its -𝕘𝕕 rotational frequency, for example if the e𝕪×-𝕘𝕕 integral area had too low a -𝕘𝕕 frequency to be absorbed by an electron it may reflect. If the e𝕪×-𝕘𝕕 photon’s -𝕘𝕕 rotational frequency is larger than that used by the electron to jump an orbital, it may be emitted as a lower frequency photon. Because the force here is -𝔾𝔻 from -𝔾𝔻×e𝕪 light work, the change is measured as the rotational frequency on a scale of the e𝕪 or e𝕧 wavelength.

A colliding photon

When the photon collides with a free electron with a e𝕐/-𝕘d light impulse this does not turn it into a particle, instead it rebounds like a spring. The impulse comes from the e𝕪 light spoke hitting the electron, then it rebounds and the photon can have its e𝕪 and e𝕧 wavelength changed with the Compton effect. In both cases the photon does not actually collapse from -𝔾D×e𝕪 light work to a e𝕐/-𝕘d light impulse or vice versa.

Photon collision

When the photon collides with a free electron then it acts as a derivative slope, the e𝕪 kinetic spoke is divided by the -𝕘d rotational axle. That is like the radius of a wheel divided by its rotational frequency to determine its velocity. A bike wheel for example might spin at 60 revolutions per second, the circumference of the rotation comes from the e𝕪 radius and the frequency of rotation from the -𝕘d axle. If the wheel is spinning and not on a surface, then this e𝕧/-𝕚d ratio is not an inertial velocity. It is a ratio like the e𝕪/-𝕘d ratio of the photon, that moves with a e𝕧/-𝕚d inertial velocity of c.

Colliding wheels with torque and compression

If two wheels such as tops collide there can be a transfer of torque between them, this comes from the -𝕀D×e𝕧 inertial work the first does to the second wheel. When this rotational frequency is high there is more -𝕀D×e𝕧 inertial work, when this is low there is more E𝕍/-𝕚d inertial impulse done because the wheel compresses and expands elastically in the collision.

The e𝕪 kinetic spoke of a photon can be compressed in a collision, that changes the -𝕘d rotational frequency of the e𝕪 and -𝕘d Pythagorean Triangle. A collision is observed with E𝕐 displacement, for this force to be conserved it acts like a spring. This is not quantized and has no phase, if it changed from the angle of the e𝕪 kinetic spoke then that would be measuring -𝔾D light torque not a straight-line displacement.

Waves have no exact time

When the -𝕘d light time is being observed then the photon is observed as a particle with e𝕐/-𝕘d light impulse. To know what -𝕘d light time it went through a slit is to define it as a particle. For example, with water waves going through double slits there is no way to observe the time accurately. Part of the wave might go through one slit at a different time to the other, the wave by its nature has no exact time. It has an approximate leading edge and trailing edge, one part of the wave might go through a first slit and another part through a second slit. The time itself is uncertain, in this model it can be measured as -𝕀D×e𝕧 inertial work as a duration from the wave's torque.

No observation without division

The wave nature in this model is an integral area with multiplication, because of this there cannot be a division of a particle needed to observe when it went through a slit. That implies knowing the inertial velocity e𝕧/-𝕚d of the photon as c, that is connected to the e𝕪/-𝕘d ratio as a division and derivative. Here then it is not possible to know what time a wheel for example passed a gate without division, that makes it a particle with a e𝕐/-𝕘d light impulse.

A wave as a probability density

When the photon is not being observed with -𝕘d light time, then it can be measured with -𝔾D×e𝕪 light work. That gives a probability density like water waves through the double slits. This is measured with e𝕧 positions because the -𝕚d inertial time cannot be exact without using a -𝕚d inertial clock gauge. By measuring with a e𝕧 scale this can only measure a -𝕀D inertial probability or inertial torque of the wave.

Collapsing and reviving a wave function

With the photons then, not observing the -𝕘d light time allows the -𝔾D light probability to form interference patterns on a screen. This interference pattern is measured by e𝕧 positions on the screen, not by when the photons reached the screen. In conventional physics the photons can be attempted to be observed between the slits and the screen, this must be measuring their e𝕧/-𝕚d inertial velocity as c so it cannot also be measuring the e𝕧 positions on the screen.

Changing from measurement to observation

Changing quickly from measurement to observation may cause an electron for example to alternate from -𝕆D×e𝕪 kinetic work to a E𝕐/-𝕠d kinetic impulse. It can be regarded as a collapse from -𝕆D×e𝕪 kinetic work to a E𝕐/-𝕠d kinetic impulse, and a revival of the -𝕆D×e𝕪 kinetic work from the E𝕐/-𝕠d kinetic impulse.

A constant Pythagorean Triangle area allows work and impulse

This can happen from the constant area of the Pythagorean Triangle, when the spin side is squared it acts with -𝕆D×e𝕪 kinetic work, when this is changed to squaring the straight side it acts with a E𝕐/-𝕠d kinetic impulse. With the example of a bike wheel, it can collide with an E𝕍/-𝕚d inertial impulse and -𝕀D×e𝕧 inertial work, as long as the wheel is not damaged then it can alternate by changing its rotational frequency. A wheel that doubles its rotational frequency when its radius was halved, like a spinning ice skater drawing in their arms, would change this work and impulse ratio.

Separating measurements in time

With this model -𝔾D×e𝕪 light work is done on the double slits, that gives -𝔾D light probabilities with a constructive and destructive interference onto the screen. Because time is not being observed, these can be separated in time without changing the interference patterns. The duration of time between a starting and final instant is used for the -𝔾D light probability, it cannot also be used to compare the times the photons go through the slits. They might then be separated by minutes, days, even weeks and give the same interference pattern.

Gambling and work

This also occurs in the macro world, a gambler for example can play craps over a long period of time. The odds still even out, even though the gambling sessions are separated like the photons are. That is because the gambling is creating a probability distribution from work, the time is not being observed only the positions of the dice and where the gambler is.

An electron in a well

When a wave function, such as an electron in a well, is measured then it oscillates according to the e𝕧 positions of the well's boundaries. This is doing -𝕆D×e𝕪 kinetic work and proportionally -𝕀D×e𝕧 inertial work on the boundary walls.

Quantum tunneling as an exponential

It can tunnel through a wall with this -𝕆D×e𝕪 kinetic work, then the -𝕆D kinetic probability decreases as a square when the thickness of the wall as e𝕧 is increased. That gives an exponential decay function, it comes from the constant Pythagorean Triangle area where one Pythagorean Triangle side is squared.

Probabilities of reflection and refraction

When the electron acts as a -𝕆D probability it may not be completely reflected by a boundary, the gaps between the atoms are like slits and so there are some probabilities of the work being reflected or going through. The -𝕠d and e𝕪 Pythagorean Triangle electron has a constant area, this means the electron is later observed with an E𝕍/-𝕚d inertial impulse it is either on one side or the other of the wall.

Collapsing a wave function with tunneling

This is another example, according to this model, of a wave function being regarded as collapsing into an observation. The -𝕆D×e𝕪 kinetic work is spread out as a -𝕆D kinetic probability distribution, then it is observed at a single -𝕠d kinetic time inside or outside the boundary. Once the electron passed through the boundary it would no longer be doing -𝕆D×e𝕪 kinetic work, then there would be no forces with the -𝕠d and e𝕪 Pythagorean Triangle. The wave function does not collapse then, it reverts to a Pythagorean Triangle and then can be observed with a E𝕐/-𝕠d kinetic impulse.

Collapsing the wave function with a clock gauge

When there is a wave function then it is work, the electron in the well is being measured by the positions of the walls. That enables quantum tunneling, when a -𝕠d clock gauge is used at a time after the tunneling this allows for the wave function to collapse into an electron particle.

Observing becomes a duration

When the particle is observed, then there tends to be a duration from an initial -𝕠d kinetic time of its forming to a final time when it becomes a wave again. This duration is like a -𝕆D kinetic torque, a clock gauge might show this as a starting instant which moves or accelerates then decelerates to the final instant. That is -𝕆D×e𝕪 kinetic work, so the particles tends to become a wave again.

The wave spreads out

It spreads out more as the probability density increases at greater e𝕪 and e𝕧 positions away from when the particle was observed. The center of this probability density would be approximately where the particle was, using the word was implies a time for this observation. This came from a displacement, the particle had to move to be observed. That would be represented as a force vector in conventional physics.

The normal curve from the probability distribution

With a greater e𝕧 distance from the center of the wave the -𝕆D kinetic probability would be lower, this is like how the normal curve is formed from squared values. Instead of the square forming an exponential curve with impulse, here the squared probability decreases as a square as the linear distance from the center increases.

Standard deviations between positions

This produces the normal curve shape as a series of integral areas of -𝕆D probabilities in between linear distances. That can be drawn as columns of -𝕆D kinetic probability with e𝕪 as linear spacings between them, this is how a normal curve is broken up into standard deviations. The normal curve can also be formed by the spin Pythagorean Triangle side squared as an exponent.

Probabilities between distances

The same -𝕆D kinetic probabilities are measured with e𝕧 distances between the double slits in the experiment, or the distances between atoms in quantum tunneling. This makes all the probabilities based on normal curves. That is not the same as observing which slit a photon went through, instead it is normal curves across the slits.

The Quantum Zeno effect

This leads to the quantum Zeno effect, there an electron can be prevented from jumping to another orbital by its being continually observed. To change orbitals -𝕆D×e𝕪 kinetic work must be done, this is because the orbitals are quantized as waves. This observation is defining a -𝕠d kinetic time for an electron, it remains a particle and so cannot jump to a quantized orbital as -𝔾D×e𝕪 light work.

Observing a double slit

That is like observing which slit a photon might go through, this prevents electrons or photons from doing work to make an interference pattern. In this model the electron jumps in an orbital by changing the number of oscillations around it, the e𝕪×-𝕘d photon is emitted or absorbed also as -𝔾D×e𝕪 light work. When observed then both of these cannot be a wave probability, it is the same to form interference patterns as to change the waves around an orbital.

Using spin for time or torque

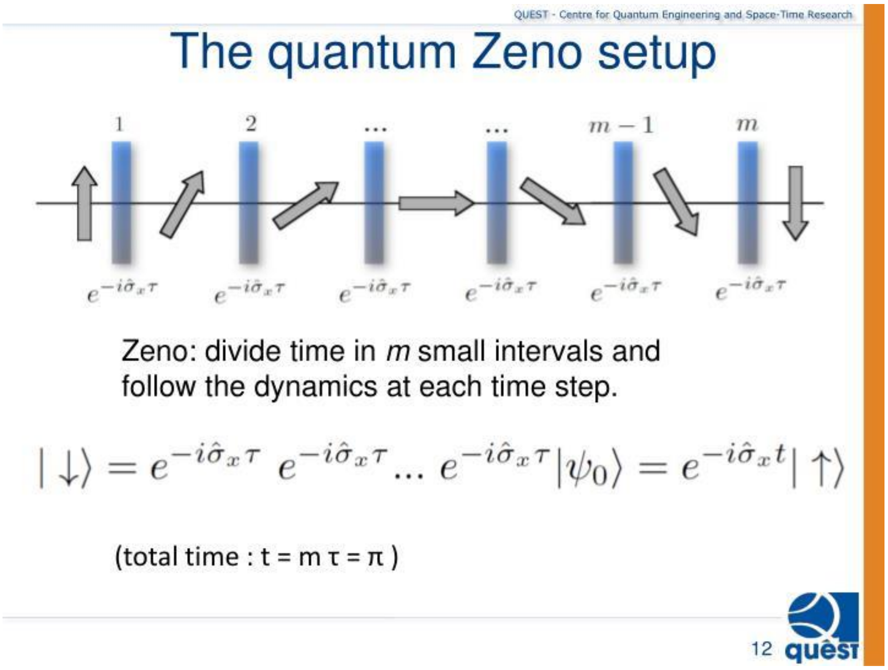
In the diagram below the spin is used to observe the -𝕆D kinetic time on a clock gauge. It cannot also be used to measure the spin as a square with -𝕆D×e𝕪 kinetic work to allow the electron to change its orbital. That would be done by a -𝕆D kinetic torque with an electron, by exerting this torque the -𝕆D kinetic probability can also be measured as to whether it is up and down.

Instants and duration

Here the exponent would be $e^{-𝕠d}$ for example where the rotation of d in a circle is like a clock gauge. This does not use i as an imaginary number, -𝕠d is already the negative square root of -1. That observation prevents it also being $e^{-𝕆D}$ at the same time as a squared probability. In that case the -𝕠d kinetic time would be used as a clock gauge of instants, and also be used as a duration in between instants.

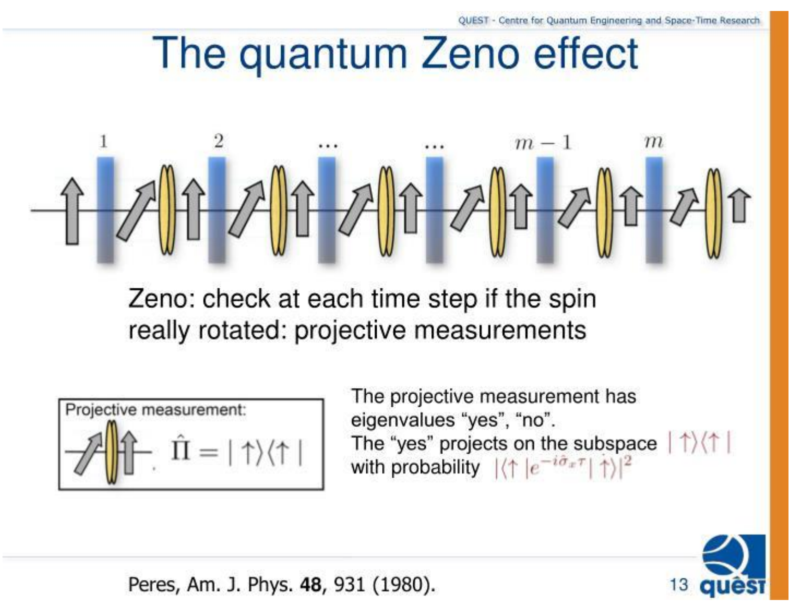
Zeno's points and lines

This is similar to Zeno's insight with points and lines. A point here would be an instant of time, a line would connect two instants as a duration. With the straight Pythagorean Triangle side the points would be e𝕧 positions for example, the displacement between the points would be a line. When it is a series of points as instants or positions, then Zeno's arrow could not move. Only when there is a displacement with an E𝕍/-𝕚d inertial impulse, or a duration with -𝕀D×e𝕧 inertial work, can the arrow move with impulse or work.



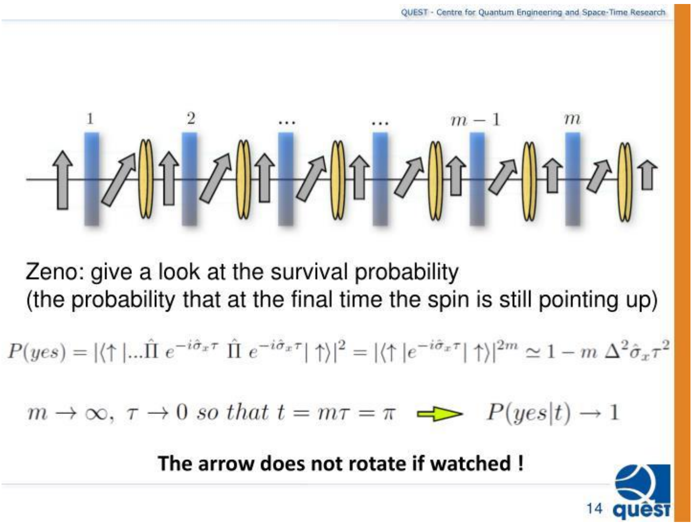
A wave does not have an exact time

In this model these would be observations not measurement, because the spin is being used as -𝕠d kinetic time with an electron. A wave cannot be observed over time because it is spread out, the time concept is fuzzy as a squared probability. When a water wave passes for example, its time is not exact because different parts of the wave can be used. Instead there is a duration over which the wave passes.



Spin is measured with torque

In this model the spin cannot be measured with its direction using E𝕐/-𝕠d kinetic impulse, the -𝕠d kinetic time is rotating on a clock gauge. To measure the direction of spin there is the -𝕆D kinetic torque, that has a different force according to the direction of the spin.

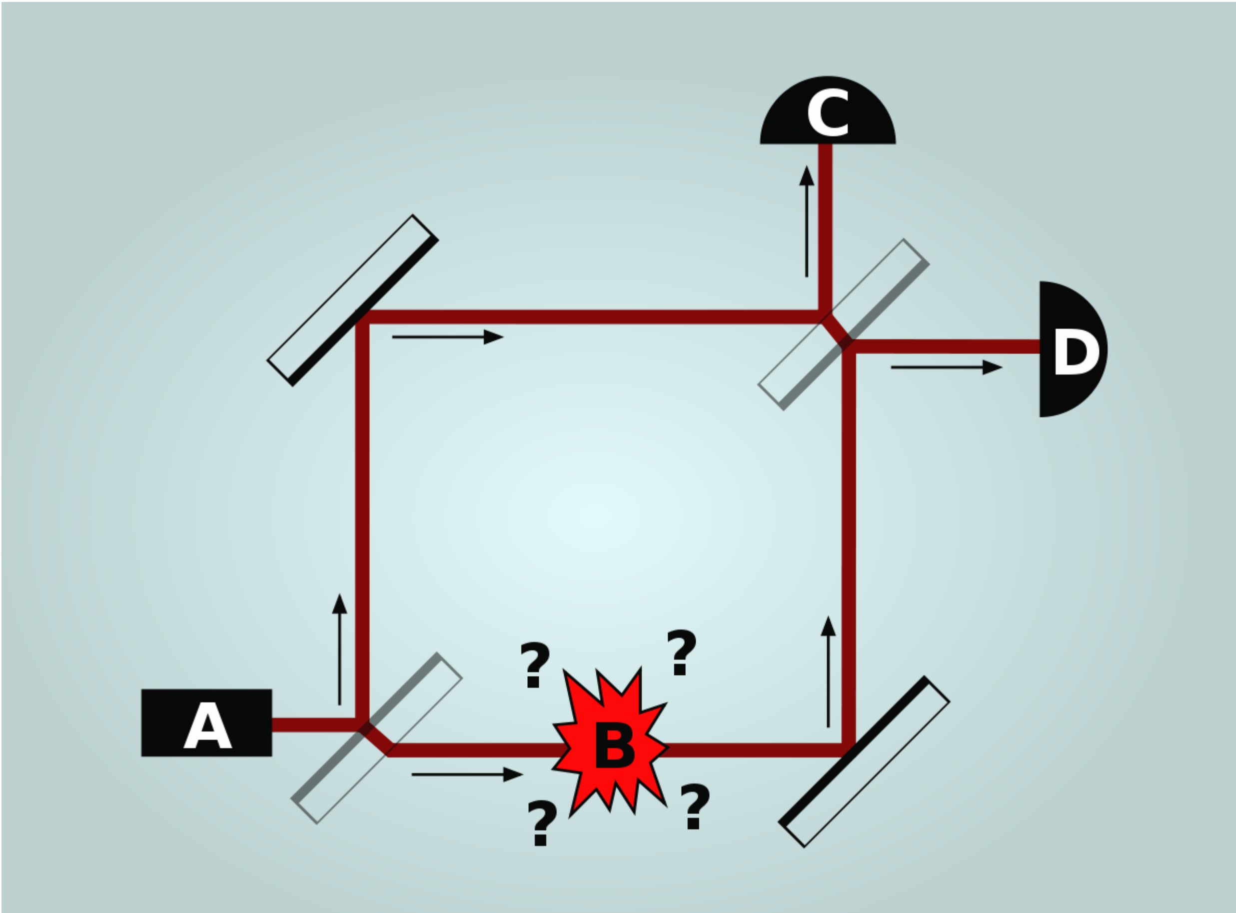


The bomb experiment

In this model photons can be split into two separate beans at A. The e𝕪 positions are the e𝕪×-𝕘d photons are being measured with -𝔾D×e𝕪 light work. This is because there is no observation of which way the photons go, this is like the double slit experiment. There is a -𝔾D light probability of the photons going along both parts, because of this they act as waves. They would tunnel through the bomb with a -𝔾D light probability, the deeper the bomb was on a e𝕧 linear scale the -𝕀D inertial probability would decrease as a square like with electron tunneling.

Observing C or D

The e𝕪×-𝕘d photons would then diffract through the bomb, if it can only observe the e𝕐/-𝕘d light impulse as photon particles then it would not explode. With C as the path not going through the bomb, observing this would give e𝕪/-𝕘d photons with a e𝕐/-𝕘d light impulse and no interference pattern. Selecting D would be observing e𝕪/-𝕘d photons with a e𝕐/-𝕘d light impulse, that would explode the bomb.



Photons from a quasar

John Wheeler proposed using photons from a quasar, they were gravitationally lensed so that there were separate beams. The photons had been traveling for billions of years, this is a -𝕘d observation using time as a light clock gauge. The -𝕘d axle on the photon rolling wheel rotates a number of times from where it was emitted to when it is observed or measured.

Deterministic time as impulse

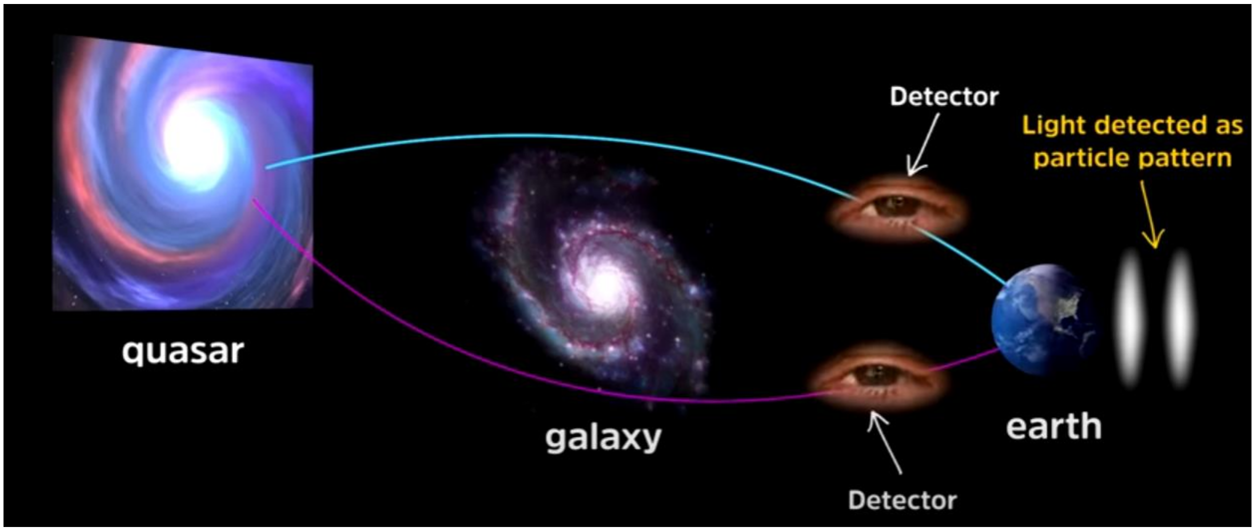
That conserves the -𝕘d light time deterministically, if the e𝕪 light wavelength has been approximately constant then the angle θ of the e𝕪 and -𝕘d Pythagorean Triangle has also been constant. In this model there would be a redshift as the rolling wheel is observed to be rotating more slowly with a e𝕐/-𝕘d light impulse. This is because the Eℍ/+𝕚d gravitational impulse was equivalent to the photons climbing up a gravitational well.

One side of the gravitational lens

When one side of the gravitational lens is observed, then the e𝕪/-𝕘d photons appear as rolling wheels. They have a e𝕧/-𝕚d inertial velocity which is observed, this is done by the E𝕍/-𝕚d inertial impulse the photons have when they collide with the observer. The rolling wheel appears to have rotated a fixed number of times on a light clock gauge, from the radius e𝕪 this gives a deterministic time to the quasar.

Observing and measuring the photons

When these photons are observed they are collided with a detector, this gives their e𝕐/-𝕘d light impulse. Because this observes which beam of e𝕪/-𝕘d photons there is no interference pattern. If there was this interference then it could not be deterministic as to which beam of photons it was.



Losing the time taken

When this path information is lost then it is not possible to know the deterministic path of the photons, they are combined with a second path where the photons traveled a different amount of -𝕘d light time. When this is impossible then the e𝕐/-𝕘d light impulse is also impossible to observe on a -𝕘d clock gauge, this is because impulse comes from possibilities. Determinism means that is something is impossible it doesn't happen, if it is possible then it either happens or not.

Probabilities when possibilities are impossible

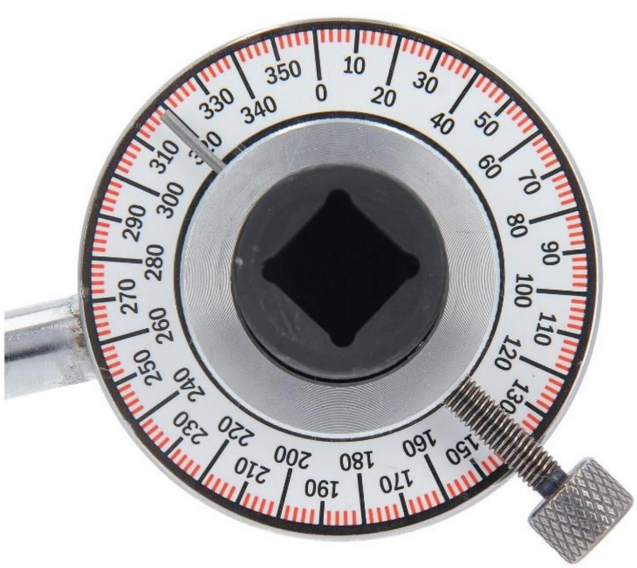
Probabilities are when observation is impossible, for example it can be impossible to observe how dice will behave when thrown in craps. Because of this they become probabilities with work. The interferometer in the diagram below made it impossible to know which path even in principle, the photons were still being received so they were not impossible to detect. This also makes their -𝕘d clock gauge time impossible to observe. That only leaves a probability of their -𝔾D×e𝕪 light work, the e𝕪×-𝕘d photons then have light constructive and destructive interference.

Observing a single billiard ball

The same would happen with a billiard ball rolling by itself. To observe it the radius is known which gives the wavelength, the rotational frequency is known in rotations/minute. That allows for a deterministic observation of its motion, if it collides with other billiard balls then the possible paths can be calculated.

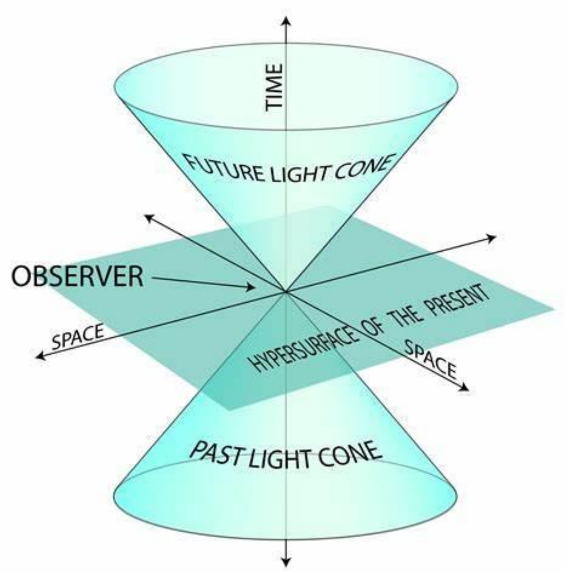
Displacement against the cushion

This observation would be done by its E𝕍/-𝕚d inertial impulse, for example if it hit the cushion then how far the rubber was depressed would give its e𝕧/-𝕚d inertial velocity from its E𝕍/-𝕚d inertial impulse. Work could not be used because the -𝕀D inertial torque of the ball is not known, for example it might have a topspin which changes this torque. Below is a device for measuring torque.



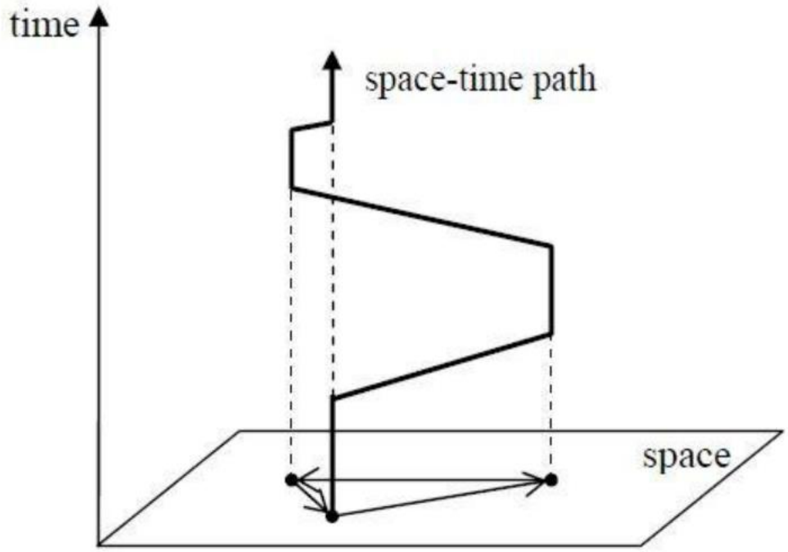
The Pythagorean Triangle in a light cone

The observable universe in this model is bounded by the light cone, which can be regarded as a cone with a high eh height and a small +id gravitational time radius. This extends to the CMB, the +id and eh Pythagorean Triangle would be a half cross section of the cone as no volumes are used here. The -id and ev Pythagorean Triangle as inertia is a future light cone, the +id and eh Pythagorean Triangle as gravity is a past light cone.



Hyperbolic trajectories in the light cone

That allows for hyperbolic trajectories to be represented in this cone according to special relativity, they would have a slower ev/-id inertial velocity than the boundary of the cone as c. This can be a vertical slice of the light cone with its base being horizontal, the hyperbolic trajectory can approach c as an asymptote. That is not at 90°, in this model c corresponds to an angle θ where ev is 3×10^8 meters and -id is one second. In this model a cross section of the cone would be used, this can be the integral areas of two -id and ev Pythagorean Triangles. In the diagram below this model would use a 2D plane, the space-time path would have a single horizontal distance as ev or eh.



The light cone cross section

One side of the cone cross section would be a e𝕧 length and the other -𝕚d inertial time, these would act as an inertial reference frame. On one side of the cross section an iota would move close to a maximum e𝕧 and a minimum -𝕚d, this can be represented by an -𝕚d and e𝕧 Pythagorean Triangle with a tangent on the hyperbola. This Pythagorean Triangle can have its angle θ changed to the opposite side, then it has a minimum inertial velocity of 1/c where e𝕧 is small and -𝕚d is large.

Observing and measuring c and 1/c

By observing the E𝕍/-𝕚d inertial impulse the γ value of -𝕚d inertial time slowing can be derived in this model. If the -𝕀D×e𝕧 inertial work is measured, then this gives the e𝕧 length contraction. Conversely in approaching 1/c the E𝕍/-𝕚d inertial impulse gives -𝕚d inertial time speeding up. This would make an electron in a box moves faster as in the uncertainty principle. If the -𝕀D×e𝕧 inertial work is measured then the e𝕧 length is dilating, this makes the e𝕧 position of the electron also less certain.

The gravitational light cone cross section

This light cone cross section can also be represented as a e𝕙/+𝕚d gravitational speed in general relativity, in approaching an event horizon then e𝕙 decreases like e𝕧 in 1/c, also +𝕚d as the gravitational time approaches it maximum. That gives the e𝕙 height contraction with +𝕀D×e𝕙 gravitational work and the +𝕚d gravitational time slowing with the Eℍ/+𝕚d gravitational impulse.

Six light cone cross sections

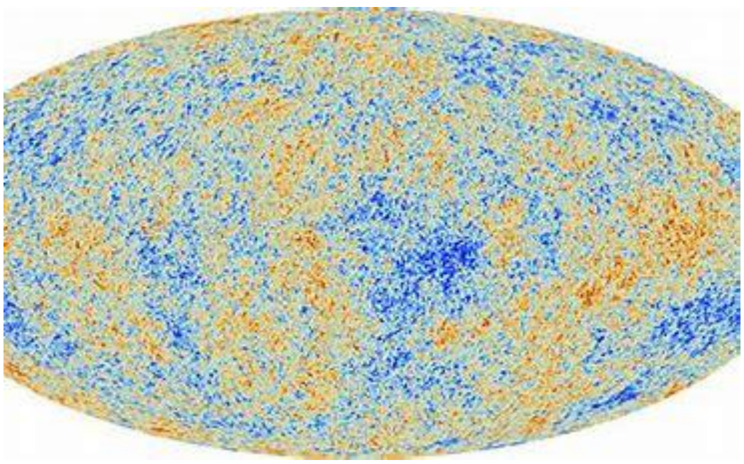
There are proportionally a kinetic light cone cross section from the -𝕠d and e𝕪 Pythagorean Triangle electron, also a potential light cone cross section from the +𝕠d and e𝕒 Pythagorean Triangle proton. In between these there are photons which have a e𝕧/-𝕚d inertial velocity at c, also a e𝕙/+𝕚d gravitational speed. These are proportional to a e𝕪/-𝕠d kinetic velocity and a e𝕒/+𝕠d potential speed. The gravis have a light cone cross section as e𝕓/+𝕘d, also c.

Deriving c from α

In this model c comes from α as the e𝕧/-𝕚d inertial velocity at the ground state, as ≈ 1/137 of c this implies a value for the speed of light. Here α appears in each Pythagorean Triangle cross section to conserve this value. Here α is derived from e as the natural logarithm with $e^{-𝕠d}$ equaling the tan of 1/α, also from δ as the first Fiegenbaum number.

The CMB and height

Conversely when e𝕙 approaches a maximum this would be the CMB, then +𝕚d gravitational time approaches the minimum. This is like 1/c for the -𝕚d and e𝕧 Pythagorean Triangle, now the e𝕙 height dilates which is like cosmological inflation. The +𝕚d gravitational time speeds up, that appears as the early universe growing quickly and then slowing at a lower e𝕙 height to the observer and measurer. In the diagram below the bluer areas would be other galaxies beyond the CMB. They redshift more of the photons so they are cooler.



No observation of speed and velocity with work

With the +𝕀D×e𝕙 gravitational work, the -𝕀D×e𝕧 inertial work, the +𝕆D×e𝕒 potential work, and the -𝕆D×e𝕪 kinetic work there is no possible observation of speeds and velocities. This allows for entanglement to be the same as if iotas were at adjacent positions.

Probability is not instantaneous

This entanglement would not be referred to as instantaneous because the spin Pythagorean Triangle side is squared as a probability. It could not also be observed directly faster than c, that means information between entangled iotas could not be observed.

Entanglement from torque

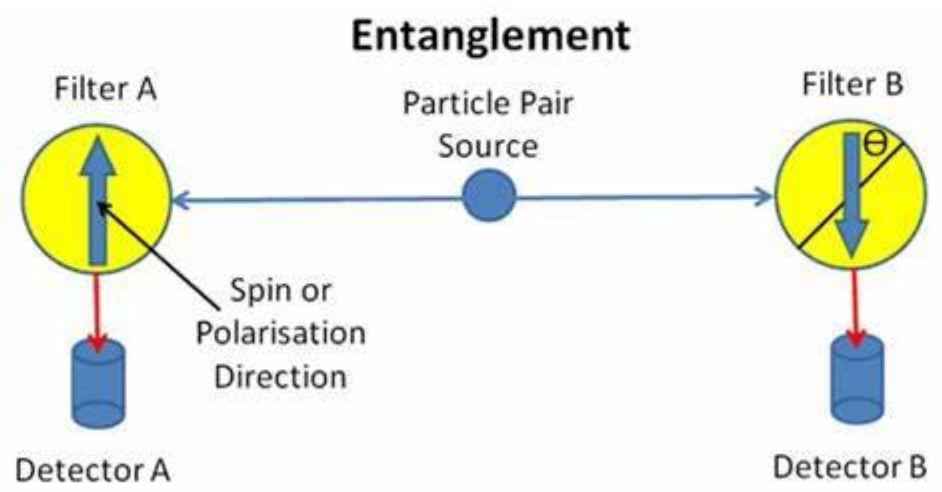
In this model entanglement comes from spin and torque. For example, two billiard balls are in space touching each other. The equivalent of a billiard cue hits in between them from an unknown side, that gives each the opposed spin to the other as they fly apart. These are not on a table, they move in empty space. That would be an analogy of two entangled photons from the one atom.

The side is not a hidden variable

It would not be known which side the billiard cue hit the balls, these would move apart until the first ball reached a measurer. The -𝕀D×e𝕧 inertial work finds for example the -𝕀D inertial torque is clockwise, that is also the -𝕀D inertial probability. Because of this it is immediately known that the second ball has a counterclockwise -𝕀D inertial torque.

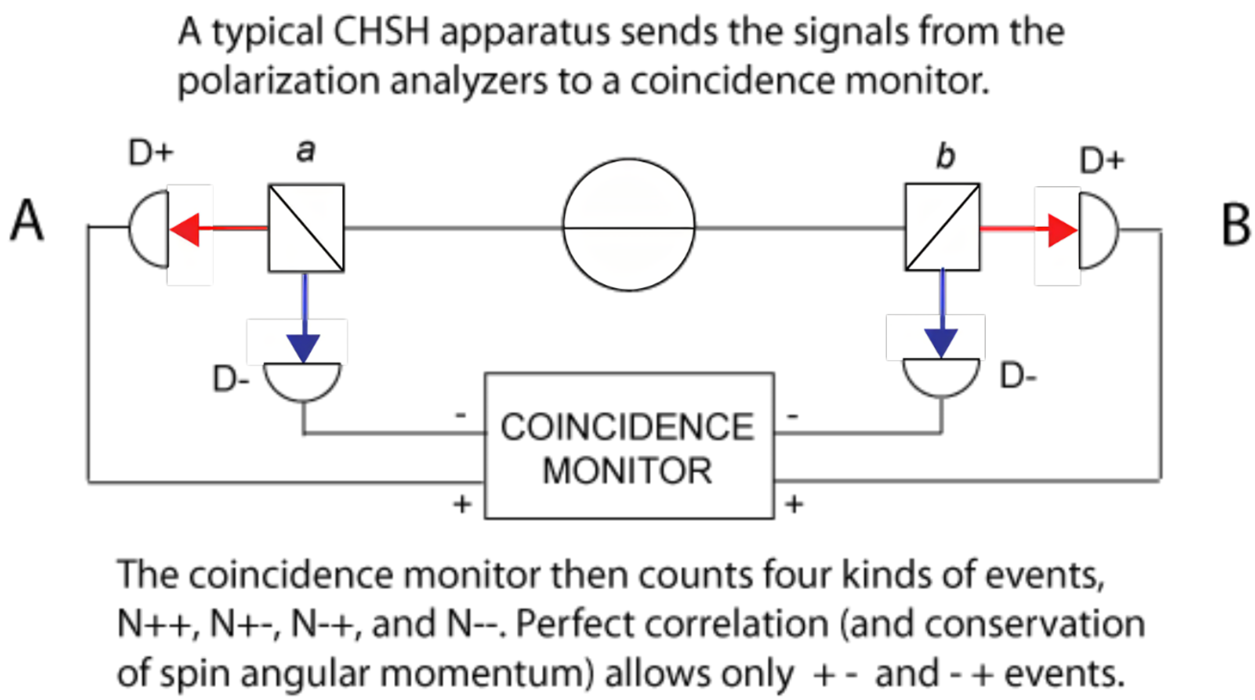
Measuring with a cushion

The measuring apparatus might be like a billiard table cushion, when the ball hits it bounces off on one side or the other. That measures a clockwise or counterclockwise torque. If this is in the plane of the torque then this will be at a maximum, if the cushion is at an angle to this torque the -𝕀D×e𝕧 inertial work will decrease as a square with the change in angle. That happens in the EPR experiment.



No torque orthogonal to the plane

If the cushion is orthogonal to the torque direction, then no torque will be measured, then nothing will be known about its torque or the second ball. If there are other nonentangled balls measured, then they will not correspond to a second ball with an opposing torque to them. They will be measured as being no different to the entangled balls. There is no hidden variable in any individual ball. A coincidence monitor can be used to work out which are the entangled photon pairs.



No hidden variables about the cue

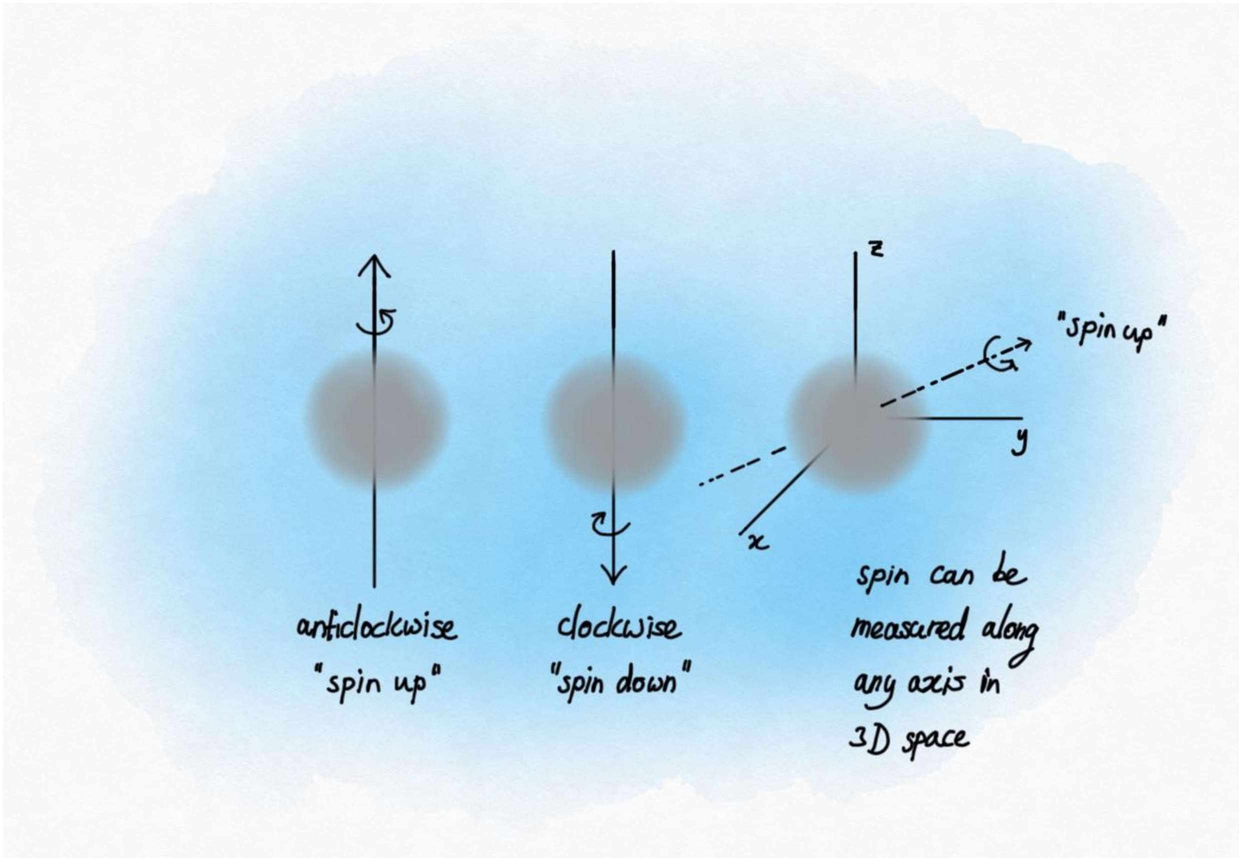
There are no hidden variables because the first ball has no information on what direction the billiard cue hit it. The -𝕀D×e𝕧 inertial work being measured also has no information on the cue's direction.

Photons with opposing spin

This is like two e𝕪×-𝕘d entangled photons, they have opposing -𝕘d spins when emitted from an atom. There is no way to observe or measure the direction of the force created this opposing spin, the photons were emitted as waves. Their -𝔾D×e𝕪 light work has an opposed -𝔾D light torque as well as a light probability. The two probabilities cancel, this means that a measurement of clockwise will give a counterclockwise measurement of the second photon.

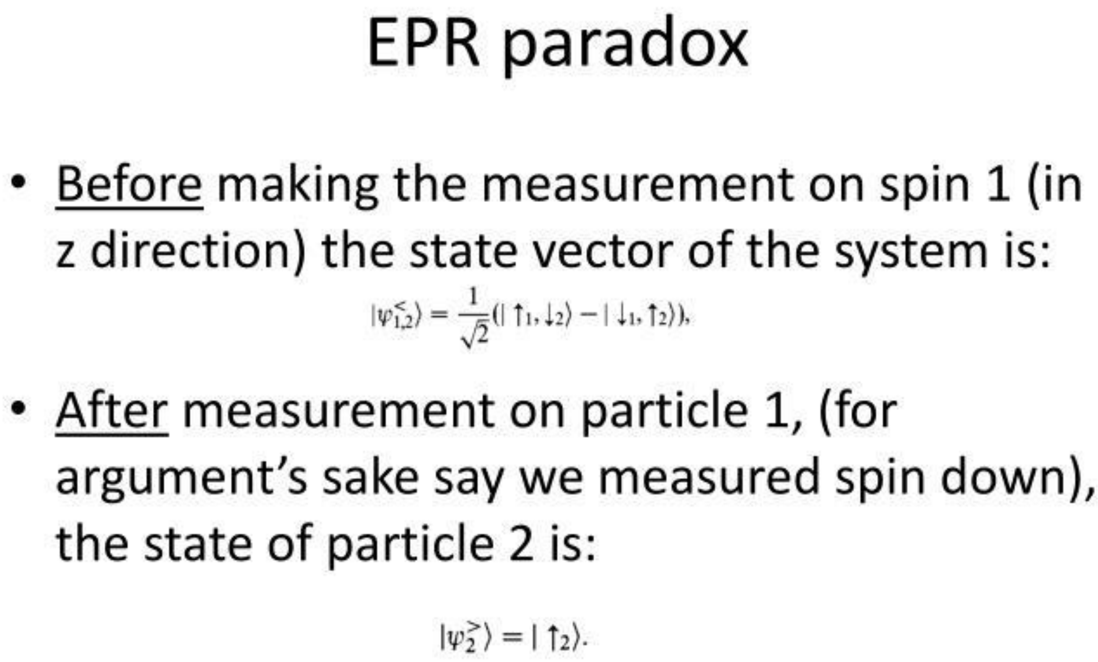
Up and down spin

This can also be referred to as up and down spin, the e𝕪 and -𝕘d Pythagorean Triangles as photons are asymmetrical. The e𝕪×-𝕘d photon has an integral area, instead of the e𝕪 spoke rotating around the -𝕘d axle the e𝕪 straight Pythagorean Triangle side can be regarded as pointing up. Then the -𝕘d spin can be clockwise but this is not being observed or measured, when the e𝕪×-𝕘d photon is flipped the e𝕪 side points down and the -𝕘d spin is counterclockwise.



State vectors

The state vector below would be e𝕪 as the straight Pythagorean Triangle side of the photon. This can point up or down. If the first photon has its -𝔾D×e𝕪 light work measured as e𝕪 up, then the second photon will have an opposed -𝔾D light torque giving e𝕪 pointing down. With the spinning ball example, this could be where a ball had a dot on the top when it was rotating clockwise. The dot would appear on the bottom when rotating counterclockwise, that would be like spin up and spin down.



After the entangled pair separates

The two entangled photons have separated, like the entangled billiard balls. There is no longer an interaction between the pairs, the spin state is still unknown because the direction of the spin creating force is not known.

EPR paradox

- Since there is no longer an interaction between particle 1 and 2, and since we haven't measured anything of particle 2, we can say that it's state before the measurement is the same as after:

$$|\psi_2^<\rangle = |\psi_2^>\rangle = |\uparrow_2\rangle,$$

Two different state vectors

There are two state vectors because the initial direction of the spin creation remains unknown.

EPR paradox

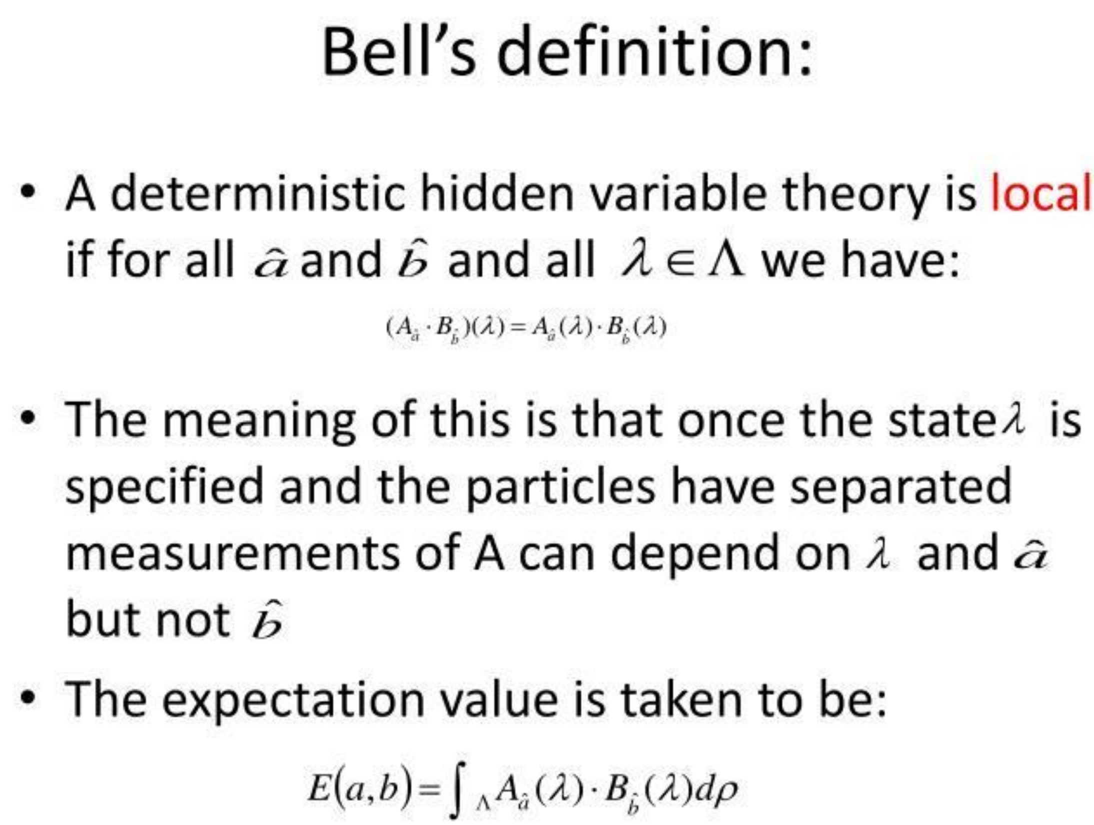
- We could apply the same argument if we have measured the spin in the x direction and receive:

$$|\phi_2^<\rangle = |+_2\rangle,$$

In other words: it is possible to assign two different state vectors to the same reality!

Bell's definition

Measurement of the first photon, like the first billiard ball, remains local to it.



Not actually spinning

This is like in conventional physics where spin is not actually spinning. It can be referred to as an angular momentum, in this model the light momentum -𝕘d×e𝕪/-𝕘d combines the integral and derivative as the field or wave and the particle. This is regarding a Pythagorean Triangle as a combination of a slope and an area like a particle/wave duality.

A Pythagorean Triangle as a slope and an area

This can be regarded as rotating, the e𝕪 side traces out an integral area like a circle. That is combining the concept of a circular area in the light momentum with the rotation of the wheel. In this model that is like referring to a Pythagorean Triangle as a slope and an area together. Measuring this circle has no information about it rotating like a wheel, there is no e𝕐/-𝕘d light impulse observation of its e𝕧/-𝕚d inertial velocity. The measuring apparatus can only detect the -𝔾D light torque in one of two probable directions.

Spin direction as a rolling wheel

When not flipped for example, a photon might have the e𝕪 spoke moving clockwise from the side as it moves to the right. That has the -𝕘d axle also turning clockwise. The second photon appears with a counterclockwise e𝕪 spoke and -𝕘d axle. This spinning of the rolling wheel can only be observed with impulse, by dividing the e𝕪 spoke by the -𝕘d axle.

Observing a spin direction

This is how a bike wheel would have its spin direction observed with its E𝕍/-𝕚d inertial impulse. That is not work because the clockwise or counterclockwise spin of the wheel is observing -𝕚d inertial time on an inertial clock gauge. The spin direction cannot be measured in the E𝕍/-𝕚d inertial impulse, but the clockwise or counterclockwise direction is part of the E𝕍/-𝕚d inertial impulse observation.

Time as spin

When spin is acting as time it on a clock gauge, that spin is not also measurable as a force in conventional physics. This makes the spin a part of an iota, but nothing is actually spinning. The actual spin is the passing of time. Two entangled wheels can be regarded as having opposing spin on two clock gauges, one appears to be going in a counterclockwise direction like a mirror image.

No rolling wheel with a field

When the bike wheel is an integral area, then the e𝕧 radius gives the size of the wheel. The -𝕚d inertial time is not observed as a clock, instead it gives the integral area. So there is no actual rolling wheel as an integral, the bike wheel appears as a circle with an area. The e𝕪×-𝕘d photon also does not measure as a rolling wheel but as a field that can have a -𝔾D light torque or probability. The model of a rolling wheel does not mean a photon or another iota has to be an actual wheel. It means a distance and spin act as a wheel when divided, as an area like a field when multiplied.

Outside the light cone cross section

When c is a derivative slope, that gives a light cone cross section with two -𝕚d and e𝕧 Pythagorean Triangles as inertia with special relativity. It has two +𝕚d and e𝕙 Pythagorean Triangles as gravity with general relativity. A e𝕧/-𝕚d inertial velocity, or a e𝕙/+𝕚d gravitational speed, greater than c are impossible.

The derivative of c

This is because the e𝕪/-𝕘d photon has a derivative slope of c, to observe the E𝕐/-𝕠d kinetic impulse of a rocket for example this has the limit of c. In this model going past c is possible because the rocket has its local E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse which continues to faster than c.

Expansion of the fabric of Biv spacetime

For example, with e𝕐/-𝕘d light impulse there are light cones where it is not possible to observe the e𝕪/-𝕘d photons outside of it. This is because light has a e𝕧/-𝕚d inertial velocity which is division. That constrains where the e𝕪/-𝕘d photons can be observed. The light cone cross section has this limit, some galaxies are still observable with four times c.

The inflationary early universe

In conventional physics this uses the expansion of Biv space-time, it expands like a field as -𝕚d×e𝕧 for inertia and +𝕚d×e𝕙 for gravity. The early universe would have this expansion of the integral fields so that c is relative to that expansion. In this model the +𝕚d and e𝕙 Pythagorean Triangle extends past c as the e𝕙 height increases, this allows for some distant galaxies to be exceeding four times c and more.

No inertial velocity with work

When the photons can only do -𝔾D×e𝕪 light work, then there can be no possible observation of their inertial velocity with division. Then the e𝕪×-𝕘d photons can arrive at -𝕘d light times that are impossible to observe as particles, in a double slit experiment this allows for a decision to measure an interference pattern after the photons have gone through the slits.

Light from a quasar

With Wheeler's use of light from a quasar, the e𝕪×-𝕘d photons have no inertial velocity, because of this they can form interference patterns when the e𝕪×-𝕘d photons left the quasar billions of years ago. This is because there is no e𝕐/-𝕘d light impulse being observed, without the -𝕘d light clock gauge the time the e𝕪/-𝕘d photons took to get from the quasar has no effect on the interference patterns.

Immedite communication between photons

This is the same with entanglement, the opposing spins of the entangled e𝕪×-𝕘d photons have opposite -𝔾D light torque and probability. This allows for an apparent immediate communication in between the photons. Because this is probabilistic it could not send deterministic information as e𝕪/-𝕘d light particles.

Path integrals and double slits

The path integral was invented by Richard Feynman from a double slit experiment. He proposed that adding more slits to one side would still cause interference patterns. The e𝕪×-𝕘d photons can then have a path as a series of e𝕪 and e𝕧 positions, the -𝔾D light and -𝕀D inertial probabilities constructively and destructively interfere so that the photons can be regarded as taking all paths through the different slits.

A curved photon path

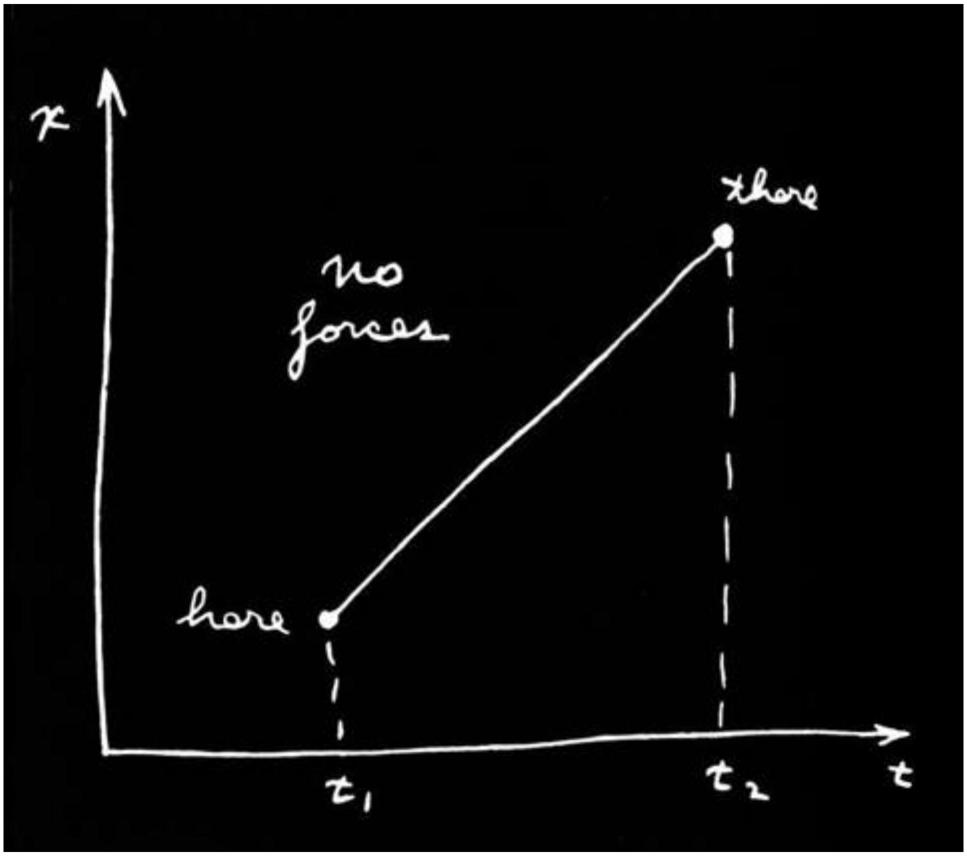
Because a curved path is longer than the straight e𝕪/-𝕘d photon path from the light source to the the double slits directly ahead, this means they can travel faster than c as probabilities like in entanglement with this model. That is not observable with e𝕪/-𝕘d photons traveling faster than c, e𝕪×-𝕘d fields have no division to observe as velocities. They can then do the impossible with interfering -𝔾D light probabilities.

Least action

In this model the least action principle comes from work, this is where the path is taken as a series of positions. The e𝕧/-𝕚d inertial velocity for example would be a straight-line in the diagram below, this comes from the straight Pythagorean Triangle side.

Curved paths interfering destructively

With -𝕀D×e𝕧 inertial work there are also -𝕀D inertial probabilities of different curved paths around this. That comes from the -𝕀D inertial torque curving the path. Because these are inertial probabilities they are on both sides of the straight-line, these interfere destructively so the inertial velocity is deterministic with no probabilities. The diagram is from the Feynman lecture on least action.



Subtracting kinetic from potential energy

The least action comes from subtracting the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy from the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. Proportionally this is also subtracting the ½×e𝕍/-𝕀d ×-𝕚d linear inertia from the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation. That also occurs in Schrodinger's equation where $p^2/2m$ is the Hamiltonian equivalent of the kinetic energy equation.

A parabola from work or impulse

A parabola can occur where the -𝕀D×e𝕧 inertial work of a projectile is subtracted from the +𝕀D×e𝕙 gravitational work of gravity. That is also proportional to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy subtracted from the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation. This comes from the squared Pythagorean Triangle sides of both the -𝕚d and e𝕧 Pythagorean Triangle and the +𝕚d and e𝕙 Pythagorean Triangle, proportionally the -𝕠d and e𝕪 Pythagorean Triangle and +𝕠d and e𝕒 Pythagorean Triangle. In this model energy is a combination of work and impulse.

Destructive interference around squared trajectories

This path also has constructive and destructive interferences around it, because it is curves the -𝕀D inertial probabilities are not symmetrical as with the straight-line velocity. Instead, the +𝕀D×eℍ gravitational work and -𝕀D×e𝕧 inertial work are inverses of each other, this comes from the constant area of both Pythagorean Triangles.

Inertia and gravity interfere destructively

When the -𝕀D inertial probability is higher than the parabola this reduces the e𝕧 length linearly. The projectile will then have a slower e𝕧/-𝕚d inertial velocity going upwards as it decelerates. The +𝕀D gravitational probability is the inverse of -𝕀D here, so as -𝕀D is stronger with a higher parabola the +𝕀D gravitational probability is weaker. If the parabola is lower then -𝕀D is weaker and +𝕀D is stronger, in all other paths the two are inverses.

Pairs of paths

There is always a pair of paths then that are equal to each other, a higher parabola might have for example D=-2 from -𝕀D and a lower parabola then has D=+2 from +𝕀D. That means e𝕧 is smaller as the projectile goes higher and slows down more. With the lower parabola the eℍ height has the same e value as e𝕧. These are like pairs of path integrals around squared probabilities and torque. They can be paired with any trajectory so that they interfere destructively leaving an impulse trajectory.

Work interferes leaving impulse

These pairs of +𝕀D×eℍ gravitational work and -𝕀D×e𝕧 inertial work interfere destructively and cancel out, that leaves the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse of the projectile where it moves as a particle. If not, then the projectile could only do +𝕀D×eℍ gravitational work and -𝕀D×e𝕧 inertial work as a wave, not have an impulse as a particle. That would means the particle/wave duality would not exist for it as energy.

Equal gravitational and inertial mass

With a given eℍ height for example there is an opposing and equal e𝕧 length in the projectile's inertial velocity, this falls with a faster eℍ/+𝕚d gravitational speed. The lower eℍ height from a lower parabola corresponds to a higher parabola with the slower e𝕧/-𝕚d inertial velocity. Because the +𝕚d and eℍ Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle have constant areas, this means the +𝕚d gravitational mass is equal to the -𝕚d inertial mass for these two parabolic positions.

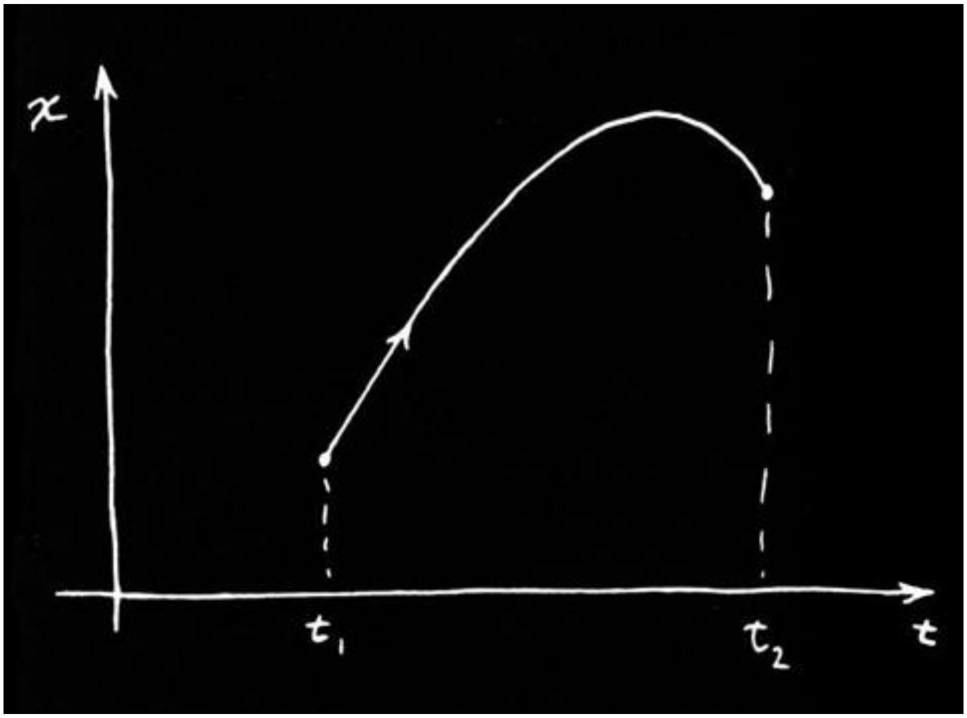
The same D and e values

That in turn means the +𝕀D×eℍ gravitational work and -𝕀D×e𝕧 inertial work have the same D and e values with these pairs, the +𝕀D gravitational probability and the -𝕀D inertial probability destructively interfere. By taking all different pairs of parabolic positions like this, the destructive interference leaves the deterministic Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse of the projectile.

Inverse eℍ and e𝕧, also inverse -𝕚d and +𝕚d

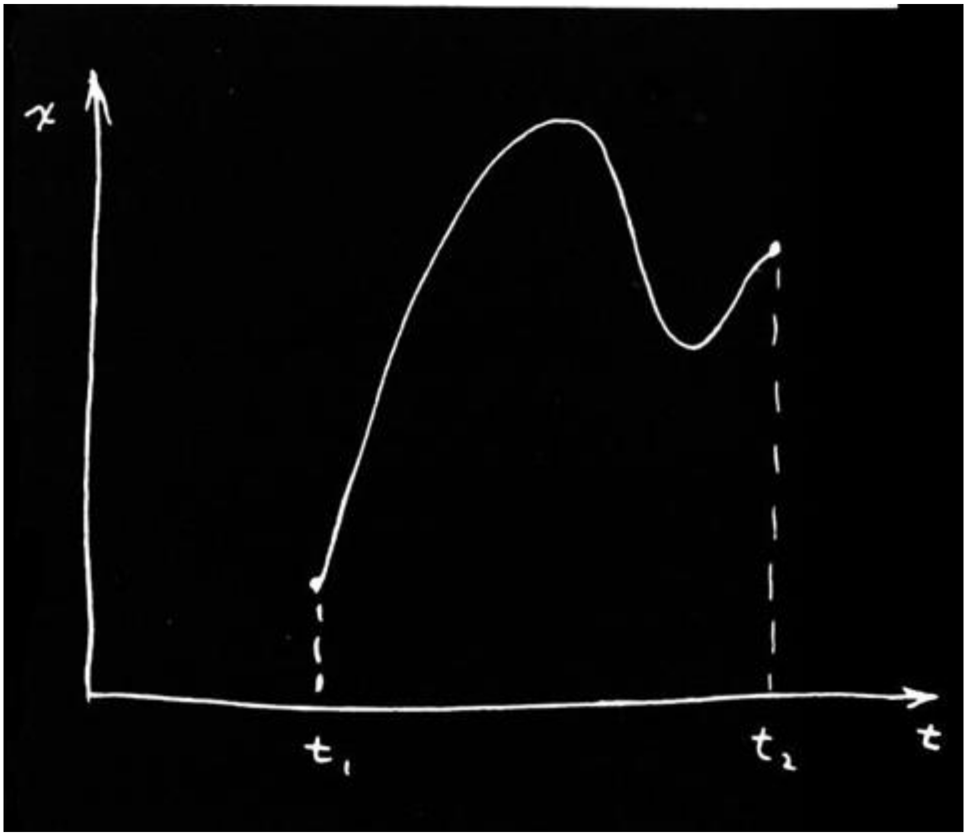
That would have the -𝕚d inertial time plotted below, here x would be the e𝕧 length opposing the eℍ height. Here eℍ and e𝕧 are inverses of each other, as the eℍ height increases then e𝕧 decreases in its e𝕧/-𝕚d inertial velocity. The time axis can be opposing -𝕚d inertial time and +𝕚d gravitational time.

With a higher parabola the -𝕚d inertial mass increases, the +𝕚d gravitational mass or field decreases inversely.



Other curves

If the path was not a parabola, then there would be a changing +𝕀D gravitational torque and -𝕀D inertial torque. This would mean the pairs of +𝕀D and -𝕀D probabilities were not completely destructively interfering. In the diagram below the +𝕀D gravitational torque would be weaker so the -𝕀D inertial torque would continue upwards. That would also mean the projectile has a different E𝕍/-𝕚d inertial impulse and Eℍ/+𝕚d gravitational impulse as time passed, this would violate the conservation of energy.



Free fall and weightlessness

The +𝕀D×eh gravitational work and -𝕀D×e𝕧 inertial work also come from when the projectile is fired, there the gravitational and inertial probabilities interfere destructively. The projectile then moves in free fall with the Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse, it is also weightless with the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work.

Changing free fall and weightlessness

There are no other forces than from when it is fired, so a change from a parabola would mean and additional force. There would no longer be free fall from impulse and weightlessness from work. This gives a parabola because the squared Pythagorean Triangle side comes from work and impulse.

F=ma as work

The projectile moves upwards with F=ma, this is -𝕀D×e𝕧 inertial work written as e𝕧/-𝕀D in meters/second^2, it also falls with +𝕀D×e𝕙 gravitational work as e𝕙/+𝕀D. These other possible paths, measured in Newtons, cancel each other out giving impulse which is the inverse of Newtons as meters^2/second.

Action as impulse

The action is defined as an integral below, because this is dt that can be regarded as reducing the denominator in the ½×e𝕍/-𝕀d ×-𝕚d linear inertia to ½×e𝕍/-𝕚d ×-𝕚d as the E𝕍/-𝕚d inertial impulse. This is proportional to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy as an integral becoming ½×e𝕐/-𝕠d ×-𝕠d. This action is also the same as h or -𝕠d ×e𝕐/-𝕠d with Planck's constant. That would be an observation of probable paths of an electron in an orbital interfering destructively, the electron is then observed with a collapse of the wave function.

$$\text{Action} = S = \int_{t_1}^{t_2} (\text{KE} - \text{PE})\, dt.$$

Energy over time versus impulse

In this model the equation above would be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy minus the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, this can also refer to Roy electromagnetism with protons and electrons in the atom. The change in these with respect to time would be an integral, but in this model the squaring of the numerator and denominator together is not used, except as an approximation. It can also be regarded as a change in energy over time, but here impulse is already a change in force over time.

Kinetic and potential displacement

In these diagrams the curves are with respect to time on the horizontal axis, the points on the curve represent the potential or kinetic energy there. Instead of this the time axis would be used with the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse. E𝕐 as the kinetic displacement goes up with hyperbolic geometry, E𝔸 goes down towards a proton as the potential displacement.

Momentum and Coulombs

Impulse would not be an integral in this model, instead it would be the second derivative with respect to e𝕪. The integral comes from energy with a squared numerator and denominator, that is not used here. The equation is the same, the first derivative is e𝕪/-𝕠d as the kinetic velocity from the -𝕠d and e𝕪 Pythagorean Triangle, when multiplied by the -𝕠d kinetic mass this is the kinetic momentum -𝕠d×e𝕪/-𝕠d. This is also the equation for Coulombs for a negative charge, the potential momentum +𝕠d×e𝕒/+𝕚d is Coulombs for a positive charge.

A derivative with Coulombs

Then take the second derivative with respect to e𝕪 to get -𝕠d×E𝕐/-𝕠d. Because this is impulse it gives a deterministic trajectory. It also uses time t in the horizontal axis, that is the -𝕠d kinetic time here. That is proportional to the E𝕍/-𝕚d inertial impulse with -𝕚d inertial time on the horizontal axis.

Derivatives for impulse, integrals for work

In conventional calculus there would be a position e𝕧, then a derivative with respect to time as -𝕚d would give e𝕧/-𝕚d. A second derivative with respect to -𝕚d time would be e𝕧/-𝕀D which is the -𝕀D×e𝕧 inertial work. In this model work is always from integration not derivatives, so this would begin as a first integral with respect to -𝕚d time on e𝕧 to become -𝕚d×e𝕧. Then a second integral with respect to -𝕚d would be the -𝕀D×e𝕧 inertial work.

Distance as the denominator

The convention with derivatives is to increase the power of the denominator. In this model the first derivative with respect to e𝕧 can be written as -𝕚d/e𝕧 in seconds per meter. This is the same as meters/second, now a derivative changes the straight Pythagorean Triangle side not spin.

Spin multiplies the numerator

With the first integral with respect to spin this would be -𝕚d×e𝕧, it can be regarded as -𝕚d^0×e𝕧 where -𝕚d^0 is an instant or fluxion then the first integral is taken to make it -𝕚d^1. The spin Pythagorean Triangle side is put first, so that a plus or minus sign is at the front instead of in the multiplication. The second integral with respect to -𝕚d would be the -𝕀D×e𝕧 inertial work as meter $seconds^2$, this is a field with a force as a torque or probability.

Changing to a denominator

That can be written as e𝕧/-𝕀D as $meters/second^2$ in F=ma, the division sign here would come from derivatives except as an approximation of the integral. For example -𝕀D×e𝕧 inertial work as $meters×second^2$ would be $meters/hours^2$ where only the time units have changed.

Energy and uncertainty

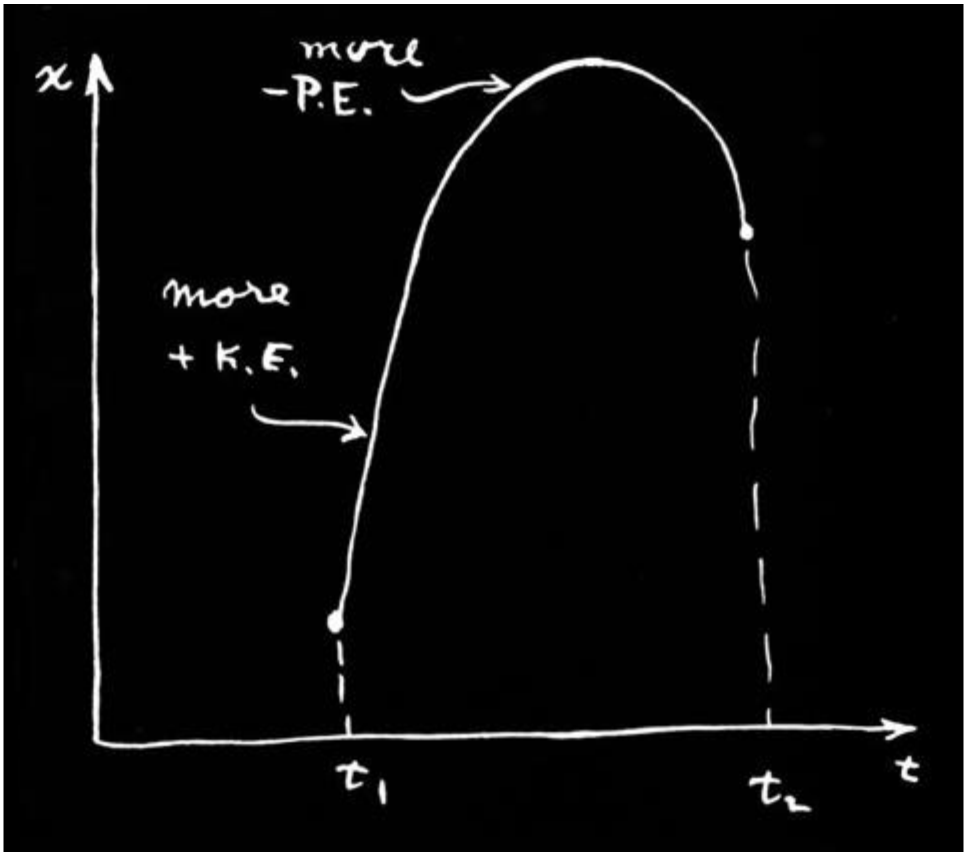
In conventional calculus an inertial velocity e𝕧/-𝕚d as an integral with respect to e𝕧/-𝕚d as the inertial velocity would give the ½×e𝕍/-𝕀d ×-𝕚d linear inertia. In this model that would be integrating both e𝕧 and -𝕚d as one term, that would not be allowed because it causes problems with the uncertainty principle. The same answers can be arrived at in this model, but squaring both the numerator and the denominator in energy is avoided as an uncertain approximation.

Schrodinger's equation and uncertainty

In Schrodinger's equation the uncertainty is added by using h, in this model that is the area of the e𝕪 and -𝕘d Pythagorean Triangle photon. That allows for the ψ wave function to be quantized, in this model the quantization comes from the +𝕆D×e𝕒 potential work from V and the -𝕆D×e𝕪 kinetic work from K. Then these are observed with h as -𝕠d ×e𝕐/-𝕠d with the E𝔸/+𝕠d potential impulse from V and the E𝕐/-𝕠d kinetic impulse from K.

The uncertainty principle

With the uncertainty principle e𝕧 as a position and -𝕚d×e𝕧/-𝕚d as the inertial momentum are used. When the e𝕧 position is known with more certainty this increases the -𝕀D inertial probability, that can be regarded as e𝕧/-𝕀D so the iota accelerates with $meters/second^2$. This can also be regarded as increasing the -𝕀D×e𝕧 inertial work so the -𝕀D inertial probability of the iota's position is more uncertain. Conversely when e𝕧 increases so does the inertial momentum, then the e𝕧 position is larger and less measurable.



Potential is positive, kinetic is negative

The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy is the potential energy in the diagram above, in this model it is positive and the kinetic energy is negative. When the integral with respect to +𝕠d is taken here it gives E𝔸/+𝕠d ×+𝕠d, the ½ is removed as it is in both equations. This is the E𝔸/+𝕠d potential impulse for a given +𝕠d potential mass. The projectile path here is then the difference between the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse.

Richard Feynman uses the equation below, this is F=ma for -𝕠d×e𝕪/-𝕆d, the difference between this and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is that e𝕪 is not squared. That means the force according to Newton came from 1/-𝕆D as seconds², in energy the force also comes from E𝕐 as the kinetic displacement.

$$\left[-m\,\frac{d^2\underline{x}}{dt^2} - V'(\underline{x})\right] = 0.$$

Here there is the potential and kinetic energies as integrals.

$$S = \int \left[\frac{m}{2}\left(\frac{dx}{dt}\right)^2 - V(x)\right] dt,$$

The light cone cross section as a Pythagorean Triangle

This light cone cross section is itself a large e𝕪 and -𝕘d Pythagorean Triangle as a reference frame, one side is a e𝕧 length and the other -𝕚d inertial time. That can only observe the e𝕐/-𝕘d light impulse and E𝕍/-𝕚d inertial impulse of the photons because the light cone has a limit of this angle θ as c.

A realistic Pythagorean Triangle angle θ

If this is shown as a more realistic angle θ then e𝕧 would be very long and -𝕚d short, this would be 3×10^8 meters long as e𝕧, with -𝕚d inertial time as one second. Then it is no longer 45° as shown in conventional physics but is a small angle θ. When a e𝕪×-𝕘d photon is shown this is an integral area only, there is no possible way to make this a division to observe an inertial velocity.

Changing basis vectors

When special relativity is shown with this narrower light cone, then the coordinates have a small angle θ as an iota approaches c. This is the same as its -𝕚d and e𝕧 Pythagorean Triangle having a smaller angle θ, instead of the coordinate system having its basis vectors changing angles here the Pythagorean Triangle sides remain orthogonal but there is the same angle change as with the basis vectors. The difference is the conventional relativistic model uses the constant hypotenuse which changes its angle, this model uses a constant Pythagorean Triangle area.

Paths faster than c

The integral area of the e𝕪 and -𝕘d Pythagorean Triangle then can move in different paths with constructively and destructively interfering path integrals. These are faster than c when converted back into observations, a -𝔾D×e𝕪 light work measurement then appears to have done the impossible by doing the probable.

Delayed choice experiments

This also allows for -𝔾D×e𝕪 light work to form interference patterns even when it is impossible with the light cone inertial velocity of c, then e𝕪×-𝕘d photons have no speed limit according to this model. A delayed choice experiment can measure -𝔾D×e𝕪 light work when it is not possible to observe e𝕐/-𝕘d light impulse as the photons are past the double slits.

Warping space past c

In this model faster than c travel could be done, but it is impossible to observe with e𝕐/-𝕘d light impulse directly. The rocket would move outside of the light cones as the angle θ of the -𝕚d and e𝕧 Pythagorean Triangle was larger than c. This would use the -𝔾D×e𝕪 light work to go faster than c, it would be warping Biv space-time in the sense that +𝕀D×e𝕙 gravitational work is related to a curved geodesic in general relativity.

Durations not instants

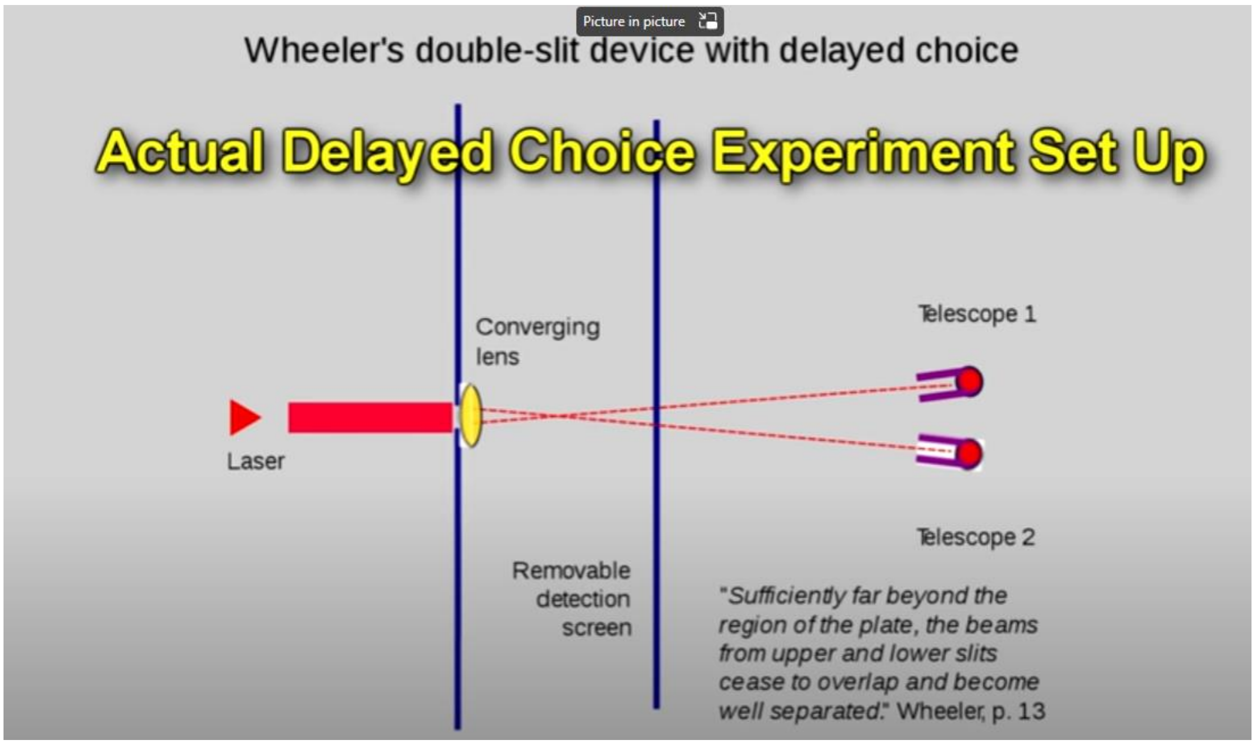
In some cases the -𝕚d×e𝕧 inertial velocity, and the +𝕚d×e𝕙 gravitational speed, would appear to be faster than c or immediate with entanglement. The word instantaneous is not used because this refers to an instant as -𝕚d or +𝕚d, these are squared as probabilities and so -𝕀D and +𝕀D are durations of time not instants.

Changing from measurement to observation

When distant galaxies are measured they give an expansion of Biv space-time, when they are observed they give a e𝕧/-𝕚d inertial velocity faster than c. The same occurs with the e𝕙/+𝕚d gravitational speed, the integral field of Biv space-time has its angle θ smaller than for c. The change from work to impulse gives this faster than c observation, then the expansion of the fabric of Biv space-time is used to explain it.

Removing the measurement screen

In the diagram below the measurement screen is removed, this changes the -𝔾D×e𝕪 light work of the photons so their changes faster than c are not being measured. Instead the beams separate and the observed with a e𝕐/-𝕘d light impulse confined to the inertial velocity e𝕧/-𝕚d of c.



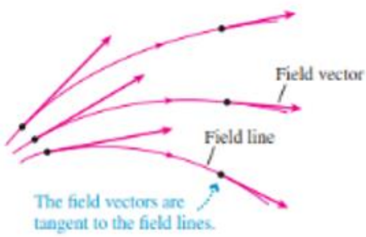
Force vectors closer together

When force vectors are closer together in the diagram below, it means with an uncertainty limit there are different displacements between starting and final points over time. This is the inverse of the magnetic field lines, they use positions as straight scale rulers to measure probability densities and torque. Both then use straight vectors, impulse as a displacement and work as a ruler. When they are closer it means the displacement occurs in a shorter time, or that for a given time there is a bigger difference in displacement.

Vectors crossing as a collision

If vectors cross then this would be a collision, like with negatively charged ions and their E𝕐/-𝕠d kinetic impulse. Without particles in between the charges there are no collisions, that would be where a field is causing particles to collide rather than the particles themselves being observed moving with their own displacements. If positive and negative ions were added, then there would be collisions with this E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. The general motion would be along these electric displacement lines.

FIGURE 23.7 Electric field lines.



Electric Field Lines

We can't see the electric field. Consequently, we need pictorial tools to help us visualize it in a region of space. One method, introduced in Chapter 22, is to picture the electric field by drawing electric field vectors at various points in space.

Another common way to picture the field is to draw **electric field lines.** As FIGURE 23.7 shows,

- Electric field lines are *continuous* curves tangent to the electric field vectors.
- Closely spaced field lines indicate a greater field strength; widely spaced field lines indicate a smaller field strength.
- Electric field lines start on positive charges and end on negative charges.
- Electric field lines never cross.

The third bullet point follows from the fact that electric fields are created by charge. However, we will have to modify this idea in Chapter 30 when we find another way to create an electric field.

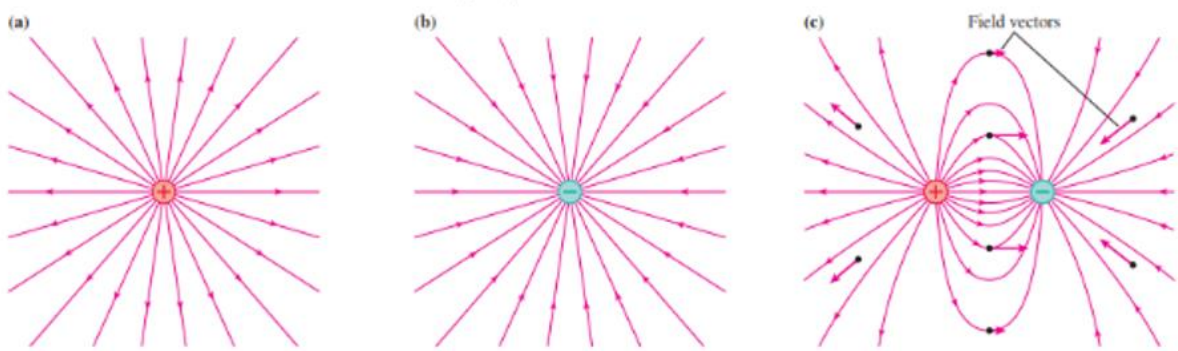
FIGURE 23.8 shows three electric fields represented by electric field lines. Notice that the electric field of a dipole points in the direction of $\vec{p}$ (left to right) on both sides of the dipole, but points opposite to $\vec{p}$ in the bisecting plane.

FIGURE 23.8 The electric field lines of (a) a positive point charge, (b) a negative point charge, and (c) a dipole.

Straight Pythagorean Triangle sides as lines

The lines here are the straight Pythagorean Triangle sides, when they are curved this is composed of many small straight displacements. They are not referred to as field lines here because this is from electric charges. The lines can also be regarded as straight Pythagorean Triangle sides used to measure work from magnetic fields.

FIGURE 23.8 The electric field lines of (a) a positive point charge, (b) a negative point charge, and (c) a dipole.



Electrons as particles

In this model electrons outside an atom generally act as particles with a E𝕐/-𝕠d kinetic impulse. A metal can have loosely held electrons that also go into orbitals as waves with -𝕆D×e𝕪 kinetic work. The number of electrons in a wire can have a density, each would have an E𝕐 kinetic displacement in collisions between each other spreading them apart.

Electron waves with voltage

These electrons can also act as waves when there is a voltage on the wire, when connected to a battery the -𝕆D kinetic difference would be from the negative terminal and the +𝕆D potential difference would be from the positive terminal. In between there is +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, the electrons move with a e𝕪/-𝕠d kinetic current which is part of the -𝕠d×e𝕪/-𝕠d kinetic momentum as Coulombs. This current can be increased in kinetic velocity by a stronger potential and kinetic difference from the battery.

Electrons in Biv spacetime

In this model the area would have individual displacements in different directions with collisions, that can also be measured as a field or integral area where there is a -𝕆D kinetic probability density of how many electrons there are at various positions. Along a wire in Biv spacetime these would do -𝕀D×e𝕧 inertial work with a voltage, in an area there would also be a -𝕀D inertial probability density. This comes from the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy and ½×e𝕍/-𝕀d ×-𝕚d linear inertia, energy combines the two as an observation and measurement of a wave/particle duality.

Zig zags of positions or vectors

Measuring the -𝕀D×e𝕧 inertial work would have e𝕧 lengths in random directions, overall that is like zig zagged points on a wire or area. With the E𝕍/-𝕚d inertial impulse these are observed as inertial displacements of zig zags between electron collisions.

No areas with straight Pythagorean Triangle sides

In this model there is no actual area such as e𝕧×e𝕧, that would be creating an integral which only occurs with the spin Pythagorean Triangle side squared. The straight Pythagorean Triangle side would be a vector, when this is squared it can be represented as a force or displacement vector E𝕍 in a single direction not an area.

Area divided by probability

This charge density would only be in straight lines as a e𝕧 length, here it cannot refer to an E𝕍 area divided by a -𝕆D inertial probability. That is observing and measuring at the same time and position which is not allowed here, except as an approximation. It would be converting the charge density into an energy equation.

Electrons spread out with work and impulse

Here the electrons spread out because they do constructive interference on each other. This makes them less likely to be measured closer to one another, their hyperbolic trajectory separating them leads to an approximately even distribution. They also spread out chaotically with E𝕐/-𝕠d kinetic impulse collisions. When measured as waves the distribution is based on normal curves, when observed as particles it is based on chaotic collisions.

23.3 The Electric Field of a Continuous Charge Distribution

Ordinary objects—tables, chairs, beakers of water—seem to our senses to be continuous distributions of matter. There is no obvious evidence for atoms, even though we have good reasons to believe that we would find atoms if we subdivided the matter sufficiently far. Thus it is easier, for many practical purposes, to consider matter to be continuous and to talk about the *density* of matter. Density—the number of kilograms of matter per cubic meter—allows us to describe the distribution of matter *as if* the matter were continuous rather than atomic.

Much the same situation occurs with charge. If a charged object contains a large number of excess electrons—for example, 10^{12} extra electrons on a metal rod—it is not practical to track every electron. It makes more sense to consider the charge to be *continuous* and to describe how it is distributed over the object.

FIGURE 23.9a shows an object of length L, such as a plastic rod or a metal wire, with charge Q spread uniformly along it. (We will use an uppercase Q for the total charge of an object, reserving lowercase q for individual point charges.) The **linear charge density** λ is defined to be

$$\lambda = \frac{Q}{L} \tag{23.12}$$

Linear charge density, which has units of C/m, is the amount of charge *per meter* of length. The linear charge density of a 20-cm-long wire with 40 nC of charge is 2.0 nC/cm or 2.0×10^{-7} C/m.

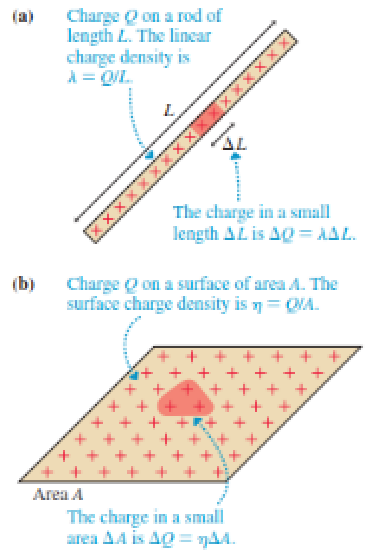
NOTE The linear charge density λ is analogous to the linear mass density μ that you used in Chapter 16 to find the speed of a wave on a string.

We'll also be interested in charged surfaces. FIGURE 23.9b shows a two-dimensional distribution of charge across a surface of area A. We define the **surface charge density** η (lowercase Greek eta) to be

$$\eta = \frac{Q}{A} \tag{23.13}$$

Surface charge density, with units of C/m^2, is the amount of charge *per square meter*. A 1.0 mm $\times$ 1.0 mm square on a surface with $\eta = 2.0 \times 10^{-4}$ C/m^2 contains 2.0×10^{-10} C or 0.20 nC of charge. (The volume charge density $\rho = Q/V$, measured in C/m^3, will be used in Chapter 24.)

FIGURE 23.9 One-dimensional and two-dimensional continuous charge distributions.



Conductivity and density

In this model the -𝕆D×eɏ kinetic work gives the surface charge density, eɏ is the kinetic electric charge and -𝕆D gives the kinetic probability density of where it is likely to be. This can be referred to as conductivity σ because voltage can move the electrons with +𝕆D×e𝕒 potential work and -𝕆D×eɏ kinetic work.

Figure 23.9 and the definitions of Equations 23.12 and 23.13 assume that the object is **uniformly charged,** meaning that the charges are evenly spread over the object. We will assume objects are uniformly charged unless noted otherwise.

NOTE Some textbooks represent the surface charge density with the symbol σ. Because σ is also used to represent *conductivity,* an idea we'll introduce in Chapter 27, we've selected a different symbol for surface charge density.

Adding fields in integration

In this model integration is adding fields that are not infinitely small, a spin Pythagorean Triangle side as -𝕚d inertial time for example this is an instant or fluxion. When it is squared it represents the duration between one e𝕧 position and another, because e𝕧 are points then this temporal duration cannot also be infinitely small.

Zeno's points and lines

This runs into Zeno's problem which an infinite number of points between two points still leaves spaces for more points. The temporal duration is a line not a point here.

Summing integral areas

These integral areas can be summed together because they have a sign, -𝕀D for example is negative so they can be added up to a negative sum. These are regarded as -𝕀D inertial probabilities because they cannot be deterministic time. When a spin Pythagorean Triangle side is squared it introduces uncertainty, it represents an acceleration from a starting to a final position. Because this acceleration is not being observed or measured between these positions, only at the start and finish, there is uncertainty.

Regular positions in an integral

In this model an integral field also has constructive and destructive interfere interference, these overlap each other according to the e𝕧 positions. It can be modeled as columns separated by e𝕧 points linearly separated from each other. The -𝕀D inertial fields here would not be constrained by e𝕧 positions, they give the -𝕀D inertial probabilities of different -𝕀D inertial densities occurring at different positions. A regular spacing can even out these interferences, then the probability densities can be modeled as columns or rows.

A Pythagorean Triangle as coordinates

Here -𝕀D can also be an inertial torque, its change causes the curve at the top of the integral to be a path of an electron for example. That is also changing the slope of the path, this can be where it is observed with an E𝕍/-𝕚d inertial impulse. When the curve has coordinates of e𝕧 and -𝕚d this gives the slope derivative for a particle, under it the integral for a wave.

Path integrals and acceleration

This is seen with path integrals for example, there are probable paths in between two e𝕧 positions but all of these are not measured. Each would have a different inertial acceleration as e𝕧/-𝕀D work, in this model these are -𝕀D inertial probabilities which interfere constructively and destructively.

Acceleration and torque

Each path then would have a different probable inertial acceleration because of its curves, a straight path would be E𝕍×-𝕚d only which could not be an integral. The probabilities are also torque as they densities change in curving the path. It is overlapping integral fields from probable paths which give the probability densities.

Derivatives use division, integrals multiplication

In this model integration is only used with work and spin Pythagorean Triangle sides, it cannot be used with impulse and squaring straight Pythagorean Triangle sides. That only uses derivatives and division, here integration only uses multiplication.

Pythagorean Triangles have a finite area

Here then integration is not adding a finite number of infinitely small areas. The -𝕠d and e𝕪 Pythagorean Triangle for example has a finite area, this can be measured with -𝕆D×e𝕪 kinetic work using integration. Only the spin Pythagorean Triangle side is squared, the straight side acts like a scale such as with e𝕪 kinetic point charges. These cannot be infinitely dense because the -𝕆D kinetic probability interferes with other electrons repelling them, this spread out the -𝕠d and e𝕪 Pythagorean Triangles from each other.

Instants and areas

In mathematical integration, according to this model, integration is bridging the difference between instants or fluxions and areas. This is related to Zeno's problem with Achilles and the Tortoise racing. Achilles is accelerating towards the Tortoise because his e𝕧/-𝕚d inertial velocity is faster. This inertial acceleration would be e𝕧/-𝕀D in meters/second^2 as -𝕀D×e𝕧 inertial work, the e𝕧 position is a point and the -𝕀D value is an area.

Points and lines as time

This can be converted to compared -𝕀D inertial areas to -𝕚d inertial times. At a given -𝕚d inertial time Achilles is at a e𝕧 point, this compares a -𝕚d inertial instant to a -𝕀D inertial duration between them. This is then like Zeno's points and lines, how many instants of -𝕚d would be in -𝕀D as an integral area.

Achilles cannot move

Zeno said that Achilles is at e𝕧 positions at -𝕚d inertial instants with his e𝕧/-𝕚d inertial velocity, but that implies he would be motionless. The e𝕧 point does not move, and the -𝕚d instant of inertial time does not change.

Achilles can accelerate

The -𝕀D inertial duration in between the -𝕚d inertial instants enables Achilles to do -𝕀D×e𝕧 inertial work and catch the Tortoise. That makes it analogous to the problem of a line and points which uses the E𝕍/-𝕚d inertial impulse. In that case the line is the E𝕍 inertial displacement between two e𝕧 points.

The arrow and Achilles both cannot move

Zeno's arrow is a related problem not using acceleration, its head and tail have fixed e𝕧 positions, but that implies it is motionless and so it cannot move. The difference is that the arrow can be stationary and cannot move, Achilles could have had a constant inertial velocity but also could not move.

The arrow and Achilles in different reference frames

Here the arrow can do -𝕀D×e𝕧 inertial work in between different e𝕧 positions as an inertial acceleration. The -𝕚d inertial time is no longer used as instants, instead there is a -𝕀D temporal duration between e𝕧 positions. The arrow would then accelerate with -𝕀D×e𝕧 inertial work from being stationary, Achilles was accelerating from a constant inertial velocity. This implies the two are equivalent, it also presages the concept of different inertial reference frames.

Zeno's problems need distance and time

By separating the E𝕍 displacement between points as a line, and e𝕧 positions as points, this explains Zeno's problem in this model. By separating a -𝕀D duration between -𝕚d instants this explains Zeno's problem for Achilles and the Tortoise. But these cannot be used to explain motion without work or impulse because that needs both distance and time.

Squaring only one Pythagorean Triangle side

In this model there are forces and changes, these come from observations and measurements. Because of this they must combine straight and spin Pythagorean Triangle sides, this is done by squaring one Pythagorean Triangle side but not the other. That allows for Zeno's arrow to be an E𝕍 inertial displacement from one -𝕚d inertial instant to another. It also allows for Achilles to catch the tortoise with an inertial acceleration as -𝕀D×e𝕧 inertial work.

Coulombs have a finite size

In (23.14) below the Coulombs are summed as infinitesimally small areas with integration, but in this model Coulombs as the kinetic momentum -𝕠d×e𝕪/-𝕠d are a combination of -𝕠d×e𝕪 integral areas and e𝕪/-𝕠d derivatives. This implies electrons can be broken down into infinitesimally small segments, but in conventional physics they have a finite -𝕚d inertial mass and e𝕧 length as size.

Changing e𝕪 positions is like infinitesimals

Because the e𝕪 kinetic positions can be anywhere this is like their being infinitesimally close together. When e𝕪 changes the -𝕆D kinetic integral areas can also change, the constructive and destructive interferences act like infinitely small changes. But in this model these would be one measurement of -𝕆D×e𝕪 kinetic work, not infinitely many measurements superposed on each other.

The light cone and path integrals

There is also a limit of the angle θ in the -𝕚d and e𝕧 Pythagorean Triangle, e𝕧/-𝕚d has this angle limit as c. The columns in the integration can then have a length e𝕧 when vertical separated by a small -𝕚d width of the column. This limits the -𝕀D inertial probabilities in a path integral to a light cone, there could not be a measurement faster than c.

Integration Is Summation

Calculating the electric field of a continuous charge distribution usually requires setting up and evaluating integrals—a skill you've been learning in calculus. It is common to think that "an integral is the area under a curve," an idea we used in our study of kinematics.

But integration is much more than a tool for finding areas. More generally, **integration is summation.** That is, an integral is a sophisticated way to add an infinite number of infinitesimally small pieces. The area under a curve happens to be a special case in which you're summing the small areas $y(x)dx$ of an infinite number of tall, narrow boxes, but the idea of integration as summation has many other applications.

Suppose, for example, that a charged object is divided into a large number of small pieces numbered $i = 1, 2, 3, \ldots, N$ having small quantities of charge $\Delta Q_1, \Delta Q_2, \Delta Q_3, \ldots, \Delta Q_N$. Figure 23.9 showed small pieces of charge for a charged rod and a charged sheet, but the object could have any shape. The total charge on the object is found by *summing* all the small charges:

$$Q = \sum_{i=1}^{N} \Delta Q_i \tag{23.14}$$

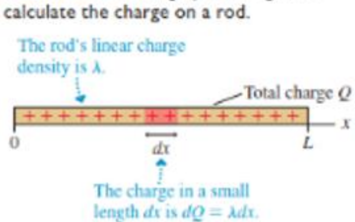
If we now let $\Delta Q_i \to 0$ and $N \to \infty$, then we *define* the integral:

$$Q = \lim_{\Delta Q \to 0} \sum_{i=1}^{N} \Delta Q_i = \int_{\text{object}} dQ \tag{23.15}$$

Integrating over a distance with work

The rod can be regarded as have -𝕆D×e𝕪 kinetic work probability densities constructively and destructively interfering. Integrating over the rod has -𝕆D kinetic probabilities from positions e𝕧=0 to e𝕧=L.

FIGURE 23.10 Setting up an integral to calculate the charge on a rod.



That is, integration is the summing of an infinite number of infinitesimally small pieces of charge. This use of integration has nothing to do with the area under a curve.

Although Equation 23.15 is a formal statement of "add up all the little pieces," it's not yet an expression that can actually be integrated with the tools of calculus. Integrals are carried out over coordinates, such as dx or dy, and we also need coordinates to specify what is meant by "integrate over the object." This is where densities come in.

Suppose we want to find the total charge of a thin, charged rod of length L. First, we establish an x-axis with the origin at one end of the rod, as shown in **FIGURE 23.10**. Then we divide the rod into lots of tiny segments of length dx. Each of these little segments has a charge dQ, and the total charge on the rod is the sum of all the dQ values—that's what Equation 23.15 is saying. Now the critical step: The rod has some linear charge density λ. Consequently, the charge of a small segment of the rod is $dQ = \lambda\, dx$. **Densities are the link between quantities and coordinates.** Finally, "integrate over the rod" means to integrate from $x = 0$ to $x = L$. Thus the total charge on the rod is

$$Q = \int_{\text{rod}} dQ = \int_0^L \lambda\, dx \tag{23.16}$$

Charge as positions not impulse

In this model quantities would be -𝕆D probability densities, coordinates would refer to a distance as e𝕪. Here the e𝕪 kinetic electric charge can be regarded as positions, not being observed with an E𝕍/-𝕚d inertial impulse. The -𝕆D probability density would be according to e𝕪 kinetic electric charge positions, in this model -𝕆D comes from the -𝕠d kinetic magnetic field.

Now we have an expression that can be integrated. If λ is constant, as it is for a uniformly charged rod, we can take it outside the integral to find $Q = \lambda L$. But we could also use Equation 23.16 for a nonuniformly charged rod where λ is some function of x.

This discussion reveals two key ideas that will be needed for calculating electric fields:

- Integration is the tool for summing a vast number of small pieces.
- Density is the connection between quantities and coordinates.

No infinite line of charge

In this model there cannot be an infinite distance of charge, this is because the Pythagorean Triangles would have a zero angle θ and could not exist. The e𝕪 vectors point outwards in hyperbolic geometry, the e𝕒 vectors point inwards with circular geometry. This is the opposite of in the diagram below, but the answers are the same.

Work and impulse

The field here would be from the spin Pythagorean Triangle side squared, the vector as 1/r would be e𝕪 for a negative charge and e𝕒 for a positive charge. When this is not squared it is the -𝕆D×e𝕪 kinetic work and +𝕆D×e𝕒 potential work respectively. When squared it is the E𝕐/-𝕠d kinetic impulse and E𝔸/+𝕠d potential impulse. The vectors are then not field lines, they are like rulers for measuring the probability densities of the magnetic fields. A longer wire has less impulse and displacement, this is because the charges are more evenly spread out in parallel to each other.

An Infinite Line of Charge

What if the rod or wire becomes very long, becoming a **line of charge,** while the linear charge density λ remains constant? To answer this question, we can rewrite the expression for E_{rod} by factoring $(L/2)^2$ out of the denominator:

$$E_{rod} = \frac{1}{4\pi\epsilon_0}\frac{|Q|}{r \cdot L/2}\frac{1}{\sqrt{1 + 4r^2/L^2}} = \frac{1}{4\pi\epsilon_0}\frac{2|\lambda|}{r}\frac{1}{\sqrt{1 + 4r^2/L^2}}$$

where $|\lambda| = |Q|/L$ is the magnitude of the linear charge density. If we now let $L \to \infty$, the last term becomes simply 1 and we're left with

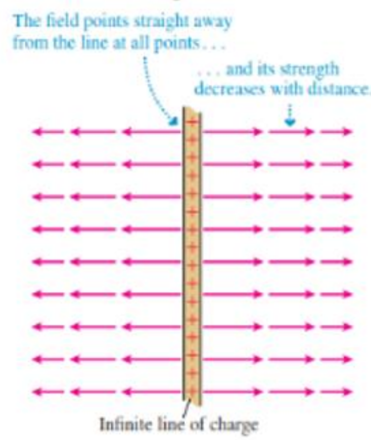
$$\vec{E}_{line} = \left(\frac{1}{4\pi\epsilon_0}\frac{2|\lambda|}{r}, \begin{cases}\text{away from line if charge } + \\ \text{toward line if charge } -\end{cases}\right) \quad \text{(line of charge)} \quad (23.17)$$

where we've now included the field's direction. FIGURE 23.13 shows the electric field vectors of an infinite line of positive charge. The vectors would point inward for a negative line of charge.

NOTE Unlike a point charge, for which the field decreases as $1/r^2$, the field of an infinitely long charged wire decreases more slowly—as only $1/r$.

The infinite line of charge is the second of our important electric field models. Although no real wire is infinitely long, the field of a realistic finite-length wire is well approximated by Equation 23.17 except at points near the end of the wire.

FIGURE 23.13 The electric field of an infinite line of charge.



Probability field at potential positions

In this model there is no electric field, so this would be the +𝕆D×e𝕒 potential work around the ring. The e𝕒 straight Pythagorean Triangle side points perpendicularly out of the ring as vectors, +𝕆D as the potential probability cancels in the center with destructive interference. The surface charge density in (23.18) would be an area as +𝕀D for the positive charge, the e𝕒 altitude pointing inwards with +𝕆D×e𝕒 potential work. In this model the +𝕠d and e𝕒 Pythagorean Triangle has reactive forces only, this means away from the center there is less destructive interference up to the ring itself.

Gravity in a ring

With the +𝕀D×e𝕙 gravitational work of a planet, each side of the center has opposing +𝕀D gravitational probabilities. These interfere destructively so gravity appears to come from the center only. Here the wing would also do +𝕀D×e𝕙 gravitational work proportionally to the +𝕆D×e𝕒 potential work. There would be destructive interference in the center so there would be no gravity there.

No work in a volume

In (23.19) there is a cubed exponent because the field is regarded as a volume, this then decreases as a square so the exponent is 3/2. In this model there is no volume with a field, only areas. Because the +𝕀D potential probability is all around the ring there is +𝕆D×e𝕒 potential work done everywhere, it fills the volume with e𝕒 potential positions. It can then appear as a volume, but the +𝕠d and e𝕒 Pythagorean Triangle in each case has an area field only.

FIGURE 23.15 The on-axis electric field of a ring of charge.

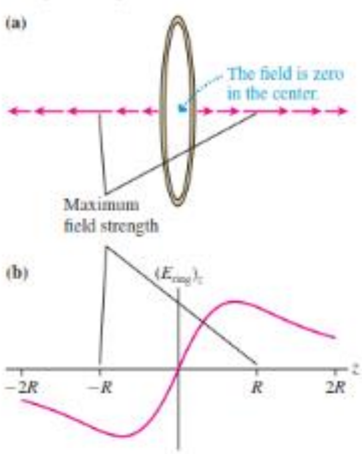


FIGURE 23.15 shows two representations of the on-axis electric field of a positively charged ring. Figure 23.15a shows that the electric field vectors point away from the ring, increasing in length until reaching a maximum when $|z| \approx R$, then decreasing. The graph of $(E_{ring})_z$ in Figure 23.15b confirms that the field strength has a maximum on either side of the ring. Notice that the electric field at the center of the ring is zero, even though this point is surrounded by charge. You might want to spend a minute thinking about why this has to be the case.

A Disk of Charge

FIGURE 23.16 shows a disk of radius R that is uniformly charged with charge Q. This is a mathematical disk, with no thickness, and its surface charge density is

$$\eta = \frac{Q}{A} = \frac{Q}{\pi R^2} \qquad (23.18)$$

We would like to calculate the on-axis electric field of this disk. Our problem-solving strategy tells us to divide a continuous charge into segments for which we already know how to find $\vec{E}$. Because we now know the on-axis electric field of a ring of charge, let's divide the disk into N very narrow rings of radius r and width Δr. One such ring, with radius r_i and charge ΔQ_i, is shown.

We need to be careful with notation. The R in Example 23.4 was the radius of the ring. Now we have many rings, and the radius of ring i is r_i. Similarly, Q was the charge on the ring. Now the charge on ring i is ΔQ_i, a small fraction of the total charge on the disk. With these changes, the electric field of ring i, with radius r_i, is

$$(E_i)_z = \frac{1}{4\pi\epsilon_0} \frac{z\,\Delta Q_i}{(z^2 + r_i^2)^{3/2}} \qquad (23.19)$$

The on-axis electric field of the charged disk is the sum of the electric fields of all of the rings:

$$(E_{disk})_z = \sum_{i=1}^{N} (E_i)_z = \frac{z}{4\pi\epsilon_0} \sum_{i=1}^{N} \frac{\Delta Q_i}{(z^2 + r_i^2)^{3/2}} \qquad (23.20)$$

A circular integral

The ring in the diagram below would have a +𝕆D potential probability, this is circular because of the +𝕆D potential torque like an orbital. This can also be the E𝔸/+𝕠d potential impulse where it varies according to R^2, that would be how negative charges for example where accelerated in the ring with a E𝕐/-𝕠d kinetic impulse.

The critical step, as always, is to relate ΔQ to a coordinate. Because we now have a surface, rather than a line, the charge in ring i is $\Delta Q = \eta\,\Delta A_i$, where ΔA_i is the area of ring i. We can find ΔA_i, as you've learned to do in calculus, by "unrolling" the ring to form a narrow rectangle of length $2\pi r_i$ and height Δr. Thus the area of ring i is $\Delta A_i = 2\pi r_i\,\Delta r$ and the charge is $\Delta Q_i = 2\pi\eta r_i\,\Delta r$. With this substitution, Equation 23.20 becomes

$$(E_{\text{disk}})_z = \frac{\eta z}{2\epsilon_0}\sum_{i=1}^{N}\frac{r_i\,\Delta r}{(z^2+r_i^2)^{3/2}} \tag{23.21}$$

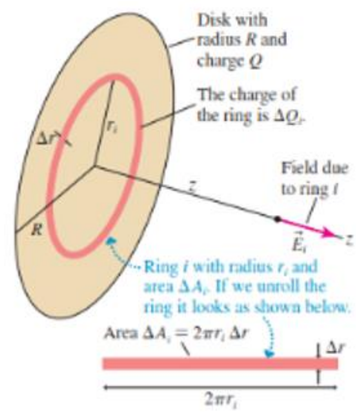
As $N \to \infty$, $\Delta r \to dr$ and the sum becomes an integral. Adding all the rings means integrating from $r = 0$ to $r = R$; thus

$$(E_{\text{disk}})_z = \frac{\eta z}{2\epsilon_0}\int_0^R \frac{r\,dr}{(z^2+r^2)^{3/2}} \tag{23.22}$$

All that remains is to carry out the integration. This is straightforward if we make the variable change $u = z^2 + r^2$. Then $du = 2r\,dr$ or, equivalently, $r\,dr = \frac{1}{2}du$. At the lower integration limit $r = 0$, our new variable is $u = z^2$. At the upper limit $r = R$, the new variable is $u = z^2 + R^2$.

NOTE When changing variables in a definite integral, you *must* also change the limits of integration.

FIGURE 23.16 Calculating the on-axis field of a charged disk.



With this variable change the integral becomes

$$(E_{\text{disk}})_z = \frac{\eta z}{2\epsilon_0}\frac{1}{2}\int_{z^2}^{z^2+R^2}\frac{du}{u^{3/2}} = \frac{\eta z}{4\epsilon_0}\frac{-2}{u^{1/2}}\bigg|_{z^2}^{z^2+R^2} = \frac{\eta z}{2\epsilon_0}\left[\frac{1}{z} - \frac{1}{\sqrt{z^2+R^2}}\right] \tag{23.23}$$

If we multiply through by z, the on-axis electric field of a charged disk with surface charge density $\eta = Q/\pi R^2$ is

$$(E_{\text{disk}})_z = \frac{\eta}{2\epsilon_0}\left[1 - \frac{z}{\sqrt{z^2+R^2}}\right] \tag{23.24}$$

NOTE This expression is valid only for $z > 0$. The field for $z < 0$ has the same magnitude but points in the opposite direction.

No infinite planes

In this model an infinite plane of charge would be impossible, this would for example have an infinite length e𝕧. But then the -𝕚d inertial mass would be zero and there would be no constant Pythagorean Triangle area. With the e𝕙 height above the plane, this is proportional to the e𝕒 altitude above the positive charges as protons. If this was constant then the +𝕠d and e𝕒 Pythagorean Triangles could not have a constant area, as e𝕒 increases then +𝕠d as the potential magnetic field must decrease inversely.

Infinite universe

The same would also happen with gravity, if the galaxies were infinite in number then the +𝕚d gravitational field would be constant everywhere with some fluctuations in the galaxies. That implies an infinite universe, in this model for the +𝕚d and e𝕙 Pythagorean Triangle to have a constant area one side must extend to a limit. This comes from the e𝕙 height increasing to the CMB, then e𝕪×-𝕘d photons cannot be measured past there as this reaches c. Here this gives the limit of observability and measurability of the universe even when it is unending.

Surface charge density

In this model the surface charge density is Coulombs as +𝕠d×e𝕒/+𝕠d divided by 1/Eℍ as the height squared. When divided by ½×ϵ which is ½×1/E𝔸 this gives Eℍ/E𝔸 which balance according to the positive charge. This leaves the potential momentum, or potential Coulombs, as +𝕠d×e𝕒/+𝕠d. When this is not infinite, then the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy changes according to the +𝕆D×e𝕒 potential work being done by the plane.

A Plane of Charge

Many electronic devices use charged, flat surfaces—disks, squares, rectangles, and so on—to steer electrons along the proper paths. These charged surfaces are called **electrodes.** Although any real electrode is finite in extent, we can often model an electrode as an infinite **plane of charge.** As long as the distance z to the electrode is small in comparison to the distance to the edges, we can reasonably treat the edges *as if* they are infinitely far away.

The electric field of a plane of charge is found from the on-axis field of a charged disk by letting the radius $R \rightarrow \infty$. That is, a disk with infinite radius is an infinite plane. From Equation 23.24, we see that the electric field of a plane of charge with surface charge density η is

$$E_{\text{plane}} = \frac{\eta}{2\epsilon_0} = \text{constant} \tag{23.28}$$

This is a simple result, but what does it tell us? First, the field strength is directly proportional to the charge density η: more charge, bigger field. Second, and more interesting, the field strength is the same at *all* points in space, independent of the distance z. The field strength 1000 m from the plane is the same as the field strength 1 mm from the plane.

How can this be? It seems that the field should get weaker as you move away from the plane of charge. But remember that we are dealing with an *infinite* plane of charge. What does it mean to be "close to" or "far from" an infinite object? For a disk of finite radius R, whether a point at distance z is "close to" or "far from" the disk is a comparison of z to R. If $z \ll R$, the point is close to the disk. If $z \gg R$, the point is far from the disk. But as $R \rightarrow \infty$, we have no *scale* for distinguishing near and far. In essence, *every* point in space is "close to" a disk of infinite radius.

No real plane is infinite in extent, but we can interpret Equation 23.28 as saying that the field of a surface of charge, regardless of its shape, is a constant $\eta/2\epsilon_0$ for those points whose distance z to the surface is much smaller than their distance to the edge.

The potential and gravity point downwards

In this model the e𝕒 potential electric charge points inwards towards the protons, it is a reactionary force but is not pointing out like -𝕠d or -𝕚d. This points inward like gravity as e𝕙, the stronger e𝕙 is as active gravity then this can crush down proton as in stars with fusion.

Kinetics and inertia point outwards

This also happens with the e𝕧 length, it can be regarded as pointing against a E𝕐/-𝕠d kinetic impulse with an E𝕍/-𝕚d inertial impulse. They are both negative, and so they point in the same direction. The inertia will reduce the acceleration of the E𝕐/-𝕠d kinetic impulse if E𝕍/-𝕚d inertial impulse is larger, but they could not oppose each other in an orbit like the E𝔸/+𝕠d potential impulse and the E𝕐/-𝕠d kinetic impulse in an atom.

A sphere of charge or gravity

A sphere of charge does +𝕆D×e𝕒 potential work, there is +𝕆D destructive interference between pairs of points e𝕒 the same altitude from the center. This cancels out the charge so it appears to come from the center in circular geometry. This also occurs with +𝕀D×e𝕙 gravitational work, pairs of points with the same e𝕙 height interfere destructively with their +𝕀D gravitational probabilities.

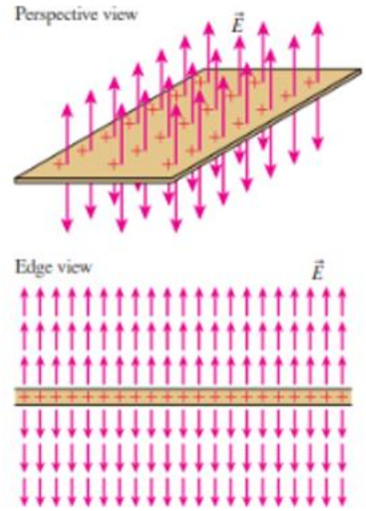
We do need to note that the derivation leading to Equation 23.28 considered only $z > 0$. For a positively charged plane, with $\eta > 0$, the electric field points *away from* the plane on both sides of the plane. This requires $E_z < 0$ ($\vec{E}$ pointing in the negative z-direction) on the side with $z < 0$. Thus a complete description of the electric field, valid for both sides of the plane and for either sign of η, is

$$\vec{E}_{\text{plane}} = \left(\frac{|\eta|}{2\epsilon_0}, \begin{cases} \text{away from plane if charge } + \\ \text{toward plane if charge } - \end{cases} \right) \quad \text{(plane of charge)} \qquad (23.29)$$

The infinite plane of charge is the third of our important electric field models.

FIGURE 23.17 shows two views of the electric field of a positively charged plane. All the arrows would be reversed for a negatively charged plane. It would have been very difficult to anticipate this result from Coulomb's law or from the electric field of a single point charge, but step by step we have been able to use the concept of the electric field to look at increasingly complex distributions of charge.

FIGURE 23.17 Two views of the electric field of a plane of charge.



A Sphere of Charge

The one last charge distribution for which we need to know the electric field is a **sphere of charge.** This problem is analogous to wanting to know the gravitational field of a spherical planet or star. The procedure for calculating the field of a sphere of charge is the same as we used for lines and planes, but the integrations are significantly more difficult. We will skip the details of the calculations and, for now, simply assert the result without proof. In Chapter 24 we'll use an alternative procedure to find the field of a sphere of charge.

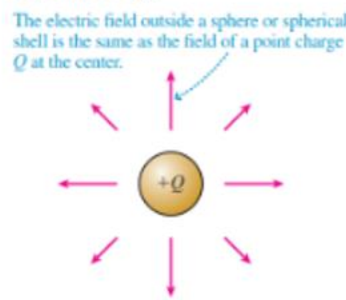
A sphere of charge Q and radius R, be it a uniformly charged sphere or just a spherical shell, has an electric field *outside* the sphere ($r \geq R$) that is exactly the same as that of a point charge Q located at the center of the sphere:

$$\vec{E}_{\text{sphere}} = \frac{Q}{4\pi\epsilon_0 r^2}\hat{r} \qquad \text{for } r \geq R \qquad (23.30)$$

This assertion is analogous to our earlier assertion that the gravitational force between stars and planets can be computed as if all the mass is at the center.

FIGURE 23.18 shows the electric field of a sphere of positive charge. The field of a negative sphere would point inward.

FIGURE 23.18 The electric field of a sphere of positive charge.



A positive charge extends past matter like gravity

In this model the +𝕠d and e𝕒 Pythagorean Triangle as the proton is proportional to the +𝕚d and e𝕙 Pythagorean Triangle as gravity, this means a positive charge extends outwards past the right plate. Negative charges from the -𝕠d and e𝕪 Pythagorean Triangle subtract from this in the plate, but the +𝕆D×e𝕒 potential work extends past the plate with a +𝕆D potential probability. Proportionaly the negative charges also have a -𝕀D inertial probability, this reduces the effect of gravity with the +𝕀D gravitational probability of the left plate. If there was a second negative plate to the right this would also subtract from the +𝕆D×e𝕒 potential work, as well as its +𝕀D×e𝕙 gravitational work.

The ideal capacitor as impulse

The ideal capacitor has a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse only, the E𝔸 potential displacement and E𝕐 kinetic displacement only move in straight lines. These are also linear vectors e𝕒 and e𝕪 for +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. In a real capacitor there is +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work giving the curved field lines.

No displacement outside the capacitor

The idea capacitor only has E𝔸 and E𝕐 force vectors in between the plates, so there is no displacement outside it. This is not an electric field with this model, instead there are lines of force as vectors in between atoms. The magnetic fields of probability are curved around atoms and extend outwards with an inverse square law, this also happens with the Biv space-time probabilities of +𝕀D and -𝕀D.

Charge density from area

Here η is +𝕠d×e𝕒/+𝕠d as potential Coulombs divided by Eℍ as the area of the positive plate. The larger the plate then the lower the density. This is divided by 2×ϵ which here would be ½×E𝕐. That gives +𝕠d×e𝕒/+𝕠d × ½ × E𝔸/Eℍ. Here Eℍ can be squared because it extends from individual atoms. The more there are, with a larger plate, then the larger Eℍ is. Then E𝔸 can be larger when the plate is more positively charged, with fewer -𝕠d and e𝕪 Pythagorean Triangle electrons.

The ½ factor cancels out

This is equivalent to the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy for the positive plate, E𝔸/Eℍ are a proportion and so reduce to E𝔸. They do not cancel in dimensional analysis because Eℍ represents the size of the plate. In between the plates there is the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, the ½ factor cancels out.

FIGURE 23.20 The electric fields inside and outside a parallel-plate capacitor.

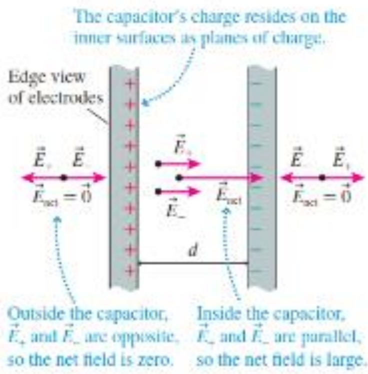


FIGURE 23.21 Ideal versus real capacitors.

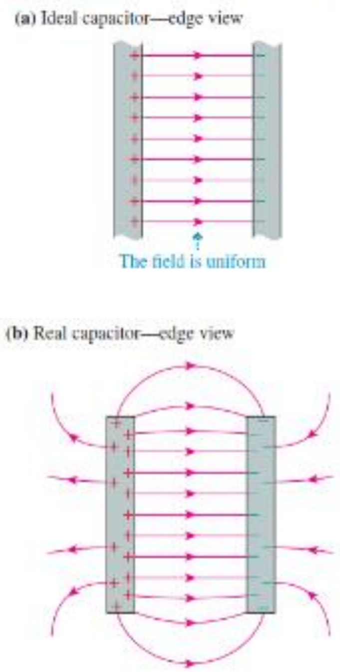


FIGURE 23.20 is an enlarged view of the capacitor plates, seen from the side. Because opposite charges attract, all of the charge is on the *inner* surfaces of the two plates. Thus the inner surfaces of the plates can be modeled as two planes of charge with equal but opposite surface charge densities. As you can see from the figure, at all points in space the electric field $\vec{E}_+$ of the positive plate points *away from* the plane of positive charges. Similarly, the field $\vec{E}_-$ of the negative plate everywhere points *toward* the plane of negative charges.

NOTE You might think the right capacitor plate would somehow "block" the electric field created by the positive plate and prevent the presence of an $\vec{E}_+$ field to the right of the capacitor. To see that it doesn't, consider an analogous situation with gravity. The strength of gravity above a table is the same as its strength below it. Just as the table doesn't block the earth's gravitational field, intervening matter or charges do not alter or block an object's electric field.

Outside the capacitor, $\vec{E}_+$ and $\vec{E}_-$ point in opposite directions and, because the field of a plane of charge is independent of the distance from the plane, have equal magnitudes. Consequently, the fields $\vec{E}_+$ and $\vec{E}_-$ add to zero outside the capacitor plates. There's *no* electric field outside an ideal parallel-plate capacitor.

Inside the capacitor, between the electrodes, field $\vec{E}_+$ points from positive to negative and has magnitude $\eta/2\epsilon_0 = Q/2\epsilon_0 A$, where A is the surface area of each electrode. Field $\vec{E}_-$ *also* points from positive to negative and *also* has magnitude $Q/2\epsilon_0 A$, so the inside field $\vec{E}_+ + \vec{E}_-$ is twice that of a plane of charge. Thus the electric field of a parallel-plate capacitor is

$$\vec{E}_{\text{capacitor}} = \begin{cases} \left(\dfrac{Q}{\epsilon_0 A}, \text{ from positive to negative}\right) & \text{inside} \\ \vec{0} & \text{outside} \end{cases} \tag{23.31}$$

FIGURE 23.21a shows the electric field—this time using field lines—of an ideal parallel-plate capacitor. Now, it's true that no real capacitor is infinite in extent, but the ideal parallel-plate capacitor is a very good approximation for all but the most precise calculations as long as the electrode separation d is much smaller than the electrodes' size. **FIGURE 23.21b** shows that the interior field of a real capacitor is virtually identical to that of an ideal capacitor but that the exterior field isn't quite zero. This weak field outside the capacitor is called the **fringe field.** We will keep things simple by always assuming the plates are very close together and using Equation 23.31 for the field inside a parallel-plate capacitor.

NOTE The shape of the electrodes—circular or square or any other shape—is not relevant as long as the electrodes are very close together.

Uniform electric charge

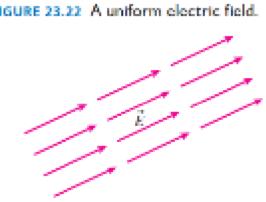
A uniform electric charge here would be a E𝔸/+𝕠d potential impulse and a E𝕐/-𝕠d kinetic impulse, this would decrease with the inverse square law. The trajectory of a particle would then change as impulse.

Uniform Electric Fields

FIGURE 23.22 shows an electric field that is the *same*—in strength and direction—at every point in a region of space. This is called a **uniform electric field.** A uniform electric field is analogous to the uniform gravitational field near the surface of the earth. Uniform fields are of great practical significance because, as you will see in the next section, computing the trajectory of a charged particle moving in a uniform electric field is a straightforward process.

The easiest way to produce a uniform electric field is with a parallel-plate capacitor, as you can see in Figure 23.21a. Indeed, our interest in capacitors is due in large measure to the fact that the electric field is uniform. Many electric field problems refer to a uniform electric field. Such problems carry an implicit assumption that the action is taking place *inside* a parallel-plate capacitor.

FIGURE 23.22 A uniform electric field.



Potential acceleration

Here a positive particle has a potential acceleration as e𝕒/+𝕆D. In (23.32) this can be written as F=ma or +𝕠d×e𝕒/+𝕆D, when divided by +𝕠d as the potential mass proportional to the +𝕚d gravitational mass, this is e𝕒/+𝕆D. That is proportional to e𝕙/+𝕀D in meters/second^2.

Changing the potential energy

This is also q as +𝕠d×e𝕒/+𝕠d × 1/+𝕠d, × ½×+e𝔸/+𝕆d ×+𝕠d as the rotational potential energy, that has a potential acceleration on the potential energy. In this model there would not be squares E𝔸/+𝕆D in the numerator and denominator, that observes and measures at the same time and position.

Force changes the angle θ

In this model the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy is reactionary only, subtracting different amounts of the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy changes its value. This assumes the uniform electric charge is negative. That causes the +𝕠d and e𝕒 Pythagorean Triangle to change its angle θ, that also changes the E𝔸/+𝕆D ratio as well as the value of +𝕠d as the potential mass. This would then be changed by the E𝔸/+𝕠d potential impulse of the positive charge and the amount of the E𝕐/-𝕠d kinetic impulse of the negative charge it was in.

Signs from the Pythagorean Triangles

The signs are important here because the +𝕠d and e𝕒 Pythagorean Triangle is positive and the -𝕠d and e𝕪 Pythagorean Triangle is negative. If the positive charge was in a positive uniform electric charge, then there would be a repulsion.

23.6 Motion of a Charged Particle in an Electric Field

Our motivation for introducing the concept of the electric field was to understand the long-range electric interaction of charges. Some charges, the *source charges*, create an electric field. Other charges then respond to that electric field. The first five sections of this chapter have focused on the electric field of the source charges. Now we turn our attention to the second half of the interaction.

FIGURE 23.23 shows a particle of charge q and mass m at a point where an electric field $\vec{E}$ has been produced by *other* charges, the source charges. The electric field exerts a force

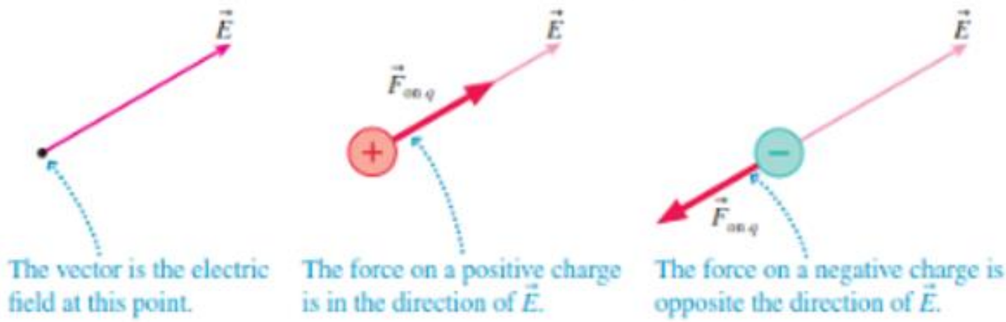
$$\vec{F}_{\text{on } q} = q\vec{E}$$

on the charged particle. Notice that the force on a negatively charged particle is *opposite* in direction to the electric field vector. Signs are important!

Forces from probabilities

In the diagram the forces are in straight lines, these would be the E𝔸/+𝕠d potential impulse for the positive charge. When this is in a positive electric charge that causes a repulsion from the destructive interference of the +𝕆Dd potential probability causing a e𝕒/+𝕆D potential acceleration. When in a negative charge there is a constructive interference with the -𝕆D kinetic probability, that causes a e𝕒/+𝕆D potential acceleration in the opposite direction. When observed as impulse these appear as a E𝔸/+𝕠d potential acceleration proportional to meters^2/second.

FIGURE 23.23 The electric field exerts a force on a charged particle.



If $\vec{F}_{\text{on } q}$ is the only force acting on q, it causes the charged particle to accelerate with

$$\vec{a} = \frac{\vec{F}_{\text{on } q}}{m} = \frac{q}{m}\vec{E} \qquad (23.32)$$

Charge to mass ratio

The q/m ratio here is the +𝕠d×e𝕒/+𝕠d potential momentum or potential Coulombs, this would have a different potential acceleration according to the value of the +𝕠d potential mass. When this is larger then +𝕠d is larger in the numerator and denominator, that makes the e𝕒/+𝕠d potential speed slower. A denser charge then would move more slowly from another charge, the e𝕒/+𝕆D potential acceleration would be less because e𝕒 decrease and +𝕆D increases as a square to maintain the constant Pythagorean Triangle area. Here the larger +𝕠d potential mass would be proportional to a larger +𝕚d gravitational mass.

This acceleration is the *response* of the charged particle to the source charges that created the electric field. The ratio q/m is especially important for the dynamics of charged-particle motion. It is called the **charge-to-mass ratio.** Two *equal* charges, say a proton and a Na^+ ion, will experience *equal* forces $\vec{F} = q\vec{E}$ if placed at the same point in an electric field, but their accelerations will be *different* because they have different masses and thus different charge-to-mass ratios. Two particles with different charges and masses *but* with the same charge-to-mass ratio will undergo the same acceleration and follow the same trajectory.

Not a constant electric charge

In this model the electric charge is not constant, further from the source of this positive charge e𝕒 would increase and the +𝕠d potential magnetic field decreases inversely to it. This can be an approximate E𝕐/-𝕠d kinetic impulse giving an acceleration. For example with gravity there is a e𝕙/+𝕚d gravitational speed where the +𝕚d gravitational field appears to be uniform. This is because the e𝕙 height may be changing by a small amount, higher up in orbit the force of the Eℍ/+𝕚d gravitational impulse would be different. It can be regarded as a constant gravitational acceleration with a squared force.

Relativistic changes

That means the gravitational momentum +𝕚d×e𝕙/+𝕚d, also gravitational Coulombs, would change as the e value of the e𝕙 height changed inversely to the d value of the +𝕚d gravitational field. This is also relativistic because, as the angle θ changes, the Eℍ/+𝕚d gravitational impulse can have a slower +𝕚d gravitational time. Also, the +𝕀D×e𝕙 gravitational work can have a e𝕙 height contraction. The constant in this model would be the Pythagorean Triangle areas.

Motion in a Uniform Field

The motion of a charged particle in a *uniform* electric field is especially important for its basic simplicity and because of its many valuable applications. A uniform field is *constant* at all points—constant in both magnitude and direction—within the region of space where the charged particle is moving. It follows, from Equation 23.32, that **a charged particle in a uniform electric field will move with constant acceleration.** The magnitude of the acceleration is

$$a = \frac{qE}{m} = \text{constant} \qquad (23.33)$$

A parabola from work and impulse

The parabola in this model comes from the E𝔸/+𝕠d potential impulse as small E𝔸 force vectors in straight lines. These change direction according to +𝕠d potential time. That is the inverse of the integral area of the parabola, that comes from the +𝕆D×e𝕒 potential work where the changing +𝕆D potential probability causes a change in the e𝕒 position of the particle or iota. There is a single dimension with impulse as a displacement or force vector, also a single dimension with work as a e𝕒 linear vector.

where E is the electric field strength, and the direction of $\vec{a}$ is parallel or antiparallel to $\vec{E}$, depending on the sign of q.

Identifying the motion of a charged particle in a uniform field as being one of constant acceleration brings into play all the kinematic machinery that we developed in Chapters 2 and 4 for constant-acceleration motion. The basic trajectory of a charged particle in a uniform field is a *parabola*, analogous to the projectile motion of a mass in the near-earth uniform gravitational field. In the special case of a charged particle moving parallel to the electric field vectors, the motion is one-dimensional, analogous to the one-dimensional vertical motion of a mass tossed straight up or falling straight down.

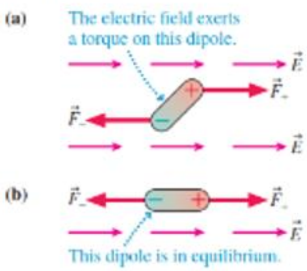
Torque on the dipole

Here E⃗ would be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, this produces a +𝕆D potential torque and a -𝕆D kinetic torque on the dipole. This is also a probability from work, the dipole is more likely to turn to a different orientation.

No impulse on the dipole

There is no E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse because the positive charge is attracted by the negative plate, also repelled by the positive plate. The +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle are inverses of each other, that means the negative charge is equally repelled by the negative plate and attracted by the positive plate.

FIGURE 23.26 A dipole in a uniform electric field.



Dipoles in a Uniform Field

FIGURE 23.26a shows an electric dipole in a *uniform* external electric field $\vec{E}$ that has been created by source charges we do not see. That is, $\vec{E}$ is *not* the field of the dipole but, instead, is a field to which the dipole is responding. In this case, because the field is uniform, the dipole is presumably inside an unseen parallel-plate capacitor.

The net force on the dipole is the sum of the forces on the two charges forming the dipole. Because the charges $\pm q$ are equal in magnitude but opposite in sign, the two forces $\vec{F}_+ = +q\vec{E}$ and $\vec{F}_- = -q\vec{E}$ are also equal but opposite. Thus the net force on the dipole is

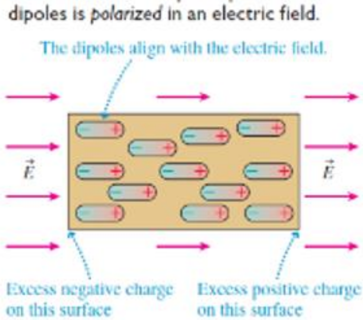
$$\vec{F}_{net} = \vec{F}_+ + \vec{F}_- = \vec{0} \qquad (23.34)$$

There is no net force on a dipole in a uniform electric field.

Polarized dipoles

The potential and kinetic torque causes the dipole to rotate. This causes the dipoles to become polarized.

FIGURE 23.27 A sample of permanent dipoles is *polarized* in an electric field.



There may be no net force, but the electric field *does* affect the dipole. Because the two forces in Figure 23.26a are in opposite directions but not aligned with each other, the electric field exerts a *torque* on the dipole and causes the dipole to *rotate*.

The torque rotates the dipole until it is aligned with the electric field, as shown in **FIGURE 23.26b**. In this position, the dipole experiences not only no net force but also no torque. Thus Figure 23.26b represents the *equilibrium position* for a dipole in a uniform electric field. Notice that the positive end of the dipole is in the direction in which $\vec{E}$ points.

FIGURE 23.27 shows a sample of permanent dipoles, such as water molecules, in an external electric field. All the dipoles rotate until they are aligned with the electric field. This is the mechanism by which the sample becomes *polarized*. Once the dipoles are aligned, there is an excess of positive charge at one end of the sample and an excess of negative charge at the other end. The excess charges at the ends of the sample are the basis of the polarization forces we discussed in Section 22.3.

Torque wrench

The torque is like turning a bolt with a wrench. The reaction force becomes a -𝕀D inertial torque against the active -𝕆D kinetic torque.

Moments of torque

In this model -𝕆D for example can be the kinetic torque, this is also called the -𝕆D kinetic moments. That is like moments on a kinetic clock gauge, a duration between a starting -𝕠d kinetic instant and a final one. Moments are used this way in conventional physics. Here sinθ is used in the cross product to give the torque or probability.

It's not hard to calculate the torque. Recall from Chapter 12 that the magnitude of a torque is the product of the force and the moment arm. FIGURE 23.28 shows that there are two forces of the same magnitude ($F_+ = F_- = qE$), each with the same moment arm ($d = \frac{1}{2}s\sin\theta$). Thus the torque on the dipole is

$$\tau = 2 \times dF_+ = 2(\tfrac{1}{2}s\sin\theta)(qE) = pE\sin\theta \qquad (23.35)$$

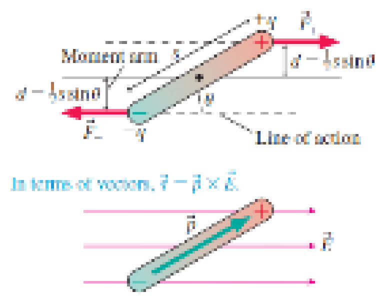
where $p = qs$ was our definition of the dipole moment. The torque is zero when the dipole is aligned with the field, making $\theta = 0$.

Also recall from Chapter 12 that the torque can be written in a compact mathematical form as the cross product between two vectors. The terms p and E in Equation 23.35 are the magnitudes of vectors, and θ is the angle between them. Thus in vector notation, the torque exerted on a dipole moment $\vec{p}$ by an electric field $\vec{E}$ is

$$\vec{\tau} = \vec{p} \times \vec{E} \qquad (23.36)$$

The torque is greatest when $\vec{p}$ is perpendicular to $\vec{E}$, zero when $\vec{p}$ is aligned with or opposite to $\vec{E}$.

FIGURE 23.28 The torque on a dipole.



The hypotenuse changes its size

Here the torque changes as the dipole aligns with the force, as the angle sinθ changes, this is the spin Pythagorean Triangle side divided by the hypotenuse ζ. The -𝕠d and e𝕪 Pythagorean Triangle, for example as the negative charge, has a constant area. As the -𝕠d spin Pythagorean Triangle side contracts then e𝕪 increases inversely, also ζ as the hyperbola increases to approach the same size as the e𝕪 kinetic electric charge.

Energy changes with work

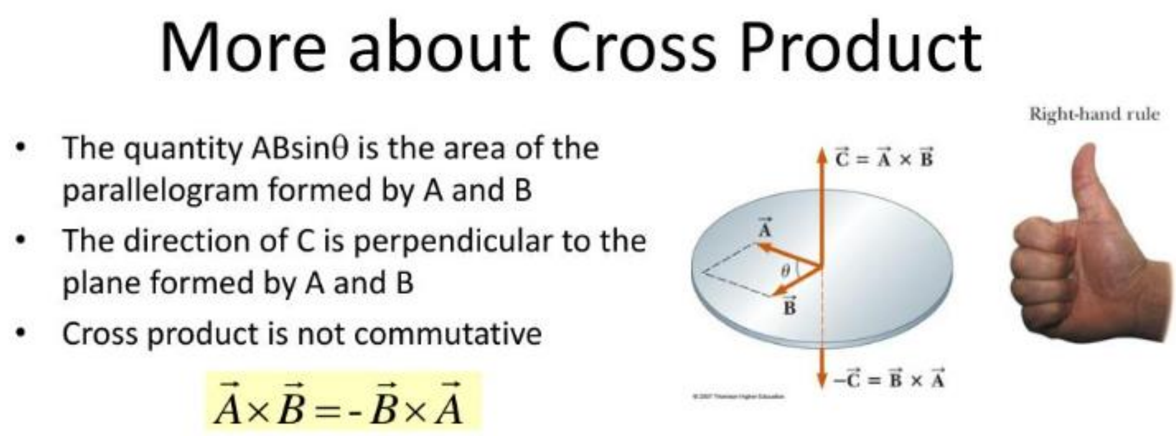
In (23.35) below the sinθ angle is multiplied by qE⃗, this would be the -𝕠d×e𝕪/-𝕠d kinetic momentum of the dipole which is constant as it is not moving towards the positive or negative plate. That is multiplied by E⃗ as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, the angle change would have the 1/-𝕆D denominator decreases as a square in -𝕆D×e𝕪 kinetic work.

The cross product

The torque is also the cross product in this model, this is because the spin Pythagorean Triangle side is changing. In the diagram below a parallelogram is created as an integral field by the two arrows. A⃗ can be e𝕒 as the straight Pythagorean Triangle side from the +𝕠d and e𝕒 Pythagorean Triangle. That would be the positive charge. B⃗ here would be +𝕠d as the potential magnetic field, B⃗ is also used in relation to a magnetic field in conventional physics.

Not commutative

This is not commutative because the +𝕠d and e𝕒 Pythagorean Triangle, and proportionally the +𝕚d and e𝕙 Pythagorean Triangle as gravity, can be flipped over. That would cause the spin direction to change from clockwise to counterclockwise for example. A straight Pythagorean Triangle side vector is not commutative either in this model. That is because its direction can be reversed.



Potential torque

The cross product can refer to the +𝕠d potential magnetic field around a proton, as +𝕆D×e𝕒 potential work this is an inverse square law. As the e𝕒 altitude decreases the +𝕆D potential torque and potential probability increases as a square. That means the potential torque is stronger when an electron is closer to the proton, it must then spin faster in its orbital to maintain this e𝕒 altitude.

Potential and gravitational probability

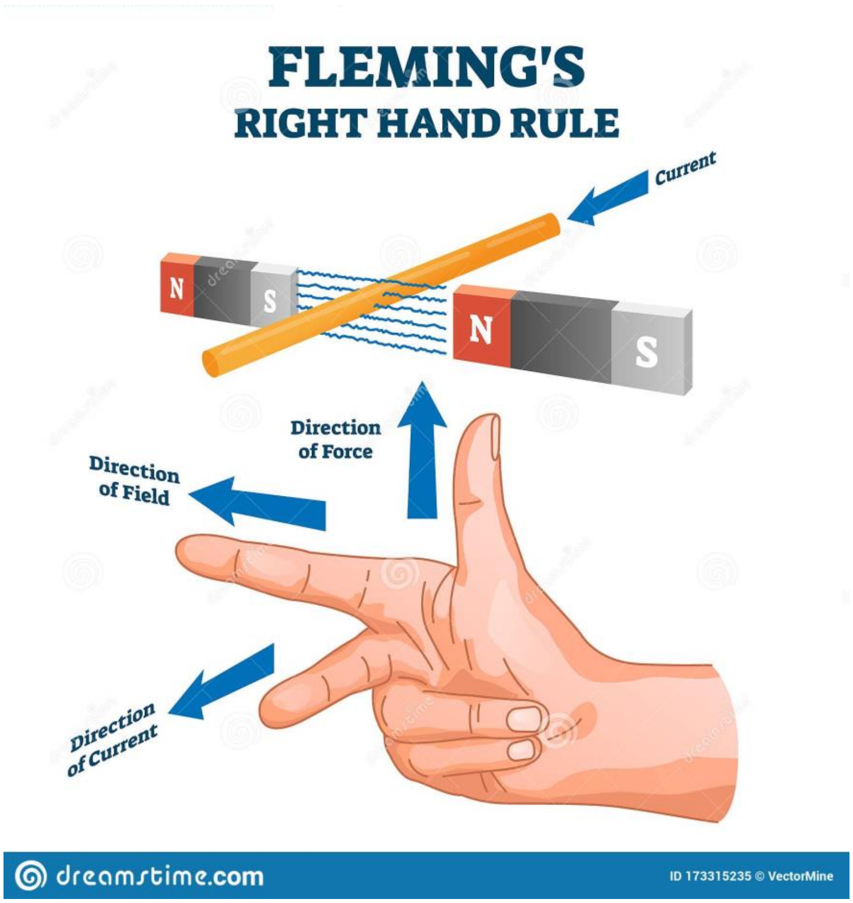
The +𝕆D potential probability is higher when the e𝕒 altitude is lower, that means it is more likely for an electron to move to a lower orbital. With the +𝕚d and e𝕙 Pythagorean Triangle as gravity, the +𝕀D×e𝕙 gravitational work also means a satellite has a higher +𝕀D gravitational probability of being at a lower e𝕙 height above a planet. As with the electron, the satellite must have a higher e𝕧/-𝕚d inertial velocity to maintain this e𝕙 height.

Drawing the parallelogram

This parallelogram can be drawn in different ways. The +𝕠d potential spin can act as the center of the circle above, then the e𝕒 potential spoke turns around it. This is like the rolling wheel model of the proton, electron, and photon. Alternatively the spin Pythagorean Triangle side can be drawn at the top of the e𝕒 altitude, then there is a sideways spin value at that altitude. As e𝕒 increases then +𝕠d decreases inversely as the potential magnetic field at that altitude.

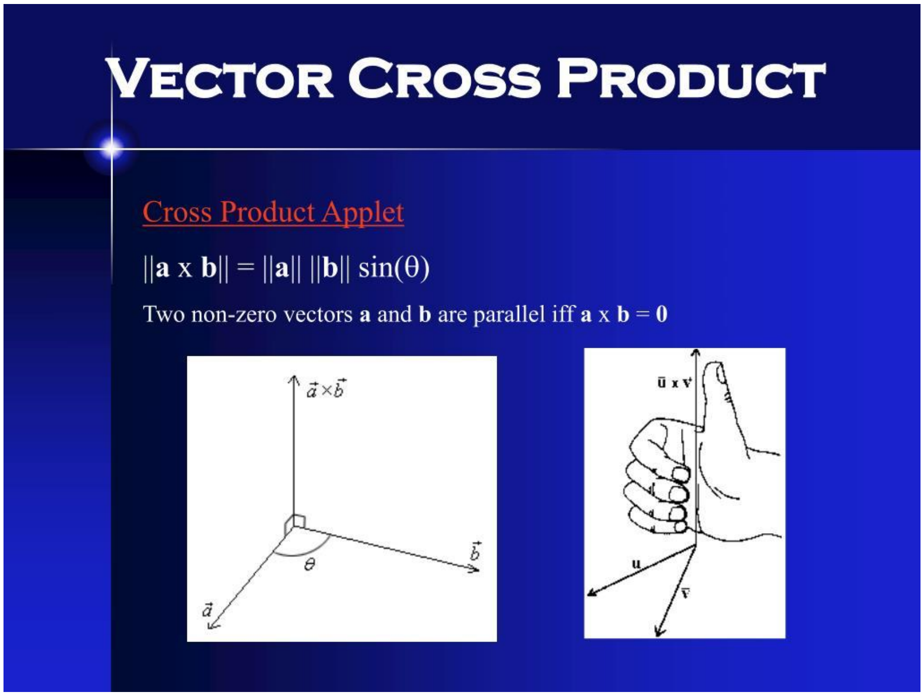
The right hand rule

The right-hand rule here would be the +𝕆D×e𝕒 potential work, for example from the +𝕠d and e𝕒 Pythagorean Triangle. It can also give the E𝔸/+𝕠d potential impulse with the dot product. The direction of this rule is a convention. The curling of the fingers can be regarded as a force with torque in +𝕆D×e𝕒 potential work, with the E𝔸/+𝕠d potential impulse it would be the direction of the +𝕠d potential time on a potential clock gauge. In the diagram below the north and south poles are arbitrary designations, changing them would make it a left hand rule.



Counterclockwise spin

Here the right-hand rule gives a spin or torque in a counterclockwise direction.

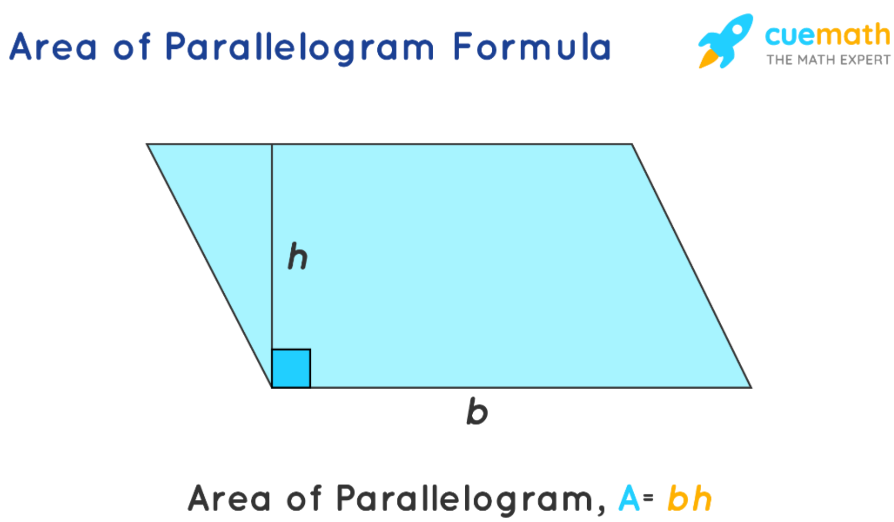


Canceling out the hypotenuse

In the diagram below, the cross product is an integral area. A parallelogram has the same area as a rectangle with a height from its top to bottom. That would make the rectangles two +𝕠d and e𝕒 Pythagorean Triangles for example, the height is the e𝕒 altitude. That gives the integral area as +𝕠d×e𝕒. The sinθ angle is +𝕠d/ζ where ζ is the hypotenuse. This is also the diagonal of the rectangle. When +𝕠d×e𝕒 is multiplied by +𝕠d/ζ then the hypotenuse is canceled out. That leaves the +𝕆D×e𝕒 potential work as +𝕠d×+𝕠d×e𝕒×ζ/ζ.

The hypotenuse times spin

The diagram below shows the parallelogram with the +𝕠d and e𝕒 Pythagorean Triangle on the left. This can be flipped and attached to the right to make a rectangle. This parallelogram has two sides, the angled side is the hypotenuse ζ here. The horizontal side would be +𝕠d. When multiplying +𝕠d×ζ, this is multiplied by +𝕠d/ζ to give the cross product. This gives +𝕆D as the potential probability or torque. In this model it is also multiplied by e𝕒 to give +𝕆D×e𝕒 potential work.



The dot product

In this model the dot product gives E𝔸 as the displacement altitude, or the potential electric force. This is e𝕒×ζ×e𝕒/ζ where the Pythagorean Triangle sides are switched. That reduces to E𝔸, here it is written as the E𝔸/+𝕠d potential impulse. The cross and dot products can be found with all the Pythagorean Triangles in this model. Here E𝔸 would not be an actual area, instead it would be a force vector. The calculations give the same answer.

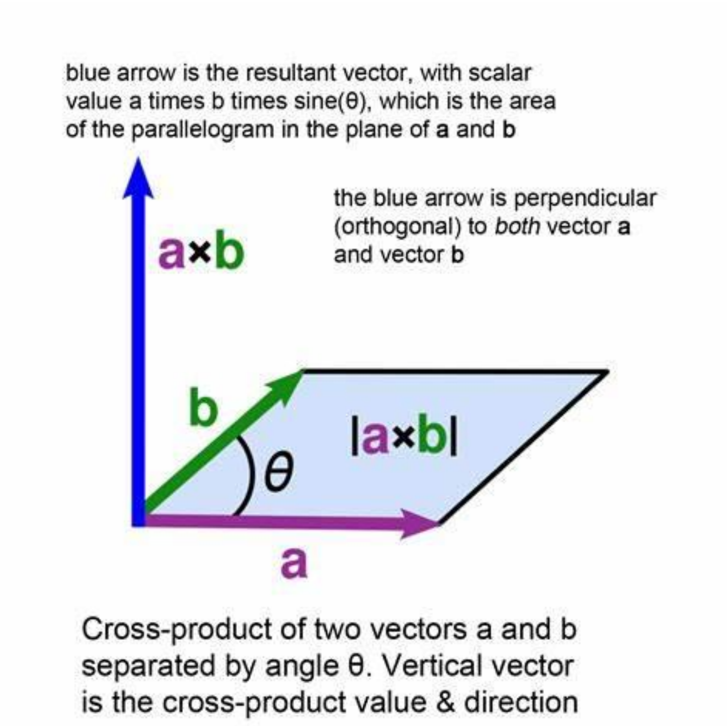
Orthogonal direction

In the diagram below the cross product is orthogonal to both a and b. This can be the axle of the rolling wheel as above, then a would be the e𝕒 altitude. As shown, b becomes the same value as this vertical arrow when multiplied by sinθ.

Making a Pythagorean Triangle with the cross product

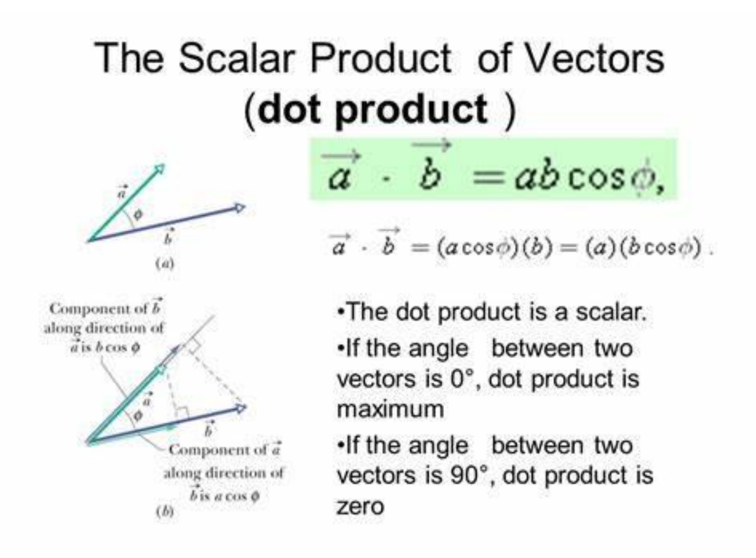
In the diagram below, a can be shortened so its end is under the end of the hypotenuse ζ here as b. That makes a Pythagorean Triangle. Then the parallelogram area is still +𝕠d×ζ, multiplied by

+𝕠d/ζ gives the same answer. After this the +𝕠d can be changed to make the line longer or shorter. The same can be done with the dot product. This parallelogram is also two Pythagorean Triangles, when one is flipped they can be rearranged as a rectangle. Then the dot and cross products give E𝔸 and +𝕆D respectively, the hypotenuse ζ cancels out in both cases.



The dot product as a force vector

In this model the dot product would be a force vector as E𝔸, this would be the displacement between a starting and final altitude. It would be the inverse of the +𝕆D potential torque or probability from the constant Pythagorean Triangle area.



Nonuniform probability fields

The +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work on a dipole can be nonuniform, such as with positive and negative ions having large nuclei. Each +𝕠d and e𝕒 Pythagorean Triangle proton would do +𝕆D×e𝕒 potential work on the dipole, also each electron in an ion would do -𝕆D×e𝕪 kinetic work. This gives a +𝕆D potential torque on probability on the negative end of the dipole, a -𝕆D kinetic torque or probability on the positive end. The +𝕆D values are reactive, they add to the -𝕆D active values to give an overall +𝕆D-𝕆D probability for measuring the dipole's e𝕒 and e𝕪 positions.

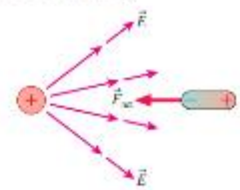
Dipoles in a Nonuniform Field

Suppose that a dipole is placed in a nonuniform electric field, one in which the field strength changes with position. For example, FIGURE 23.30 shows a dipole in the nonuniform field of a point charge. The first response of the dipole is to rotate until it is aligned with the field, with the dipole's positive end pointing in the same direction as the field. Now, however, there is a *slight difference* between the forces acting on the two ends of the dipole. This difference occurs because the electric field, which depends on the distance from the point charge, is stronger at the end of the dipole nearest the charge. This causes a net force to be exerted on the dipole.

Which way does the force point? Once the dipole is aligned, the leftward attractive force on its negative end is slightly stronger than the rightward repulsive force on its positive end. This causes a net force *toward* the point charge.

In fact, for any nonuniform electric field, **the net force on a dipole is toward the direction of the strongest field.** Because any finite-size charged object, such as a charged rod or a charged disk, has a field strength that increases as you get closer to the object, we can conclude that **a dipole will experience a net force toward any charged object.**

FIGURE 23.30 An aligned dipole is drawn toward a point charge.



No innate cylindrical symmetry

In this model there is no innate cylindrical symmetry. Each +𝕠d and e𝕒 Pythagorean Triangle with a positive charge has the same area, its angle θ can be different. This gives a symmetry in that the e𝕒 altitude of each Pythagorean Triangle is pointing outwards, but the spin Pythagorean Triangle side points in one asymmetrical direction.

Translation and displacement

When a positive charge is translated or displaced, such as with the E𝔸/+𝕠d potential impulse, a displacement is from a starting to a final e𝕒 position. The cylinder can be rotated, then the +𝕠d and e𝕒 Pythagorean Triangles pointing outwards are the same as each other. When reflected in a mirror the +𝕠d and e𝕒 Pythagorean Triangle would be flipped, to flip these without a mirror would need a +𝕆D potential torque on a Pythagorean Triangle.

Flipping a proton

Rotating the Pythagorean Triangle once would be a +𝕆D potential torque doing work, this would flip over the asymmetrical Pythagorean Triangle. Then a second +𝕆D potential torque would restore it to the same energy state, that is equivalent to in the reverse direction so the two torques destructively interfere. This is not directly measurable unlike flipping an electron. The proton has reactive forces only, the difference would be how it was added to a negative charge.

Electron as a rolling wheel

When the electron is measured with -𝕆D×e𝕪 kinetic work, it acts like a rolling wheel in this model, the +𝕠d kinetic axle points out on one side of the electron. A wheel might be measured as having -𝕀D×e𝕧 inertial work as it rolls to the right, the -𝕀D inertial torque appears to be clockwise. From the other side the same wheel appears to have this -𝕀D inertial torque as being counterclockwise.

A protruding axle

However, the -𝕠d kinetic axle might have been protruding outwards at first, from the other side it appears to go inwards. That shows reversing the wheel's direction is not the same as changing the reference frame. That is because the -𝕠d kinetic axle must connect to the e𝕪 spoke at right angles, not in the middle of the axle. This makes the axle stick out one side as the Pythagorean Triangle rotates.

A collision changing the torque

When the wheel is rolling, a -𝕆D kinetic torque can be applied to change its direction. For example, the rightwards moving wheel rotates clockwise, if it collides with a wall its -𝕀D inertial torque now looks counterclockwise as it moves from right to left. This is not the same as looking at the wheel from the other side, its energy as -𝕀D×e𝕧 inertial work has been changed. This is like rotating an electron once, it is in a different energy state.

A flip needs a torque

The wheel flips over after the collision so the spin goes from clockwise to the right, then to counterclockwise to the left. This flip requires a torque and so the energy states are not the same. A second flip restores the original orientation, the two -𝕀D inertial torques cancel with destructive interference. They cannot add together in constructive interference because this would be like a changed probability leading to the same state.

The axle side cannot be observed or measured

While the side on which the -𝕚d inertial axle points outwards has changed, this cannot be measured because spin is not a straight Pythagorean Triangle side with a e𝕧 length. Work is only measured with the straight Pythagorean Triangle side. If the flipped electron was observed with an E𝕍/-𝕚d inertial impulse, it would have a reversed -𝕚d inertial time direction.

Canceling the torque or probability

If the wheel collides with another wall, then it can resume its original -𝕚d×e𝕧/-𝕚d inertial momentum like turning the wheel around. This is the same state as before, it is not double the -𝕀D inertial torque. Instead, the two -𝕀D inertial probabilities cancel each other with destructive interference.

A flipped electron in a boson

With this model the reversed time direction means an electron cannot be affected by the weak force. When a flipped electron joins with an unflipped electron in a boson pair, this has a destructive interference with their -𝕆D×e𝕪 kinetic work, the two electrons would be entangled with opposing spins as time directions.

Turning the wheel or a collision

In this model reversing the wheel's inertial momentum can either be done by -𝕀D×e𝕧 inertial work or an E𝕍/-𝕚d inertial impulse. When the -𝕀D inertial torque is applied to the wheel this is like turning the wheel around, it has a different energy state. A second torque restores the original direction. When the wheel collides with an E𝕍/-𝕚d inertial impulse, that can reverse direction as a straight-line displacement without flipping the wheel. This is because a displacement is not a rotation, the wheel hits the wall like a spring rebounding.

Flipping the direction

An electron as a particle can then rebound without the changed probability state. However, it can absorb or emit photons with another electron it collides with, this is also a change in its energy state because this can be the opposite direction rather than an opposite spin. A second collision from the opposite direction can restore its original direction like flipping the electron twice. This is not quantized and so the photon exchange can be continuous rather than discrete like a spectrum, with the flip it cannot be a fractional spin change.

Changing electron spin as quantized or non-quantized

A collision of electrons with a E𝕐/-𝕠d kinetic impulse then can have the first electron with a non-quantized change in its -𝕠d kinetic spin, relative to the second electron. This is the same as the -𝕠d kinetic spin of an electron in an orbital changing when it jumps to another orbital, emitting or absorbing a quantized photon. Because this is -𝕆D×e𝕪 kinetic work it cannot be a continuous frequency exchange like with the electron collision, that acts more like a virtual photon because it is not measured or observed except by the changing e𝕪/-𝕠d kinetic speeds of the electrons.

Work does not measure time

When the electron flips twice it is the same state even though its -𝕀D×e𝕧 inertial work is different, that is because -𝕀D×e𝕧 inertial work does not measure the -𝕚d inertial time only a e𝕧 length. The -𝕀D inertial probability density has changed, its e𝕧 position is more likely to be different than without the two flips. Its -𝕀D inertial temporal history has changed.

An electron rotates twice with work

With its E𝕍/-𝕚d inertial impulse the collision reverses the direction of the wheel, from left to right and then right to left. With the second collision this again has the same E𝕍/-𝕚d inertial impulse. This is the same state because the E𝕍 value is again the same as before, also the -𝕚d inertial time has the same ratio as before. Here -𝕚d is like an inertial clock gauge, its ratio to the e𝕧 length in the -𝕚d and e𝕧 Pythagorean Triangle determines its inertial velocity.

A wheel as a clock

The wheel can be regarded as having a clock on its axle, a hand rotating counts the rotations as -𝕚d inertial time. This can either continue to go forward in a collision or go backwards, that would depend on the amount of torque from the collision as -𝕀D×e𝕧 inertial work. Without this torque the wheel would continue with -𝕚d inertial time in a forward direction. With the torque the electron can flip, it is then like a movie of the electron running backwards.

Quantized rotations

When an electron flips with torque it is a complete rotation, that is because the -𝕆D kinetic probability or torque is quantized as one. It cannot be a fraction, that would be an observation of impulse. The electron cannot then be measured as rotating to a half state, then a continued rotation of a half completing a single turn. It also cannot rotate clockwise half a turn, then rotate counterclockwise half a turn again to return to the same state.

24.1 Symmetry

To continue our exploration of electric fields, suppose we knew only two things:

1. The field points away from positive charges, toward negative charges, and
2. An electric field exerts a force on a charged particle.

From this information alone, what can we deduce about the electric field of the infinitely long charged cylinder shown in FIGURE 24.1?

We don't know if the cylinder's diameter is large or small. We don't know if the charge density is the same at the outer edge as along the axis. All we know is that the charge is positive and the charge distribution has *cylindrical symmetry*. We say that a charge distribution is **symmetric** if there is a group of *geometric transformations* that don't cause any *physical* change.

To make this idea concrete, suppose you close your eyes while a friend transforms a charge distribution in one of the following three ways. He or she can

- *Translate* (that is, displace) the charge parallel to an axis,
- *Rotate* the charge about an axis, or
- *Reflect* the charge in a mirror.

FIGURE 24.1 A charge distribution with cylindrical symmetry.

A cylinder with spin and straight-line translation

A cylinder is a combination of spin or rotation, and a straight-line translation along it. The spin occurs with torque and work, the translation with displacement and impulse. These are orthogonal to each other and are inverses. A reflection exchanges left to right, this would also flip the left and right ends of the cylinder in the mirror's reference frame. A mirror also flips the direction towards the real reference frame, for example a mirror might be north of the cylinder. Moving the cylinder north towards the mirror, the mirror image moves south towards the real cylinder.

No preferred spin direction

When the +𝕠d and e𝕒 Pythagorean Triangle is measured, this has a +𝕆D potential torque. Moving towards the mirror this is measured as a series of e𝕒 positions. In the mirror image reference frame, the +𝕠d and e𝕒 Pythagorean Triangle is moving towards the real +𝕠d and e𝕒 Pythagorean Triangle with a series of e𝕒 positions as well. This is a symmetry, but as with the bike wheel, the +𝕆D potential torque measured as clockwise on one side and counterclockwise on the other.

Moving to the right or left

If the +𝕠d and e𝕒 Pythagorean Triangle is moving as a rolling wheel to the right, parallel to a mirror in the real reference frame with a clockwise +𝕆D potential torque, it is measured to be the same as the mirror image reference frame. This is another symmetry, but the +𝕠d potential axle would have switched direction pointing out of the mirror.

The mirror reference frame

From this mirror reference frame, the +𝕠d and e𝕒 Pythagorean Triangle would be measured as having a counterclockwise +𝕆D potential torque. The spin direction has changed, also the +𝕠d potential axle has flipped sides. In this model that would be a flipped state with a different energy. To duplicate this in the real reference frame, the +𝕠d and e𝕒 Pythagorean Triangle would need to be flipped over and rotated in the opposite direction.

Charge, Parity, Time

In this model the mirror reference frame has a different parity, this is like the -𝕚d inertial time being reversed. That can also be seen in a mirror, from its reference frame a clock would seem to go backwards. This is like an opposing charge such as with the electron as -𝕠d and the positron as +𝕠d, a flipped electron is referred to as an anti-positron.

A flipped electron and the weak force

To flip the +𝕠d potential axle to the other side requires a +𝕆D potential torque. A flipped electron like this cannot combine into a neutron, nor would it be affected by the weak force. This is because its -𝕆D kinetic probability is interfering destructively with the proton instead of constructively.

A single spin direction

The difference between the flipped and unflipped electron is that the electron moves forward in time. The flipped electron moves backwards in time like a proton as +𝕠d. This means there is no preferred spin direction, the unflipped electron moves forward in time opposing the proton moving backwards in time. Because of the destructive interference between the flipped electron and a proton, they would repel each other and so with time reversed they could not come together to form the neutron.

Matter versus antimatter

This time direction then becomes matter versus antimatter, as shown earlier if the charge and time is reversed then it would be like a reversed movie with the same properties. Observing and measuring in this movie would appear to be the same, also the parity would be reversed like a mirror image.

The impulse direction changes

If the -𝕠d and e𝕪 Pythagorean Triangle has a E𝕐/-𝕠d kinetic impulse towards the mirror with the clockwise rotating +𝕠d axle on the right, then from the mirror reference frame it is observed to move back towards the real Pythagorean Triangle's potential reference frame. This is the same as flipping the +𝕠d and e𝕒 Pythagorean Triangle, the spin direction changes to counterclockwise along with the opposite direction, the -𝕠d spoke is now on the left. The -𝕠d and e𝕪 Pythagorean Triangle is not flipped with spin because this is the E𝕐/-𝕠d kinetic impulse, instead the -𝕠d potential time is running backwards.

A spin is not a distance

This -𝕠d kinetic axle cannot be regarded as being like a e𝕧 length for example, so it cannot be observed or measured on one side or the other. It is like the spinning center of a disk, this rotation has no height or length. It can only be clockwise or counterclockwise. This spin can be changed however, when its torque is reversed it has a different energy state.

The axle is orthogonal to the spoke

The +𝕠d potential axle points out one side of the wheel, for example the right, this is to make a right angle with the e𝕒 spoke. That makes it asymmetrical, to reverse the direction of the +𝕆D×e𝕒 potential work then the +𝕠d and e𝕒 Pythagorean Triangle must flip over, the +𝕠d potential axle would then be on the left.

The Pythagorean Triangle and conic sections

The rotation of the +𝕠d and e𝕒 Pythagorean Triangle, and proportionally the +𝕚d and e𝕙 Pythagorean Triangle as gravity, is mathematically like a cone, that makes the different conic sections also properties and forces from the Pythagorean Triangle. The e𝕒 spoke would be the radius of the cone base, the +𝕠d potential spin would be the central height of the cone. Different conic sections would then have different values of e𝕒 and +𝕠d.

Tracing out a circle

For example, a rotating +𝕠d and e𝕒 Pythagorean Triangle can trace out a circle, the +𝕠d potential axis rotates the e𝕒 spoke around to form the circular base. If e𝕒 doubles for example then +𝕠d halves, the cone would then be half the height. The +𝕠d and e𝕒 Pythagorean Triangle here would be half the cross section of the cone. This can be an integral area as +𝕠d×e𝕒, if the e𝕒/+𝕠d Pythagorean Triangle slope is observed then this gives the E𝔸/+𝕠d potential impulse.

A hyperbola as a vertical slice

A hyperbola can be drawn in the cone as a vertical slice. If the cone is 90° on the vertex, then an -𝕠d and e𝕪 Pythagorean Triangle as the electron can change its angle θ, while maintaining a tangent and constant area to the hyperbola. This hyperbola can change its vertical position in the cone, it would then be at right angles to different square roots of integers as e𝕒 altitudes in the base. That can give quantized -𝕠d and e𝕪 Pythagorean Triangle values with -𝕆D×e𝕪 kinetic work, they would correspond to different orbitals. If these hyperbolas are not quantized, then they can be used to observe the E𝕐/-𝕠d kinetic impulse.

The parabola

When a slice is made at 45° through the cone, this gives a parabola. It is midway between the +𝕠d and e𝕒 Pythagorean Triangle horizontal base and the -𝕠d and e𝕪 Pythagorean Triangle at a tangent to the vertical hyperbola. This uses part of each of the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle, the electron in a parabolic path moves upwards to a higher orbital then downwards to a lower orbital. This downward force, in relation to the base, comes from the +𝕆D×e𝕒 potential work.

The parabolic height as +𝕠d

The height of each point on the parabola corresponds to a +𝕠d value in relation to the central height. It moves downwards because there is a higher +𝕆D potential probability of this tangent point moving to a smaller e𝕒 altitude closer to the base. The parabola can also change with a E𝕐/-𝕠d kinetic impulse, for example an electron outside an atom as a particle being attracted towards it.

The inverse square law and the parabola

This change in the parabolic path also changes the -𝕠d and e𝕪 Pythagorean Triangle's angle θ in the hyperbola, that does inverse -𝕆D×e𝕪 kinetic work as this parabolic path is measured. That gives the inverse square law with the +𝕆D potential and -𝕆D kinetic probabilities. This change is a torque, the parabola has its spin changing in a nonconstant way. When the spin is constant, then the displacement changes with an acceleration and deceleration.

Parabolic impulse

When the parabolic impulse is observed, this comes from the E𝔸/+𝕠d potential impulse pointing at right angles to the parabolic E𝔸/+𝕠d potential impulse. That would have the parabolic trajectory moving outwards on the cone using the base as a reference frame. For example, if the cone is composed of horizontal circles, then the clock gauges observing the parabola would be at different radii of this circles. When compared to the base circle, this is like moving outwards then inwards. For example each level of the cone would be like a snapshot of a different instant on the clock gauge.

The parabola increases then decreases altitude

The parabola would be considered to start at one side of an internal circle drawn on the base, for example with half the radius or e𝕒 altitude. Then it would move outwards to a higher e𝕒 altitude then return to the other side of this smaller circle. The parabola is then moving outwards from the center of the base in a horizontal reference frame, from where the e𝕒 altitude is a minimum, to a higher e𝕒 altitude and then back again.

From the ground state and returning to it

This could be from the ground state to a higher e𝕒 altitude in the atom but not a quantized orbital, or the electron leaves the atom then returns to the ground state. With this curve, the +𝕠d potential clock gauge observes a change in angle. A point on the parabola would change its orientation to the spin axle as the height of the cone. An energentic photon might knock an electron partially out of an atom with a E𝕐/-𝕠d kinetic impulse, then it could fall back to an orbital resuming -𝕆D×e𝕪 kinetic work.

The rotation as time

The parabola also rotates along its trajectory in relation to the base, that rotation is like a hand on a clock gauge. For example, if the parabolic impulse starts at 12 o'clock on this base, then it would return on the other side of the circle at 6 o'clock. This is like the hands of a clock having moved an amount observing time in impulse.

Leaving the atom

With the -𝕠d and e𝕪 Pythagorean Triangle this also affects the parabolic trajectory, here this can be like an electron particle being ejected from a Hydrogen atom with a E𝕐/-𝕠d kinetic impulse, then falling back in with a E𝔸/+𝕠d potential impulse. That changes the e𝕪 kinetic electric charge which is proportional to a e𝕧 length, the electron moves to one side in the parabolic trajectory as e𝕪 or e𝕧.

e𝕪 as yard

In this model e𝕒 can be referred to as a distance as yard, that is selected as a friendly name because it also starts with y. That would mean e𝕪 yard is proportional to a e𝕧 length. When the electron leaves the atom, this is like the vertical hyperbola moving so only part of it slices the cone, the rest is the trajectory of the electron away from the atom.

Observing the kinetic time

That observation of the electron's trajectory would be an E𝕍/-𝕚d inertial impulse. The angle θ of the -𝕠d and e𝕪 Pythagorean Triangle also changes, this observes the impulse of the electron particle as +𝕠d kinetic and -𝕚d inertial time on a clock gauge. Because the -𝕠d and e𝕪 Pythagorean Triangle is vertical here, the parabola is at 45° to it as well as the -𝕠d and e𝕪 Pythagorean Triangle. That observes a change in the -𝕠d kinetic time as well as the +𝕠d potential time. If the cone does not have a 90° angle at the apex, this can give other trajectories.

The ellipse

The ellipse would be at an angle between the circular base and the parabola, the +𝕠d and e𝕒 Pythagorean Triangle has more influence on an electron in an elliptical orbital doing -𝕆D×e𝕪 kinetic work than with a parabola. The -𝕠d and e𝕪 Pythagorean Triangle as the tangent to the hyperbola acts inversely to the +𝕆D×e𝕒 potential work of the proton, the area of the ellipse is the integral field as this work changes. This can be measured as +𝕆D×e𝕒 potential work added to -𝕆D×e𝕪 kinetic work.

Elliptical impulse

With the ellipse as a particle, like an electron in an elliptical orbit around an Hydrogen ion, then there is the E𝔸/+𝕠d potential impulse moving it inwards towards the proton to minimize the e𝕒 altitude in an oscillation. The -𝕠d and e𝕪 Pythagorean Triangle acts as the inverse with its E𝕐/-𝕠d kinetic impulse maximizing its e𝕧 length opposite to the e𝕒 altitude.

When you open your eyes, will you be able to tell if the charge distribution has been changed? You might tell by observing a visual difference in the distribution. Or the results of an experiment with charged particles could reveal that the distribution has changed. If nothing you can see or do reveals any change, then we say that the charge distribution is symmetric under that particular transformation.

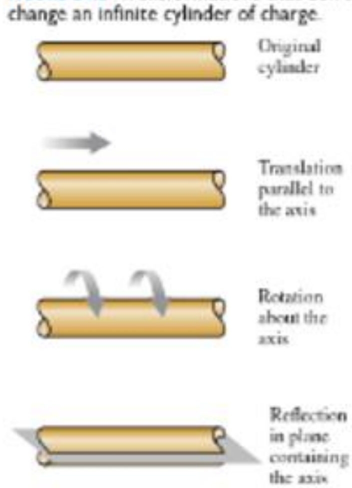
FIGURE 24.2 shows that the charge distribution of Figure 24.1 is symmetric with respect to

- Translation parallel to the cylinder axis. Shifting an infinitely long cylinder by 1 mm or 1000 m makes no noticeable or measurable change.
- Rotation by any angle about the cylinder axis. Turning a cylinder about its axis by 1° or 100° makes no detectable change.
- Reflections in any plane containing or perpendicular to the cylinder axis. Exchanging top and bottom, front and back, or left and right makes no detectable change.

A charge distribution that is symmetric under these three groups of geometric transformations is said to be *cylindrically symmetric*. Other charge distributions have other types of symmetries. Some charge distributions have no symmetry at all.

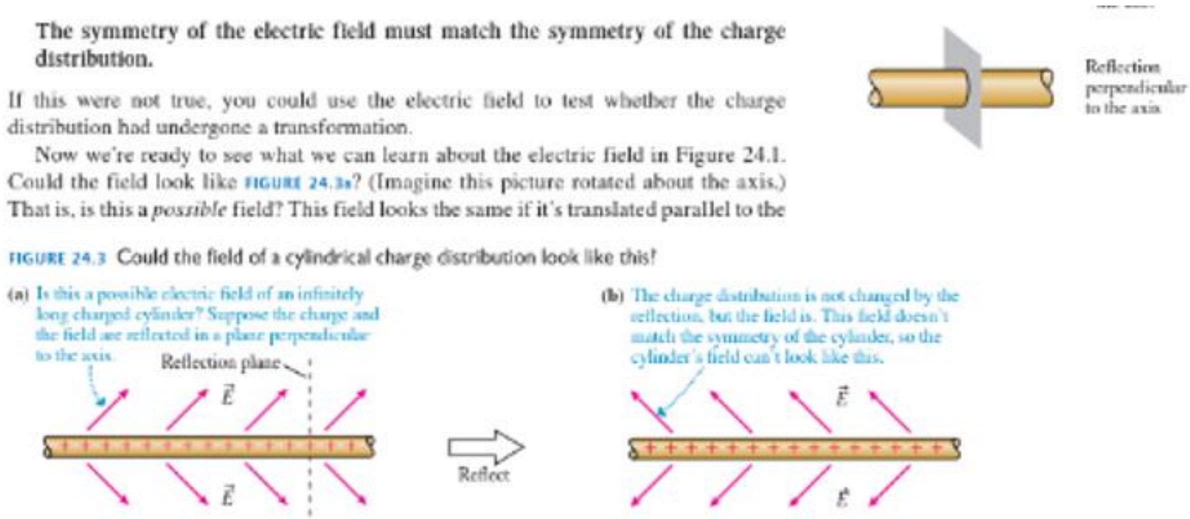
Our interest in symmetry can be summed up in a single statement:

FIGURE 24.2 Transformations that don't change an infinite cylinder of charge.



The spin axle is not symmetrical

In the diagram below the mirror reference frame is not symmetrical to the real reference frame. That also happens in this model because the +𝕠d potential axle changes sides in the mirror reference frame. In the diagram it would also need a +𝕆D potential torque to flip it. In this model there is no possible field, only a probable field. Possibilities are only observed with impulse.


The symmetry of the electric field must match the symmetry of the charge distribution.

If this were not true, you could use the electric field to test whether the charge distribution had undergone a transformation.

Now we're ready to see what we can learn about the electric field in Figure 24.1. Could the field look like FIGURE 24.3a? (Imagine this picture rotated about the axis.) That is, is this a *possible* field? This field looks the same if it's translated parallel to the

FIGURE 24.3 Could the field of a cylindrical charge distribution look like this?

A changed spin direction needs work

In the diagram the spin direction changes, from clockwise to counterclockwise in the mirror image. This would be how the +𝕠d and e𝕒 Pythagorean Triangle changes, it would take +𝕆D×e𝕒 potential work to flip this spin. This is like with magnetic fields, in conventional physics they use an arrow as e𝕪 which points in or out of the page for a -𝕠d kinetic magnetic field.

North and south magnetic poles

Then there is a clockwise or counterclockwise spin, upwards might be for the north pole and downwards for the south pole. This is not flipping the electrons, it is looking at the spin from above or below. Two north or two south poles destructively interfere with the -𝕆D kinetic probabilities, that makes them less likely to be measured close to each other as repulsion. A north and south pole constructively interfere.

Bosons with opposed spins

In this model the opposed spins, in the diagram below, allow for bosons and entanglement to occur. An electron's -𝕠d and e𝕪 Pythagorean Triangle can be flipped over with -𝕆D×e𝕪 kinetic work like in the mirror image, then the -𝕆D kinetic torque or probability of each pair of electrons constructively interferes. That enables the electron pair to be closer to each other, also the lower -𝕆D kinetic torque allows them to occupy a lower orbital than two fermions with the same spin direction. The clockwise spin below can be a first electron, the counterclockwise spin the flipped second electron.

Boson constructive interference

The -𝕆D kinetic probability of each electron interferes constructively, this is because in between them there is a higher -𝕆D kinetic probability density. That causes the electron pair to attract each other in a boson, also in a Cooper pair.

Photon entanglement

With photon entanglement they also appear like the clockwise and counterclockwise spins below. As the photons separate the spin entanglement is retained as opposing -𝔾D light probabilities. The opposing -𝕘d light spin is then measured clockwise in one detector for the first photon, and counterclockwise at a second detector for the second photon. The probability of each is opposed and interferes destructively, so this becomes deterministic with opposite spins being measured.

The e𝕧 length between them does not matter, to conserve the -𝔾D light probabilities with their constructive interference the -𝔾D×e𝕪 light work does not change.

Only one Pythagorean Triangle side observed or measured

In both cases this happens because the Pythagorean Triangles are not symmetric, they can appear with a symmetry in a cylinder because only one Pythagorean Triangle side can be observed or measured in a time and position. The e𝕒 vectors by themselves can be observed to attract electrons and repel protons all around the cylinder cross section as a symmetry. The +𝕠d potential spin by itself appears as rotational symmetry.

Freezing time with vector symmetry

The E𝔸/+𝕠d potential impulse is observed on a +𝕠d potential clock gauge, when the proton is flipped this clock appears to go counterclockwise in reverse. So the straight Pythagorean Triangle side is symmetric but the spin direction is not. If the time is frozen then the e𝕒 vectors are like clock hands pointing symmetrically in all directions. But they can turn in two directions which is not symmetric.

Flipping the proton spin

The proton is more complicated in flipping its spin, it contains both +𝕠d potential spin as two +𝕠2/3 +𝕠2/3 quarks. It also has one -𝕠1/3 down quark, in this model they would be on three orthogonal Pythagorean Triangles. To flip the spin like an electron then it may be that all three have to flip, that could be a different energy state.

The strong force and proton boson pairs

For example it could be part of the strong force where protons attract each other like boson pairs, or neutrons might be attracted to a flipped proton. Without this flipped state it may be why the nucleus without neutrons is less stable.

Freezing position with spin symmetry

When the torque is measured it would appear like in the diagram below, from the real reference frame the +𝕆D potential torque would be clockwise and in the mirror reference frame counterclockwise. This appears as a symmetry when only the torque is measured, but that is done by ignoring the e𝕒 vectors.

The mirror as a flipped state

If e𝕒 is pointing towards the mirror with a clockwise spin, then from inside the mirror with its reference frame the e𝕒 vector points opposite to the real e𝕒 vector. The spin is now counterclockwise, so this is like a flipped state. A second flip is needed to return the +𝕠d and e𝕒 Pythagorean Triangle to the real reference frame, that is like having to rotate an electron twice to return it to its original state.

A clock with no hands

With the e𝕒 vector this is like a clock gauge telling time without hands on it. The real reference frame has an opposing torque to the mirror reference frame, this can only be measured by adding the e𝕒 vectors as hands onto the clock gauges. The vectors in the diagram can be regarded as the hypotenuse of each +𝕠d and e𝕒 Pythagorean Triangle, but this is not generally used here. Because of this a proton or electron have a handedness in this spin with conventional physics. This appears to be a symmetry, but in this model the Pythagorean Triangle itself is symmetry breaking.

Different +𝕠d and e𝕒 Pythagorean Triangle configurations

The diagram can also be regarded as the central axle of the cylinder being +𝕠d, this spin clockwise as a convention. Then one of the vectors shown would be an e𝕒 spoke, alternatively with its offset it could be a +𝕠d spin Pythagorean Triangle side connected at the end of the e𝕒 spoke coming out of the cylinder center. These can be the same +𝕠d and e𝕒 Pythagorean Triangle, they can also flip into the mirror image state. The spin Pythagorean Triangle side should not be thought of as a vector, it represents a curved spin only. As an axle it can spin, but this spin is not being represented by a vector.

Translational and rotational symmetry

Translational symmetry is the E𝔸/+𝕠d potential impulse of the positive charge, this appears to be symmetric because the time direction of the vector hands on the clock gauge is ignored. Rotational symmetry also appears because the vector clock hands are ignored. Together they create uncertainty in observing and measuring.

Conserving symmetry separately with work and impulse

This symmetry can be conserved, according to Emmy Noether where symmetry is equivalent to conservation laws, because they are two different forces as work and impulse giving a translational and rotational symmetry. When only impulse is observed, then there is a conventional assumption that time moves forward on a clockwise clock gauge even when the impulse is flipped.

CPT symmetry

That causes the rotation of the vector clock hands to be ignored, but in CPT symmetry time reverses with parity in a mirror image. The mirror reflection is a symmetry, but this translational symmetry is broken when the clock is running backwards.

Electrons and antiprotons

In this model that is resolved by the flipped state, parity and time change, also the electron in a flipped state acts like the antiproton in conventional physics. When the electron and antiproton are paired this gives a boson, because the time directions are reversed this becomes stable. It would break up if the antiproton flipped back to an electron moving forward in -𝕠d kinetic time.

Measuring a spinning circle

When only work is measured, then there appears to be a rotational symmetry. Without the asymmetric e𝕒 Pythagorean Triangle side connected the rotation looks like a circle spinning but there is no radial e𝕒 vector or spoke to measure it. In this model there is no measurable integral field as a circle alone, this would be an integral field without a straight-line ruler to measure it with. Without this there would be no way to measure how fast the circle was spinning, and what torque there was to produce this spin.

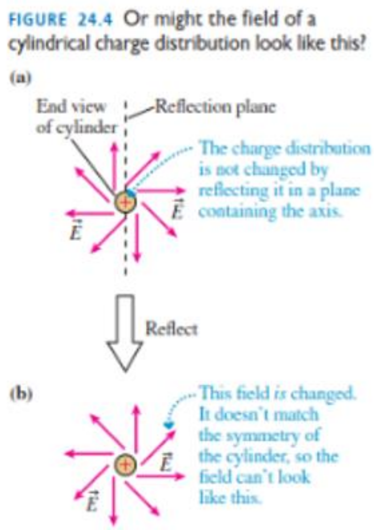


FIGURE 24.4 Or might the field of a cylindrical charge distribution look like this?

cylinder axis, if up and down are exchanged by reflecting the field in a plane coming out of the page, or if you rotate the cylinder about its axis.

But the proposed field fails one test: reflection in a plane perpendicular to the axis, a reflection that exchanges left and right. This reflection, which would *not* make any change in the charge distribution itself, produces the field shown in FIGURE 24.3b. This change in the field is detectable because a positively charged particle would now have a component of motion to the left instead of to the right.

The field of Figure 24.3a, which makes a distinction between left and right, is not cylindrically symmetric and thus is *not* a possible field. In general, **the electric field of a cylindrically symmetric charge distribution cannot have a component parallel to the cylinder axis.**

Well then, what about the electric field shown in FIGURE 24.4a? Here we're looking down the axis of the cylinder. The electric field vectors are restricted to planes perpendicular to the cylinder and thus do not have any component parallel to the cylinder axis. This field is symmetric for rotations about the axis, but it's *not* symmetric for a reflection in a plane containing the axis.

The field of FIGURE 24.4b, after this reflection, is easily distinguishable from the field of Figure 24.4a. Thus **the electric field of a cylindrically symmetric charge distribution cannot have a component tangent to the circular cross section.**

The uncertainty principle and symmetry

The vectors in the diagram below can be symmetric because the spin direction is ignored. That means these vectors are not rotating, like frozen hands on a clock gauge. That violates the uncertainty principle, the position of the e𝕒 vectors as the potential electric charge is assumed to be known. But this means the +𝕠d potential magnetic field is completely unknown, in this model that comes from examining the electric charge without magnetism. The E𝔸/+𝕠d potential impulse uses this potential magnetism as the spin of a potential clock gauge.

Position/momentum uncertainty

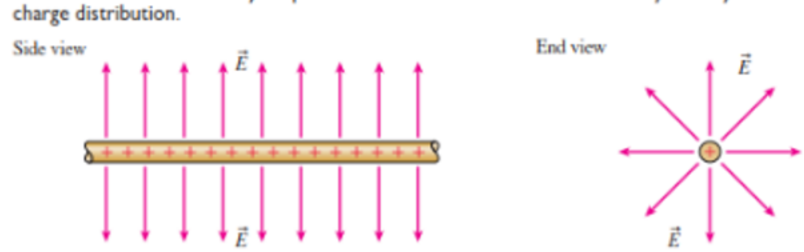
The e𝕒 positions of the vectors below are known, that means the +𝕠d×e𝕒/+𝕠d potential momentum is unknown with the position/momentum uncertainty. That reduces to +𝕠d×e𝕒 as an integral and e𝕒/+𝕠d as a derivative, together that is the uncertainty as to whether the integral or derivative are being referred to. The +𝕠d×e𝕒 integral is measured at a position e𝕒 with +𝕆D×e𝕒 potential work. The e𝕒/+𝕠d derivative is being observed at a time with the E𝔸/+𝕠d potential impulse.

Angular momentum without time

A potential rolling wheel has angular momentum, when this is frozen there is no way to observe the rotational frequency of the wheel axle. In conventional physics the angular momentum is referred to like this, as not actually spinning.

FIGURE 24.5 shows the only remaining possible field shape. The electric field is radial, pointing straight out from the cylinder like the bristles on a bottle brush. This is the one electric field shape matching the symmetry of the charge distribution.

FIGURE 24.5 This is the only shape for the electric field that matches the symmetry of the charge distribution.



Shape of the field and Pythagorean Triangles

The shape of the +𝕠d and e𝕒 Pythagorean Triangle would be the e𝕒 altitude vectors, these are not a field. As e𝕒 increases linearly the +𝕆D potential probability decreases as a square. This uses 1/r as an inverse square law, the +𝕆D potential probability weakens inversely to it as a square. There is also $1/r^2$, this comes from the E𝔸/+𝕠d potential impulse where E𝔸 is a square, then a potential acceleration would be E𝔸/+𝕠d proportional to Eℍ/+𝕚d as meters^2/second. Both are inverse square laws, the first is an integral field like the geodesic in general relativity.

What Good Is Symmetry?

Given how little we assumed about Figure 24.1—that the charge distribution is cylindrically symmetric and that electric fields point away from positive charges—we've been able to deduce a great deal about the electric field. In particular, we've deduced the *shape* of the electric field.

Now, shape is not everything. We've learned nothing about the strength of the field or how strength changes with distance. Is E constant? Does it decrease like $1/r$ or $1/r^2$? We don't yet have a complete description of the field, but knowing what shape the field *has* to have will make finding the field strength a much easier task.

That's the good of symmetry. Symmetry arguments allow us to *rule out* many conceivable field shapes as simply being incompatible with the symmetry of the charge distribution. Knowing what doesn't happen, or can't happen, is often as useful as knowing what does happen. By the process of elimination, we're led to the one and only shape the field can possibly have. Reasoning on the basis of symmetry is a sometimes subtle but always powerful means of reasoning.

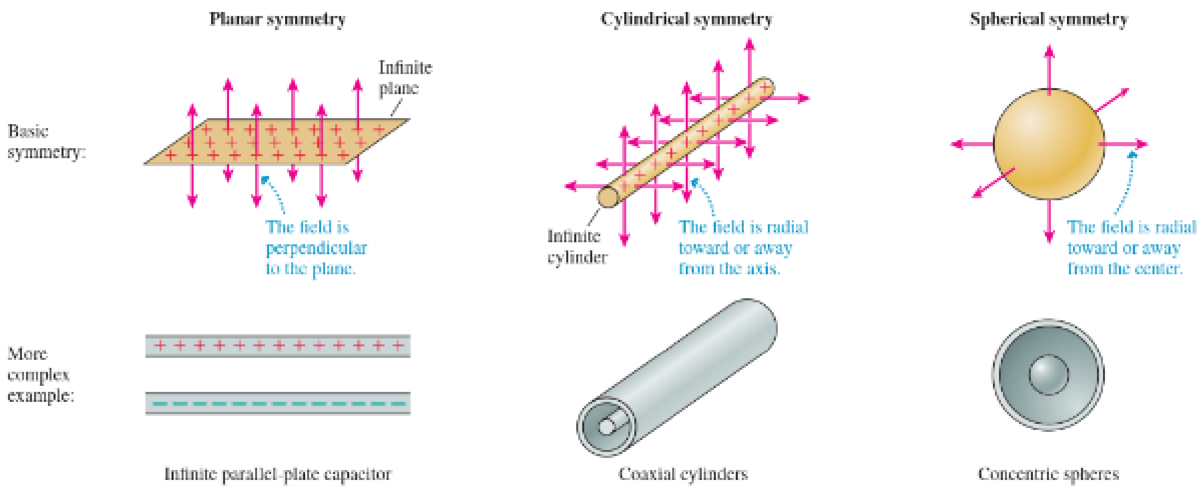
Pythagorean Triangles are asymmetric

In this model the Pythagorean Triangles are asymmetric, a symmetry only occurs by only observing or measuring one Pythagorean Triangle side. A spherical symmetry would come from a plane or area such as the +𝕆D potential probability. Because this can be in any direction, it is approximately spherical. However, it changes with an inverse square law, not an inverse cube law.

Three Fundamental Symmetries

Three fundamental symmetries appear frequently in electrostatics. The first row of **FIGURE 24.6** shows the simplest form of each symmetry. The second row shows a more complex, but more realistic, situation with the same symmetry.

FIGURE 24.6 Three fundamental symmetries.



NOTE Figures must be finite in extent, but the planes and cylinders in Figure 24.6 are assumed to be infinite.

Objects do exist that are extremely close to being perfect spheres, but no real cylinder or plane can be infinite in extent. Even so, the fields of infinite planes and cylinders are good models for the fields of finite planes and cylinders at points not too close to an edge or an end. The fields that we'll study in this chapter, even if idealized, have many important applications.

A flux as particles or fields

In this model a flux can mean particles as derivatives, for example the -𝕠d and e𝕪 Pythagorean Triangles can move with a e𝕪/-𝕠d kinetic velocity through a box. As a -𝕠d×e𝕪 kinetic field this can be measured as a -𝕆D kinetic probability distributions through the box. When these kinetic fields come from individual -𝕠d and e𝕪 Pythagorean Triangles, they are conserved as a probability density.

Direction of vectors

If there is an +𝕠d and e𝕒 Pythagorean Triangle inside the box, this has a +𝕠d×e𝕒 potential field around it. The e𝕒 altitude vectors would point into the box not out, this is the same as with the +𝕚d and e𝕙 Pythagorean Triangle as gravity pointing inwards. The direction of these vectors is a convention in physics, with this model they would point downwards.

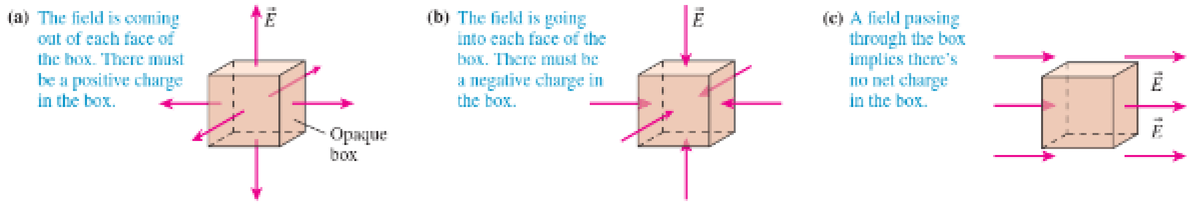
Reaction forces

They can also be regarded as a reaction force opposing the electron's active force. That would be like an E𝕍/-𝕚d inertial impulse being represented as an opposing force to a E𝕐/-𝕠d kinetic impulse. In this model the e𝕒 vector is proportional to the e𝕙 vector in gravity, so they both point downwards here.

Conservation of flux

When the -𝕠d×e𝕪 kinetic field passes through the box there is not net e𝕪 kinetic electric charge in it. The -𝕆D kinetic probability density is conserved, the flux can always be observed as a conserved number of particles with a E𝕐/-𝕠d kinetic impulse.

FIGURE 24.7 Although we can't see into the boxes, the electric fields passing through the faces tell us something about what's in them.

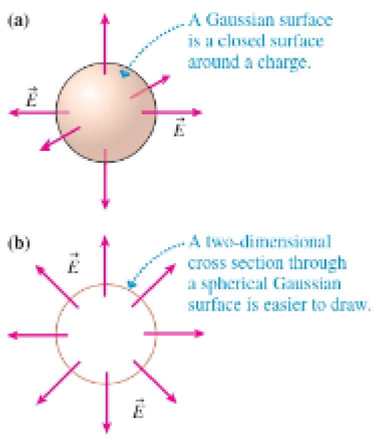


Of course you can. Because electric fields point away from positive charges, it seems clear that the box contains a positive charge or charges. Similarly, the box in FIGURE 24.7b certainly contains a negative charge.

A Gaussian surface

With the +𝕠d and e𝕒 Pythagorean Triangle a Gaussian surface would be an arbitrary e𝕒 altitude, the +𝕠d potential magnetic field varies inversely to e𝕒 up to this altitude. A cross section of this would be an integral field. The e𝕒 vectors below are symmetric, their +𝕠d spin Pythagorean Triangle sides would be asymmetric.

FIGURE 24.8 Gaussian surface surrounding a charge. A two-dimensional cross section is usually easier to draw.



What can we tell about the box in FIGURE 24.7c? The electric field points into the box on the left. An equal electric field points out on the right. An electric field passes *through* the box, but we see no evidence there's any charge (or at least any net charge) inside the box. These examples suggest that the electric field as it passes into, out of, or through the box is in some way connected to the charge within the box.

To explore this idea, suppose we surround a region of space with a *closed surface,* a surface that divides space into distinct inside and outside regions. Within the context of electrostatics, a closed surface through which an electric field passes is called a **Gaussian surface,** named after the 19th-century mathematician Karl Gauss. This is an imaginary, mathematical surface, not a physical surface, although it might coincide with a physical surface. For example, FIGURE 24.8a shows a spherical Gaussian surface surrounding a charge.

A closed surface must, of necessity, be a surface in three dimensions. But three-dimensional pictures are hard to draw, so we'll often look at two-dimensional cross sections through a Gaussian surface, such as the one shown in FIGURE 24.8b. Now we can tell from the *spherical symmetry* of the electric field vectors poking through the surface that the positive charge inside must be spherically symmetric and centered at the *center* of the sphere.

A single axle

This leads to the spin of a sphere being around a single axle, such as the +𝕚d gravitational mass of a planet. This is the only way the asymmetry can exist, the +𝕚d gravitational spin points to one side at a e𝕙 height above a planet. Inverse to this is the -𝕚d and e𝕧 Pythagorean Triangle as inertia, because of this the rotation has different e𝕧/-𝕚d inertial velocity at different latitudes on the ground.

Lowest gravity at the equator

These cause the +𝕚d gravitational field to be different according to the latitude. At the equator the e𝕧/-𝕚d inertial velocity is greatest, if this was fast enough matter might be flung from the surface of a planet in hyperbolic geometry. There would then be overall an equal or larger -𝕀D×e𝕧 inertial work to the +𝕀D×e𝕙 gravitational work. That is because the -𝕀D inertial torque is subtracted from the +𝕀D gravitational torque. This means the same matter would weigh less at the equator than at a pole, the subtraction means it is as if gravity is weaker there.

Inertial torque or probability

The -𝕀D×e𝕧 inertial work is then stronger at the equator, and weakest at the poles. This is because the pole is mainly rotating, there is less e𝕧/-𝕚d inertial velocity there is little straight-line motion though individual atoms still have inertia. Because of this, the Eℍ/+𝕚d gravitational impulse is stronger at the poles so matter weighs more there. The -𝕀D×e𝕧 inertial work is also lower at the poles because there is no -𝕀D inertial torque of the ground rotating around the planet's center like at the equator.

Three degrees of spin freedom

From this Pythagorean Triangle asymmetry comes three kinds of rotation, each of which is also asymmetric because it can be flipped over. A circle is symmetric because rotating it does not change its appearance. The +𝕠d and e𝕒 Pythagorean Triangle rotates in this model with circular geometry clockwise or counterclockwise, this is an asymmetric spin like a planet around an axle.

Torque cannot be spherical

It also has a +𝕠d potential magnetic field which is spherical according to the e𝕒 altitude orientation being observed or measured, but this is only because the e𝕒 altitude can measure the +𝕆D×e𝕒 potential work in any direction. It does not mean this +𝕆D potential torque is spherical, this cannot happen because torque only rotates around an axis. Because there are many positive charges they can point in different directions.

The electron spinning wheel

The second degree of spin freedom is the electron, in this model it moves like a rolling wheel. In the ground state of a Hydrogen atom, it would have its -𝕠d kinetic axle orthogonal to the +𝕠d potential axle of the proton. The e𝕒 altitude would spin around the +𝕠d potential axle like a spoke with the proton, the e𝕪 kinetic spoke of the electron also spins around the -𝕠d kinetic axle like this. That makes e𝕒 and e𝕪 orthogonal to each other.

Protons and electrons with different orientations

A planet can have this e𝕒 altitude pointing in any direction like a sphere. This is because there are many protons that are not aligned with the planet's axis of rotations. The +𝕚d gravitational axle of the planet is in one orientation, but the individual protons can have any orientation. When the planetary matter is solid, this must rotate around a single axis, a mainly liquid or gaseous planet would have more constructive and destructive interference with their changing atomic motions. The electrons around the proton can also have any orientation compared to the planetary axis.

The wheel is not directly observed or measured

The axles and spokes allow for either an observation or measurement. The E𝕐/-𝕠d kinetic impulse for example acts like a spring exerting an E𝕐 kinetic displacement on a target. The -𝕆D×e𝕪 kinetic work gives a -𝕆D kinetic torque or probability. In both cases these arise from a spinning wheel, but the wheel itself is not observed or measured at the same time and position.

A wheel has a particle/wave duality

If a bike wheel for example was not directly detected, then its displacement and torque forces would be like a particle/wave duality. The bike wheel could impart a displacement by colliding with a wall like a particle, it could also exert a torque on the wall if it was spinning much faster. A slow rotation then is more like a particle collision, a faster rotational frequency would cause the wheel to bounce off at an angle. This is like how an ocean wave at the beach, for example, can push a swimmer with a displacement or spin them with torque.

A path is either straight or curved

Just as a bike wheel can exert impulse like a spring or torque like an axle, the proton and electron are observed and measured only by this displacement and torque. This cannot be done together because displacement is a straight-line impulse, torque is a curve. A path cannot be both straight and curved.

A wheel produces sine waves

In conventional physics this wheel is also used to produce sine waves of electrons around an orbital. If there is a dot on the rim of the bike wheel, this would trace out a sine wave as the wheel rolls. In this model there are no cosine waves, instead the E𝕐/-𝕠d kinetic impulse of the electron only produces a displacement. This comes from the straight-line inertial velocity of the wheel, the spin is used to determine time not as a torque.

The neutrino as the third degree of spin freedom

The third degree of spin freedom gives the neutrino in this model. It is known to have a helical spin along its direction of travel, the 𝕠d neutrino axle points along this 𝕨 direction as width. The e𝕙 height of gravity, the e𝕧 length of inertia, and the 𝕨 width complete the three orthogonal degrees of straight-line and spin freedom.

Precession without the neutrino

When the neutrino leaves the neutron, this leaves two degrees of spin in the Hydrogen atom. Then there can be a precession, for example with electron elliptical orbitals. A planet in an elliptical orbit can also precess.

Axis of precession like the proton

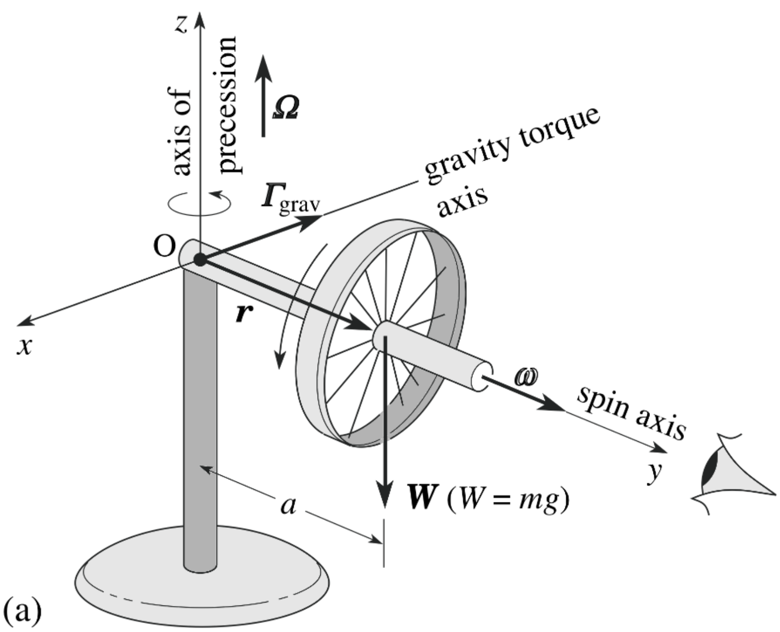
In the diagram the axis of precession would be like the proton, the wheel is like the inertial rolling wheel of the electron. The rotation of this wheel causes the spin of the proton, here as the +𝕚d gravitational spin. This makes the two spins connect to each other, the spin of the proton and electron combine like the e𝕙 height above this proton and the orthogonal e𝕧 length as the direction of the electron's motion. Because these are orthogonal the +𝕠d potential spin of the proton would also be orthogonal to the -𝕠d kinetic spin of the electron. This is not necessary to be maintained, but in the neutron they would be orthogonal.

Precession up and down

The third degree of spin freedom comes from the neutrino, this would be where the vertical axle in the diagram could precess. A planet can then have its axis precess or nutate where the axis at the pole moves in a circle, then the wheel in the diagram below would move upwards and downwards in this cycle. The third degree of freedom is the 𝕨 width up and down as the neutrino, the precession or nutation is 𝕠d. If the gravitational torque axis in the diagram also had a gyroscopic wheel, then there would be three orthogonal spins. That would prevent a precession from occurring. In this model that acts like the neutrino in a neutron.

Direction of spin

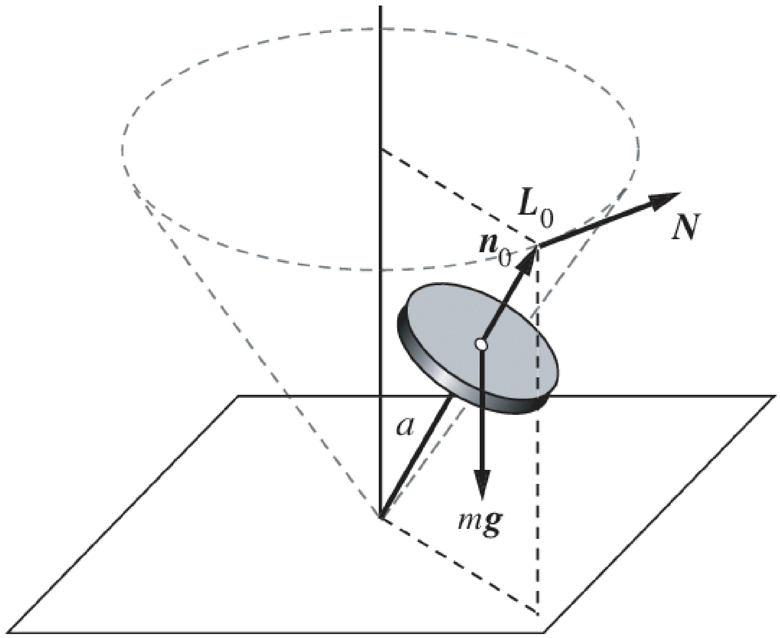
In this model there is -𝕀D×e𝕧 inertial work done by the rolling wheel, it is also pulled downwards by the +𝕀D×e𝕙 gravitational work. On the right-hand side of the wheel it is moving upwards, the -𝕀D inertial probability is greater and is subtracted from the +𝕀D gravitational probability. The wheel is then measured to be lighter on the right, on the left it is going downwards. That gives the +𝕀D gravitational probability minus a weaker -𝕀D inertial probability, this side of the wheel has stronger gravity. This stronger -𝕀D inertial probability on the right means the wheel moves in that direction, the +𝕀D gravitational probability is weaker on this side.



(a)

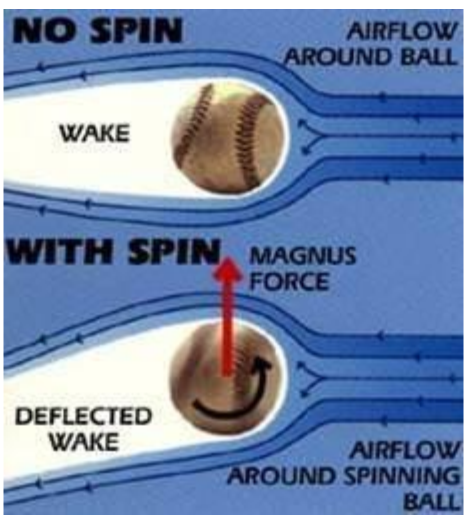
Precession as spin

In this diagram the precession spin is shown. This traces out a circle like the equator of the spinning disk, for example if it was sphere shaped. If the rolling wheel above was attached to this disk, then its spin would cause the disk-shaped rotation. The second rolling wheel orthogonal to this, like the neutrino, would prevent this recession from occurring. In this model torque always has a direction in which it does work, without this second gyroscopic wheel the top is free to precess. The disc is like the rolling wheel in the previous diagram, here it would move to the right because it would be turning counterclockwise.



A curveball and work

In this model the spin also makes a curveball move upwards. The right-hand side of the ball below is rotating upwards, this has a higher -𝕀D inertial probability or torque. The +𝕀D gravitational probability or torque is weakened on the right so the ball moves upward with a curved path.



A rotating versus nonrotating flywheel

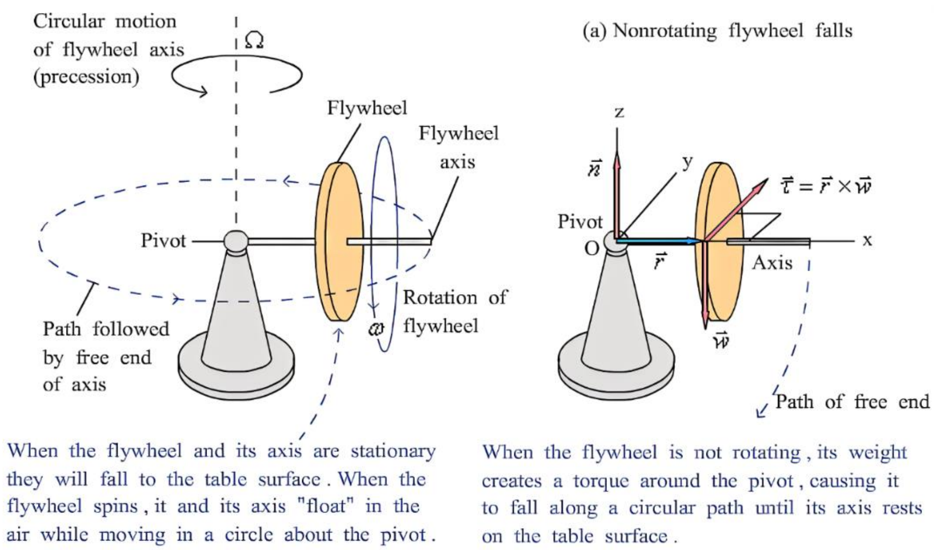
In the diagram the nonrotating flywheel falls in the third degree of spin freedom 𝕠d, this is prevented by the -𝕀D inertial torque of the rotating flywheel. In between these two rotations there can be a precession. Gravitational work and impulse, as well as inertial work and impulse, go together like Biv electromagnetism in this model, impulse comes from the displacement of the electric charge and work from the torque of the magnetic field.

Asymmetrical electromagnetism

Electromagnetism is where the electric charge has a magnetic component, this is an asymmetric +𝕠d and e𝕒 Pythagorean Triangle or -𝕠d and e𝕪 Pythagorean Triangle. When a gyroscope spins, there is -𝕀D×e𝕧 inertial work, the planet below the flywheel does +𝕀D×e𝕙 gravitational work as an orthogonal spin to this. Because these are inverses, the spinning wheel turns around the central axis. The flywheel moves like an orbit above the gravitational field below it. The e𝕙 height of the gravity is vertical, the e𝕧 length of the inertia must be horizontal. Then the +𝕚d gravitational, and -𝕚d inertial spins must also be orthogonal.

The flywheel turns counterclockwise

In the diagram the path of the flywheel is counterclockwise, this is because the -𝕀D inertial probability is weaker on the left than the right. That makes the wheel process to the right. The rotating flywheel has overall a -𝕀D inertial probability and torque, it reacts against falling downwards because that would change the orientation of the -𝕀D inertial torque axle.

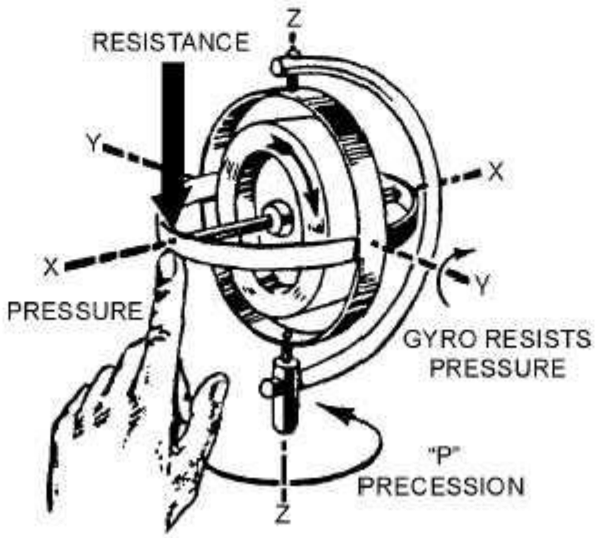


Inertial probability and impulse

In the diagram below, a E𝕐/-𝕠d kinetic impulse is exerted on the gyroscope as pressure. There is a reaction against this from the -𝕀D×e𝕧 inertial work being done by the gyroscope's rotation. Its inertial probability is not changed by impulse. This is like a higher e𝕪 Fermi temperature in atoms, it increases the E𝕐/-𝕠d kinetic impulse on electrons there. Because the -𝕆D×e𝕪 kinetic work of the electrons is in quantized orbitals, a straight-line impulse on these electrons does not move them out of the atom. In the diagram pushing on the gyroscope is like exerting an impulse on the electrons in orbitals.

Turning the gyroscope

If the flywheel is horizontal instead of vertical in the diagram, then pushing it is like gravity pulling down the rotating wheel in the diagrams above. That causes a sideways motion of the -𝕚d inertial mass, this comes from the -𝕀D inertial probability being stronger on one side.



Path integrals and orbitals

In this model electrons in an atom can also curve their paths with constructive and destructive interference. The leading edge of each -𝕆D kinetic probability can interfere destructively with other electrons, this leads them to repel each other. They can also turn like a curve ball, their rolling wheel spin would have a higher -𝕆D kinetic torque on one side of an electron. Because the atom has many areas of constructive and destructive interference, these also create path integrals with different probable paths.

Electron clouds

That would create an electron cloud rather than their remaining in an orbital like a satellite. This interference cancels out overall, the electrons still have their quantized orbital numbers, their curving paths averages out to these orbitals.

Photons and curved paths

In this model photons are also affected by this asymmetric torque. The e𝕪×-𝕘d photons can approach a star, the leading edge's -𝕀D inertial probability is subtracted from the star's +𝕀D gravitational probability on the leading edge. This causes the path integral to curve downwards towards the star. In matter the photons are also diffracted by the +𝕆D potential probabilities of the atoms. This causes the photons to curve like a path integral when entering lenses and transparent materials at an angle. They are also curved by the +𝕀D gravitational probability of the nuclei.

Prograde rotation and destructive interference

In this model planets tend to rotate in the same direction as the star they revolve around. From the reference frame of the sun's north pole, the sun and six planets rotate counterclockwise. This is like fermions with the same spin as each other, there is a +𝕀D gravitational probability between them that interferes destructively when they are too close to each other. This causes the planets to separate in a dust cloud around a star as they form.

Quantized resonation and destructive interference

There is also a -𝕀D inertial probability from their motion, this leads to gravitational and inertial resonances between a star and its planets like quantized orbitals. This would come from the planets forming from dust, when two have opposing spins then they would combine into one planet from their constructive interference like bosons. The asteroid belt and planetary rings also have destructive interference, most rotate the same way as each other.

The right-hand rule and electrons

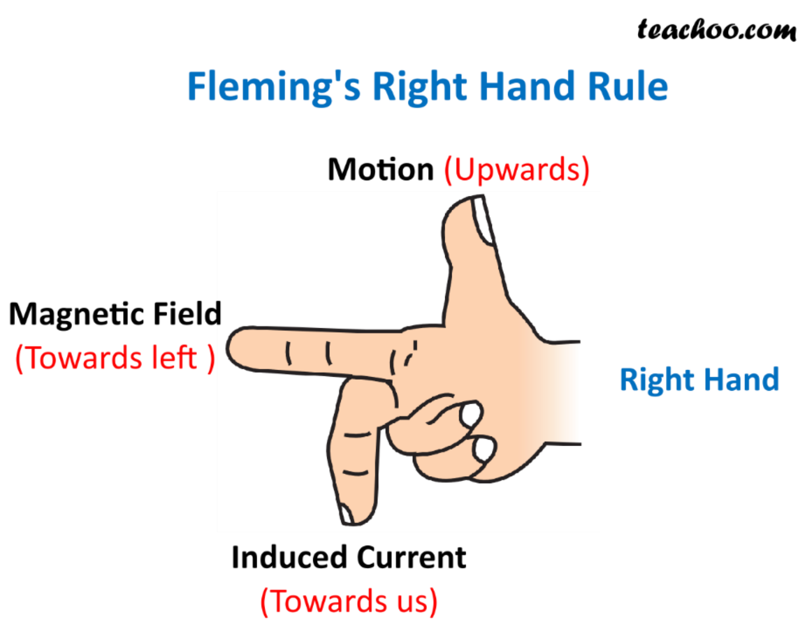
That gives the right-hand rule, the -𝕚d inertial spin of a gyroscope is like the -𝕠d kinetic spin of electrons in a magnet, they produce a magnetic field. With an e𝕪/-𝕠d kinetic current at right angle to the magnets, this is like electron rolling wheels that have the same spin orientation as the magnetic field. These electron wheels increase or decrease their -𝕆D kinetic torque from the magnets depending on the north south orientation, that changes the electrons' e𝕪/-𝕠d kinetic velocity.

The Stern Gerlach experiment

The same occurs in the Stern Gerlach experiment, the external magnets cause the electrons to curve their path up or down. Because the electrons can be pointing in any direction, the external magnetic field causes about half to go in either direction. This is like a curveball, with some clockwise and counterclockwise they would also separate into up or down.

Torque and motion

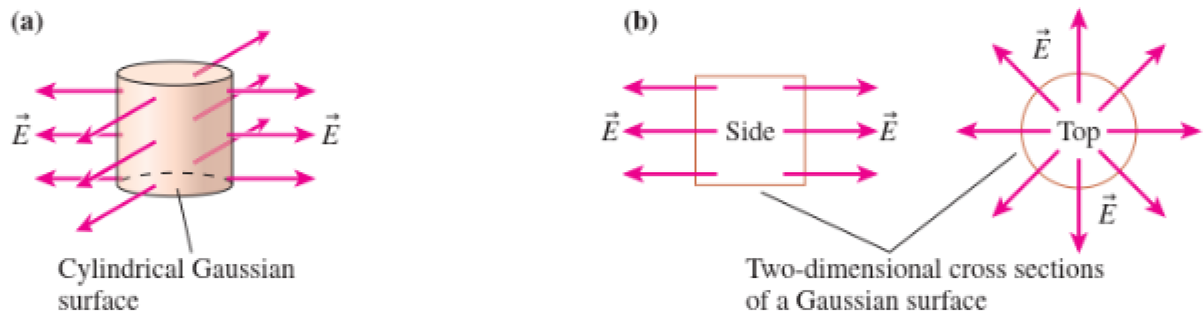
The additional torque causes the electron to move orthogonally as their path becomes more curved. This must be in a direction to measure the -𝕆D×e𝕪 kinetic work, the electrons would then curve upwards or downwards on a e𝕪 path. If this path did not curve, then it would be acting like a E𝕐/-𝕠d kinetic impulse. The electrons act like gyroscopes, the magnetic field spins them more on their leading edge which causes them to move in the orthogonal direction. The leading edge then has a different -𝕆D kinetic probability to the trailing edge, this is like the rolling wheel which precess or the curveball that moves upward.



Flux and Pythagorean Triangles

When the Gaussian surface matches the flux, this aligns most with the Pythagorean Triangles.

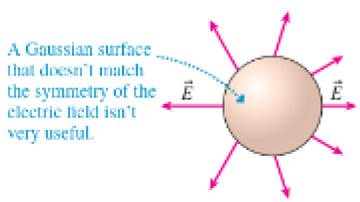
FIGURE 24.9 A Gaussian surface is most useful when it matches the shape of the field.



Constant Pythagorean Triangle area and Gaussian surfaces

When a Gaussian surface has a constant distance, such as e𝕒 or e𝕪, then the +𝕠d potential magnetic field and -𝕠d kinetic magnetic field respectively are also constant on that surface. This surface is then proportional to the constant Pythagorean Triangle areas.

FIGURE 24.10 Not every surface is useful for learning about charge.



A Gaussian surface is most useful when it matches the shape and symmetry of the field. For example, **FIGURE 24.9a** shows a cylindrical Gaussian surface—a *closed* cylinder—surrounding some kind of cylindrical charge distribution, such as a charged wire. **FIGURE 24.9b** simplifies the drawing by showing two-dimensional end and side views. Because the Gaussian surface matches the symmetry of the charge distribution, the electric field is everywhere *perpendicular* to the side wall and *no* field passes through the top and bottom surfaces.

For contrast, consider the spherical surface in **FIGURE 24.10**. This is also a Gaussian surface, and the protruding electric field tells us there's a positive charge inside. It might be a point charge located on the left side, but we can't really say. A Gaussian surface that doesn't match the symmetry of the charge distribution isn't terribly useful.

These examples lead us to two conclusions:

Flux as a flow or field

In this model a flux flows because there is an e𝕒/+𝕠d potential speed from the positive charge, a e𝕪/-𝕠d kinetic velocity from the negative charge. Each can also be a field as +𝕠d×e𝕒 and -𝕠d×e𝕪. With no net charge as e𝕒 or e𝕪, there can be no overall +𝕠d or -𝕠d field. The net flow goes into Pythagorean Triangle areas, these are constant so the flux surface is also constant for the flows. It is like a tank with an inlet and outlet, the Pythagorean Triangle areas act as an incompressible fluid so the net flow is the same on both sides.

A Gaussian surface and general relativity

In general relativity, a Gaussian surface might surround a black hole. The +𝕚d and e𝕙 Pythagorean Triangles as gravity would have a e𝕙 height contraction around them, also a +𝕚d gravitational time slowing. This would act as the same conserved Pythagorean Triangle areas. When the +𝕀D×e𝕙 gravitational work is measured for this surface as a e𝕙 height, this also has no net flow from a satellite's +𝕀D×e𝕙 gravitational work for example. That is because there is no matter to be flowing, the gravitational flux only refers to e𝕙 like a gravitational charge and +𝕚d like a gravitational magnetic field.

Two Gaussian surfaces

If there are two Gaussian surfaces at different e𝕙 heights around a black hole, there is still no net flow. This is because the e𝕙/+𝕚d gravitational speed changes linearly with the different heights not as squares. This changing speed would be measured as +𝕀D×e𝕙 gravitational work or a Eℍ/+𝕚d gravitational impulse, these would be inverses of each other from the constant Pythagorean Triangle areas.

Inverse gravitational speed and inertial velocity

To maintain a e𝕙 height on a Gaussian surface, a satellite would have a constant e𝕧/-𝕚d inertial velocity, this is the inverse of the e𝕙/+𝕚d gravitational speed so there is no net flow of satellites spiraling down into the gravitational source. This could only occur if the inertial velocity and gravitational speed were not inverses of each other.

Inverse potential speed and kinetic velocity

In Roy electromagnetism the same occurs with the potential flux from protons, this has a potential speed of e𝕒/+𝕠d. The Gaussian surface at an altitude e𝕒 is proportional to that of the e𝕙 height in Biv space-time. The electrons maintain a constant orbital with their e𝕪/-𝕠d kinetic velocities, as the inverse there is no net flow between them. If not then the electrons would spiral into the nucleus or leave the atom. Also the electrons do -𝕆D×e𝕪 kinetic work which is quantized preventing a spiral.

The three body problem

Here +𝕀D×e𝕙 gravitational work is also quantized so planets and moons tend to form resonations instead of spiraling into each other. With this model the three-body problem is an axception, two must be spinning the same way and are attracted with constructive interference. The third has destructive interference to both and is repeled, for the same reason three electrons could not form stable interactions like boson pairs can.

1. The electric field, in some sense, "flows" *out of* a closed surface surrounding a region of space containing a net positive charge and *into* a closed surface surrounding a net negative charge. The electric field may flow *through* a closed surface surrounding a region of space in which there is no net charge, but the *net flow* is zero.
2. The electric field pattern through the surface is particularly simple if the closed surface matches the symmetry of the charge distribution inside.

The electric field doesn't really flow like a fluid, but the metaphor is a useful one. The Latin word for flow is *flux*, and the amount of electric field passing through a surface is called the **electric flux.** Our first conclusions, stated in terms of electric flux, are

- There is an outward flux through a closed surface around a net positive charge.
- There is an inward flux through a closed surface around a net negative charge.
- There is no net flux through a closed surface around a region of space in which there is no net charge.

Surface integrals and probability

The surface integral is like a path integral in this model. There is +𝕆D×e𝕒 potential work done by the positive charge, then the e𝕒 altitude gives the surface at different e𝕒 potential positions. Electrons also do -𝕆D×e𝕪 kinetic work, around them there can also be a Gaussian surface with a e𝕧 length. The integral is the +𝕆D potential probability inside that e𝕒 altitude as an integral area, not volume, this gives the probability of changes in the flux. Around a positive charge this +𝕆D potential probability does not change, that is because the e𝕒 altitude is defined as a constant.

Symmetry of one Pythagorean Triangle side

This e𝕒 straight Pythagorean Triangle is symmetric around the positive charge, when measured it gives a +𝕆D potential probability at a point e𝕒. This is like the wave function being created by the act of measurement. Conversely trying to observe the E𝔸/+𝕠d potential impulse on this surface would be done by accelerating a proton or electron, this displacement creates the +𝕠d and e𝕒 Pythagorean Triangle at that +𝕠d potential time. With that observation there is an E𝔸 force vector in a particular direction as a particle.

24.3 Calculating Electric Flux

Let's start with a brief overview of where this section will take us. We'll begin with a definition of flux that is easy to understand, then we'll turn that simple definition into a formidable-looking integral. We need the integral because the simple definition applies only to uniform electric fields and flat surfaces. Those are good starting points, but we'll soon need to calculate the flux of nonuniform fields through curved surfaces.

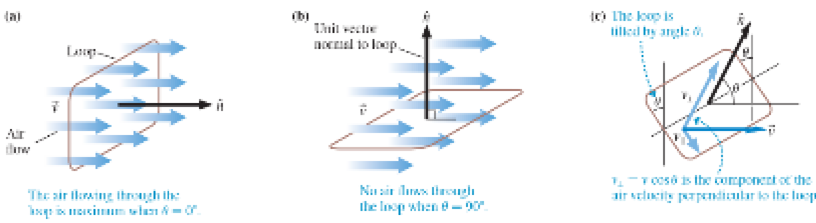
Mathematically, the flux of a nonuniform field through a curved surface is described by a special kind of integral called a *surface integral*. It's quite possible that you have not yet encountered surface integrals in your calculus course, and the "novelty factor" contributes to making this integral look worse than it really is. We will emphasize over and over the idea that an integral is just a fancy way of doing a sum, in this case the sum of the small amounts of flux through many small pieces of a surface.

The good news is that *every* surface integral we need to evaluate in this chapter, or that you will need to evaluate for the homework problems, is either zero or is so easy that you will be able to do it in your head. This seems like an astounding claim, but you will soon see it is true. The key will be to make effective use of the *symmetry* of the electric field.

Air flowing through a loop

In this model the air flowing through the loop would have the same e𝕧/-𝕚d inertial velocity. As thew loop turns this is like an orthogonal grating that closes, half closed would allow half the air through.

FIGURE 24.11 The amount of air flowing through a loop depends on the angle between $\vec{v}$ and $\hat{n}$.



Cosθ

The air flowing through the loop has a e𝕧/-𝕚d inertial velocity in meters/second. The loop can be regarded as the hypotenuse of an -𝕚d and e𝕧 Pythagorean Triangle, as the angle θ decreases the e𝕒 length as the height here contracts and the -𝕚d inertial time side increases. Here cosθ is e𝕧/ζ, the hypotenuse ζ is a constant because the loop does not change its shape. As the angle θ changes the e𝕧 length increases or decreases.

Turning the loop

When e𝕧 halves for example so does the length of the loop the air can get through, so the air flow halves as well. If this is an -𝕚d and e𝕧 Pythagorean Triangle, then has e𝕧 halves the -𝕚d Pythagorean Triangle side is horizontal so it doubles. That would also cause the hypotenuse ζ to increase. This does not change the equation (24.1), it only measures e𝕧 as a length.

You can see from Figure 24.11c that the velocity vector $\vec{v}$ can be decomposed into components $v_\perp = v\cos\theta$ perpendicular to the loop and $v_\parallel = v\sin\theta$ parallel to the loop. Only the perpendicular component $v_\perp$ carries air *through* the loop. Consequently, the volume of air flowing through the loop each second is

$$\text{volume of air per second } (\text{m}^3/\text{s}) = v_\perp A = vA\cos\theta \qquad (24.1)$$

$\theta = 0°$ is the orientation for maximum flow through the loop, as expected, and no air flows through the loop if it is tilted 90°.

An electric field doesn't flow in a literal sense, but we can apply the same idea to an electric field passing through a surface. FIGURE 24.12 shows a surface of area A in a uniform electric field $\vec{E}$. Unit vector $\hat{n}$ is normal to the surface, and θ is the angle between $\hat{n}$ and $\vec{E}$. Only the component $E_\perp = E\cos\theta$ passes *through* the surface.

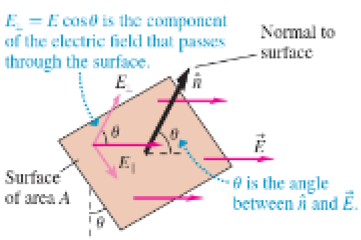
With this in mind, and using Equation 24.1 as an analog, let's define the *electric flux* Φ_e (uppercase Greek phi) as

$$\Phi_e = E_\perp A = EA\cos\theta \qquad (24.2)$$

The electric flux measures the amount of electric field passing through a surface of area A if the normal to the surface is tilted at angle θ from the field.

Equation 24.2 looks very much like a vector dot product: $\vec{E}\cdot\vec{A} = EA\cos\theta$. For this idea to work, let's define an **area vector** $\vec{A} = A\hat{n}$ to be a vector in the direction of $\hat{n}$—that is, *perpendicular* to the surface—with a magnitude A equal to the area of the surface. Vector $\vec{A}$ has units of m². FIGURE 24.13a shows two area vectors.

FIGURE 24.12 An electric field passing through a surface.



The loop area and hypotenuse are constants

The A⃗ is the hypotenuse ζ, the E⃗ is the e𝕧 length of the air's inertial velocity. The loop area is a constant, multiplying this by cosθ is e𝕧/ζ where ζ can be set as 1. As the angle θ changes then so does E⃗ from the cosine, for example if e𝕧 halves then so does cosθ as e𝕧/ζ. The flux is e𝕧/-𝕚d with its inertial velocity, if e𝕧 halves this is the same as the inertial velocity halving. When -𝕚d×e𝕧 is regarded as an inertial field of air molecules, then half of this goes through the loop. The e𝕧/-𝕚d inertial velocity is not being observed or measured here, so there is no need to use a constant area Pythagorean Triangle. The angle θ itself is not changing linearly with e𝕧.

FIGURE 24.13 The electric flux can be defined in terms of the area vector $\vec{A}$.

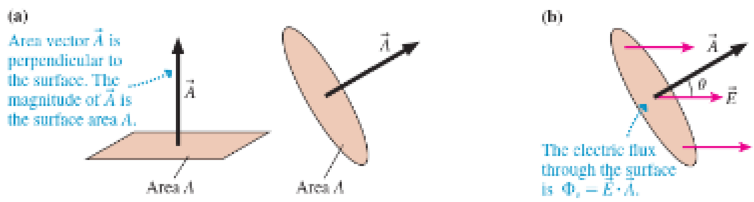


FIGURE 24.13b shows an electric field passing through a surface of area A. The angle between vectors $\vec{A}$ and $\vec{E}$ is the same angle used in Equation 24.2 to define the electric flux, so Equation 24.2 really is a dot product. We can define the electric flux more concisely as

$$\Phi_e = \vec{E} \cdot \vec{A} \quad \text{(electric flux of a constant electric field)} \qquad (24.3)$$

Writing the flux as a dot product helps make clear how angle θ is defined: θ is the angle between the electric field and a line *perpendicular* to the plane of the surface.

From a sum to an integral

In this model it is an approximation to go from a sum of particles to an integral field. Iotas here are particles which also have a wave nature, as work these waves are fields of probability. As particles they have a deterministic nature from a derivative such as e𝕧/-𝕚d. This gives an inertial velocity, it must then refer to an object because a wave has only a probability of where it can be measured. When the number of -𝕚d is known as well as the length e𝕧, this gives an exact position of a particle.

A wave velocity

If positions in a wave are widely separated, then the velocities between them would also vary so much as to make a single wave velocity meaningless. The wave has circular eddies in it which have different velocities on the top and bottom as well.

Infinitely small areas

An infinitely small Pythagorean Triangle has no area, so this cannot be a constant area in this model. Because a -𝕠d×e𝕪 kinetic field has no division signs it cannot be separated into separate pieces. That can only be done by dividing the integral into separate pieces with division signs, the reverse of the process in (24.5). But then there is still a probability that overlaps with these pieces, so they must become separate objects or particles.

Division creates particles

In this model then a derivative is a division that creates particles, it cuts something into pieces that have a separate identity. These are observed because they are pieces, their motion is over time as impulse. It is not possible to make a field without multiplication, adding small pieces together over time in conventional calculus gives many particles. The change is from measurement, in 24.6 the integral is measuring an area which is a multiplication of two variables.

The heap paradox

This is illustrated by the ancient Greek heap paradox. A heap is a subjective definition, no segments are referred to. Grains of sand are objects, there is nothing subjective about counting them. Adding grains of sand together cannot arrive at a heap, because then a heap is defined as a number of objects. The grains of sand are like derivatives with division, such as with a rock divided up into sand. A heap is like an integral, a larger heap has a greater area. It is also like the original rock which was divided up into sand, that does not mean putting the grains of sand together makes them a rock.

The Electric Flux of a Nonuniform Electric Field

Our initial definition of the electric flux assumed that the electric field $\vec{E}$ was constant over the surface. How should we calculate the electric flux if $\vec{E}$ varies from point to point on the surface? We can answer this question by returning to the analogy of air flowing through a loop. Suppose the airflow varies from point to point. We can still find the total volume of air passing through the loop each second by dividing the loop into many small areas, finding the flow through each small area, then adding them. Similarly, **the electric flux through a surface can be calculated as the sum of the fluxes through smaller pieces of the surface.** Because flux is a scalar, adding fluxes is easier than adding electric fields.

FIGURE 24.14 shows a surface in a nonuniform electric field. Imagine dividing the surface into many small pieces of area δA. Each little area has an area vector $\delta\vec{A}$ perpendicular to the surface. Two of the little pieces are shown in the figure. The electric fluxes through these two pieces differ because the electric fields are different.

Consider the small piece i where the electric field is $\vec{E}_i$. The small electric flux $\delta\Phi_i$ through area $(\delta\vec{A})_i$ is

$$\delta\Phi_i = \vec{E}_i \cdot (\delta\vec{A})_i \qquad (24.4)$$

The flux through every other little piece of the surface is found the same way. The total electric flux through the entire surface is then the sum of the fluxes through each of the small areas:

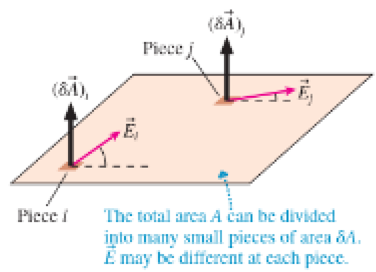
$$\Phi_e = \sum_i \delta\Phi_i = \sum_i \vec{E}_i \cdot (\delta\vec{A})_i \qquad (24.5)$$

Now let's go to the limit $\delta\vec{A} \to d\vec{A}$. That is, the little areas become infinitesimally small, and there are infinitely many of them. Then the sum becomes an integral, and the electric flux through the surface is

$$\Phi_e = \int_{\text{surface}} \vec{E} \cdot d\vec{A} \qquad (24.6)$$

The integral in Equation 24.6 is called a **surface integral.**

FIGURE 24.14 A surface in a nonuniform electric field.



A cell in the Pascal's Triangle calculus

In this model the change from derivative particles to integral fields comes from the Pascal's Triangle calculus. Each cell in Pascal's Triangle has this particle/wave duality, in a row it is part of a probability distribution that approaches a normal curve. In a column it grows exponentially, as logarithms they become linear. To be exponential they must be separate objects or particles, this is deterministic so there is no probability.

Permutations and combinations

A cell can be a permutation or combination, this is also a particle/wave duality. A permutation is deterministic because the possibilities cannot change as nothing is repeated. A combination can change because the same parts can be combined in different ways. That gives probability as work and waves, for example a pack of cards can be shuffled in different combinations.

A cell as a derivative and an integral

In this model each cell is then composed of a particle and wave, this comes from a derivative and an integral. For example, the third row is e𝕪^3, 3e𝕪^2×-𝕠d, 3e𝕪×-𝕠d^2, -𝕠d^3, in lower rows this comes closer to a normal curve integral. Starting with e𝕪^3, the first derivative is 3e𝕪^2 so this operation gives the rule for derivatives from Pascal's triangle. The second derivative is 6e𝕪, this is different from 3e𝕪×-𝕠d^2, that is because it is multiplied by an integral ½×-𝕠d^2. The ½ changes 6 to 3, the -𝕠d^2 becomes a factor. The third derivative from 3e𝕪×-𝕠d^2 is 3, this is multiplied by the second integral 1/3×-𝕠d^3 to give -𝕠d^3.

Derivatives always with respect to straight sides

It is not necessary here to write the derivative with respect to e𝕪 because this always refers to the straight Pythagorean Triangle side only. The integral is always with respect to the spin Pythagorean Triangle side.

All derivative and integral rules

From this all derivative and integral rules can be found, there is no need to change from a sum to an integral using infinitesimals and infinities. A cell can be regarded as a derivative or an integral, like it contains a permutation or a combination. An integral as a cell is part of a probability distribution row, as a derivative it is part of an exponential column.

Integrals as rows, derivatives as columns

Integral fields are probability densities, these are a row of the Pascal's Triangle calculus. The position in the row is a cell, this measures the work there. The derivatives are exponentials because the exponent changes by one with each derivative. When a cell is composed of a derivative and an exponential this becomes a pure exponential. When the rows as a whole are seen as columns, they increase as 2^n where n is the row number. When a column is seen as an infinite sequence this gives values such as with Taylor and McLaurin series.

> Equation 24.6 may look rather frightening if you haven't seen surface integrals before. Despite its appearance, a surface integral is no more complicated than integrals you know from calculus. After all, what does $\int f(x)\,dx$ really mean? This expression is a shorthand way to say "Divide the x-axis into many little segments of length δx, evaluate the function $f(x)$ in each of them, then add up $f(x)\,\delta x$ for all the segments along the line." The integral in Equation 24.6 differs only in that we're dividing a surface into little pieces instead of a line into little segments. In particular, we're summing the fluxes through a vast number of very tiny pieces.

An integral is not bound by a distance

Here the integral implies work is being done, according to this model. The changing angle θ with the -𝕠d and e𝕪 Pythagorean Triangle electrons for example, that has a -𝕆D probability distribution like an area. This is not bounded by straight Pythagorean Triangle sides so it cannot be defined as a restricted area, that means it also cannot be a piece of area to be summed to make an integral.

Unbounded but not infinite

In this model then an integral area when measured is not bounded, this does not make it infinite because the -𝕆D probability density would drop off as the e𝕪 distance or yards increased linearly.

That has a limit of the -𝕠d and e𝕪 Pythagorean Triangle angle θ, when it reaches c it can no longer be measured by photons.

No areas with straight Pythagorean Triangle sides

An area also cannot be bounded by two straight Pythagorean Triangle sides in this model, such as e𝕧 meters by e𝕧 meters. That is because this is a straight-line only, it would be a displacement vector as E𝕍 meters^2 not square meters. That makes it impossible for the E𝕍/-𝕚d inertial impulse to describe an area and hence an integral field. Conversely a -𝕀D inertial probability is not bounded by distances, it cannot be used to describe a displacement E𝕍 as square seconds.

Pythagorean Triangles as reference frames

To resolve this the particle/wave duality of a Pythagorean Triangles cell allows for a Pythagorean Triangle itself to be a reference frame for a derivative or an integral. The slope of the Pythagorean Triangle comes from the angle θ opposite the spin Pythagorean Triangle side. This slope is then the derivative such as e𝕧/-𝕚d from the inertial -𝕚d and e𝕧 Pythagorean Triangle.

Integral columns as spin and straight lines

The integral area comes from the Pythagorean Triangle area, this would be ½×-𝕚d×e𝕧. The Pythagorean Triangle area can be divided into columns like conventional integrals, with a length e𝕧 as the width of these columns. The height of each is the -𝕚d inertial mass or time. Each can be compared to the adjacent column to approximate segments as Σ adding together to become the integral ∫.

Slope at the top of the integral columns

Conversely the derivative slope at the top of each column can be regarded as being associated with the integral area of it. That allows for the derivative slope to change into a curve, because this is no longer straight it becomes part particle as a changing slope and part wave as a changing integral.

A curve as torque

That allows for complicated derivatives to be estimated, here these would change with an E𝕍/-𝕚d inertial impulse as a changing slope. More complicated derivatives would be estimated as -𝕀D×e𝕧 inertial work with waves or probabilities. The area of each column would be the relative torque to produce the curve or the relative probability of which way the curve as a path goes.

You may be thinking, "OK, I understand the idea, but I don't know what to *do*. In calculus, I learned formulas for evaluating integrals such as $\int x^2\,dx$. How do I evaluate a surface integral?" This is a good question. We'll deal with evaluation shortly, and it will turn out that the surface integrals in electrostatics are quite easy to evaluate. But don't confuse *evaluating* the integral with understanding what the integral *means*. The surface integral in Equation 24.6 is simply a shorthand notation for the summation of the electric fluxes through a vast number of very tiny pieces of a surface.

The electric field might be different at every point on the surface, but suppose it isn't. That is, suppose a flat surface is in a uniform electric field $\vec{E}$. A field that is the same at every single point on a surface is a constant as far as the integration of Equation 24.6 is concerned, so we can take it outside the integral. In that case,

$$\Phi_e = \int_{\text{surface}} \vec{E} \cdot d\vec{A} = \int_{\text{surface}} E\cos\theta\, dA = E\cos\theta \int_{\text{surface}} dA \qquad (24.7)$$

Probability of air through the loop

The integral then becomes the area A, this is the probability that air going through the loop as opposed to outside it. This air is like a flux, it also has a e𝕧/-𝕚d derivative as the inertial velocity going through it. Because this is constant there is no impulse, conversely no work is being done.

Accelerating the loop

Moving the loop requires an acceleration from a stationary orientation, this can reach a constant rotation and then a final deceleration to a second stationary orientation. That would be an E𝕍/-𝕚d inertial impulse as an observation, also -𝕀D×e𝕧 inertial work as a measurement. The amount of air going through the loop would then not change as a constant either. This allows for the air change to also be measured and observed.

The integral that remains in Equation 24.7 tells us to add up all the little areas into which the full surface was subdivided. But the sum of all the little areas is simply the area of the surface:

$$\int_{\text{surface}} dA = A \qquad (24.8)$$

This idea—that the surface integral of dA is the area of the surface—is one we'll use to evaluate most of the surface integrals of electrostatics. If we substitute Equation 24.8 into Equation 24.7, we find that the electric flux in a uniform electric field is $\Phi_e = EA\cos\theta$. We already knew this, from Equation 24.2, but it was important to see that the surface integral of Equation 24.6 gives the correct result for the case of a uniform electric field.

A surface integral around an irregular asteroid

The flux through a curved surface would be breaking it up into smaller areas, this can be approximated as Pythagorean Triangles. Taking this as gravity with the +𝕚d and e𝕙 Pythagorean Triangle, proportional to the proton's +𝕠d and e𝕒 Pythagorean Triangle with a positive charge, there can be a curved surface around an irregular asteroid for example.

Each proton has a gravitational field

The irregular asteroid's +𝕚d gravitational field is different on a regular surface such as with a sphere. Then this can be broken up into the individual +𝕚d and e𝕙 Pythagorean Triangles from each proton in the asteroid, that is proportional to the individual +𝕠d and e𝕒 Pythagorean Triangles with their positive charges.

Measuring gravitational work around an asteroid

In this model the number of protons is the limit of each proton's E𝕙/+𝕚d gravitational impulse and E𝔸/+𝕠d potential impulse, like smaller pieces in calculus. Measuring the +𝕀D×e𝕙 gravitational work at different e𝕙 height positions above the asteroid is irregular from its non-spherical shape.

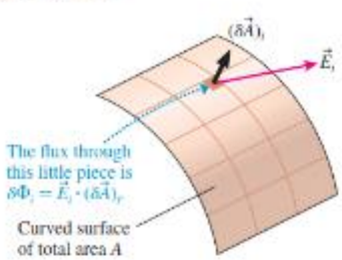
Dust on the spherical surface

These probabilities would be interfering constructively and destructively with each other. Over this surface then the probabilities would change, that would make it more likely for matter to move to its most probable locations on this surface. For example dust in space might accumulate on parts of the sphere where there was more +𝕚d gravitational mass under them.

Dust moving on the sphere with gravity and inertia

Because this is a flux, the dust moves with a e𝕙/+𝕚d gravitational speed and an e𝕒/+𝕠d potential speed. That also means it would move with a e𝕧/-𝕚d inertial velocity and electrons in the dust would move with a e𝕪/-𝕠d kinetic velocity. They would do -𝕀D×e𝕧 inertial work and -𝕆D×e𝕪 kinetic work in this motion, this could also be observed as an E𝕍/-𝕚d inertial impulse and E𝕐/-𝕠d kinetic impulse. The downward force would be observed as a Eℍ/+𝕚d gravitational impulse and a E𝔸/+𝕠d potential impulse.

FIGURE 24.15 A curved surface in an electric field.



The Flux Through a Curved Surface

Most of the Gaussian surfaces we considered in the last section were curved surfaces. **FIGURE 24.15** shows an electric field passing through a curved surface. How do we find the electric flux through this surface? Just as we did for a flat surface!

Divide the surface into many small pieces of area δA. For each, define the area vector $\delta\vec{A}$ perpendicular to the surface *at that point*. Compared to Figure 24.14, the only difference that the curvature of the surface makes is that the $\delta\vec{A}$ are no longer parallel to each other. Find the small electric flux $\delta\Phi_i = \vec{E}_i \cdot (\delta\vec{A})_i$ through each little area, then add them all up. The result, once again, is

$$\Phi_e = \int_{\text{surface}} \vec{E} \cdot d\vec{A} \qquad (24.9)$$

We *assumed*, in deriving this expression the first time, that the surface was flat and that all the $\delta\vec{A}$ were parallel to each other. But that assumption wasn't necessary. The *meaning* of Equation 24.9—a summation of the fluxes through a vast number of very tiny pieces—is unchanged if the pieces lie on a curved surface.

In this model E⃗ would be e𝕙 extending outwards from the proton, that can be at an angle to the sphere's surface because the asteroid has an irregular shape. The area is similar to a +𝕀D gravitational density, where dust is more likely to be attracted to some parts of the sphere's surface. This also applies to Roy electromagnetism, the protons with a +𝕚d gravitational field have a +𝕠d potential magnetic field. If the dust is negatively charged, then this moves with a -𝕚d inertial mass and a -𝕠d kinetic magnetic field.

Dust on the sphere with work and impulse

The dust would then move according to +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, proportionally to +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. It would also move as particles with a Eℍ/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse, proportionally a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. In this way all motion of the dust, as where it is probably found, can be observed and measured.

We seem to be getting more and more complex, using surface integrals first for nonuniform fields and now for curved surfaces. But consider the two situations shown in **FIGURE 24.16**. The electric field $\vec{E}$ in Figure 24.16a is everywhere tangent, or parallel, to the curved surface. We don't need to know the magnitude of $\vec{E}$ to recognize that $\vec{E}\cdot d\vec{A}$ is *zero at every point* on the surface because $\vec{E}$ is perpendicular to $d\vec{A}$ at every point. Thus $\Phi_e = 0$. A tangent electric field never pokes through the surface, so it has no flux through the surface.

The electric field in Figure 24.16b is everywhere perpendicular to the surface *and* has the same magnitude E at every point. $\vec{E}$ differs in direction at different points on a curved surface, but at any particular point $\vec{E}$ is parallel to $d\vec{A}$ and $\vec{E}\cdot d\vec{A}$ is simply $E\,dA$. In this case,

$$\Phi_e = \int_{\text{surface}} \vec{E}\cdot d\vec{A} = \int_{\text{surface}} E\,dA = E\int_{\text{surface}} dA = EA \qquad (24.10)$$

As we evaluated the integral, the fact that E has the same magnitude at every point on the surface allowed us to bring the constant value outside the integral. We then used the fact that the integral of dA over the surface is the surface area A.

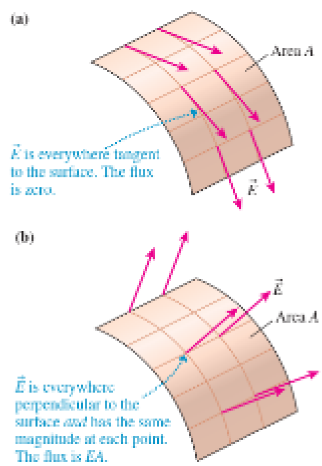
We can summarize these two situations with a Tactics Box.

TACTICS BOX 24.1 MP

Evaluating surface integrals

1. If the electric field is everywhere tangent to a surface, the electric flux through the surface is $\Phi_e = 0$.
2. If the electric field is everywhere perpendicular to a surface *and* has the same magnitude E at every point, the electric flux through the surface is $\Phi_e = EA$.

FIGURE 24.16 Electric fields that are everywhere tangent to or everywhere perpendicular to a curved surface.



No closed surface

In this model there is no closed surface, that is because a field cannot be a volume. It changes only linearly or with an inverse square law and not as cubes. A probability density cannot be regarded as a surface because it has no straight-line dimensions, when observed it changes with time as a rotation like a clock gauge.

The Electric Flux Through a Closed Surface

Our final step, to calculate the electric flux through a closed surface such as a box, a cylinder, or a sphere, requires nothing new. We've already learned how to calculate the electric flux through flat and curved surfaces, and a closed surface is nothing more than a surface that happens to be closed.

However, the mathematical notation for the surface integral over a closed surface differs slightly from what we've been using. It is customary to use a little circle on the integral sign to indicate that the surface integral is to be performed over a closed surface. With this notation, the electric flux through a closed surface is

$$\Phi_e = \oint \vec{E} \cdot d\vec{A} \qquad (24.11)$$

Only the notation has changed. The electric flux is still the summation of the fluxes through a vast number of tiny pieces, pieces that now cover a closed surface.

Planck's constant and the flux integral

The flux below changes with r^2 not r^3, this would be E𝔸 with the +𝕠d and e𝕒 Pythagorean Triangle positive charge and Eℍ which the +𝕚d and e𝕙 Pythagorean Triangle as gravity. Here q/ϵ is the potential Coulomb as +𝕠d×e𝕒/+𝕠d times e𝕒 as 1/ϵ. That gives +𝕠d×E𝔸/+𝕠d which is the same dimensions as with Planck's constant. This is observing the +𝕠d potential magnetic field, with electrons in an orbital the wave function is collapsed into an observation.

A constant as a square

This is a constant because it is a square, that means it can observe the inverse square law of the different orbitals with a constant increment between them. With a Gaussian surface this also observes a linear change in the e𝕒 altitude above a positive charge as r^2 or E𝔸. This is like F=ma in Newtons, that measures a Coulomb constant as a square 1/+𝕆D instead of E𝔸. That is also related to the Boltzmann constant as +𝕠d×e𝕒/+𝕆D with this model.

Coulombs to work or impulse

Taking Coulombs as the potential momentum +𝕠d×e𝕒/+𝕠d, this is measured in Newtons to be a constant. The momentum of gas molecules is also measured this way to give Boltzmann's constant. In (24.13) the electric flux is observed as a different inverse square to 1/+𝕆D, here it is 1/E𝔸 or $1/r^2$. This also gives a constant from Coulombs but here it uses the electric flux instead of Newtons. This is then a change from work with Newton to an electric flux as impulse. In this model that would be a change from a magnetic field to an electric flux as vectors.

Let's start with Coulomb's law for the electric field of a point charge. **FIGURE 24.18** shows a spherical Gaussian surface of radius r centered on a positive charge q. Keep in mind that this is an imaginary, mathematical surface, not a physical surface. There is a net flux through this surface because the electric field points outward at every point on the surface. To evaluate the flux, given formally by the surface integral of Equation 24.11, notice that the electric field is perpendicular to the surface at every point on the surface *and*, from Coulomb's law, it has the same magnitude $E = q/4\pi\epsilon_0 r^2$ at every point on the surface. This simple situation arises because **the Gaussian surface has the same symmetry as the electric field.**

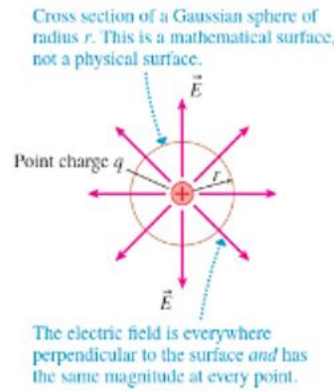
Thus we know, without having to do any hard work, that the flux integral is

$$\Phi_e = \oint \vec{E} \cdot d\vec{A} = EA_{\text{sphere}} \tag{24.12}$$

The surface area of a sphere of radius r is $A_{\text{sphere}} = 4\pi r^2$. If we use A_{sphere} and the Coulomb-law expression for E in Equation 24.12, we find that the electric flux through the spherical surface is

$$\Phi_e = \frac{q}{4\pi\epsilon_0 r^2}\, 4\pi r^2 = \frac{q}{\epsilon_0} \tag{24.13}$$

FIGURE 24.18 A spherical Gaussian surface surrounding a point charge.

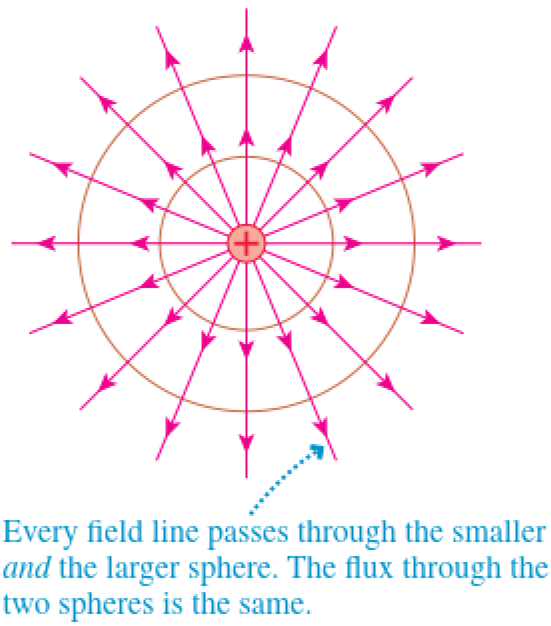


You should examine the logic of this calculation closely. We really did evaluate the surface integral of Equation 24.11, although it may appear, at first, as if we didn't do much. The integral was easily evaluated, we reiterate for emphasis, because the closed surface on which we performed the integration matched the *symmetry* of the charge distribution.

The flux from the center of the charge

In this model the flux is like the geodesic with gravity, that would be a e𝕙 height proportional to the e𝕒 altitude as with the asteroid. The two circles are different e𝕙 height values, these are rotated around with the +𝕚d gravitational spin to give the circle. This comes from the center of the charge because +𝕠d potential magnetic field values with an equal e𝕒 altitude from the center cancel would with destructive interference in +𝕆D×e𝕒 potential work. That only leaves the center, the same happens with gravity so it appears to come from the center of a planet.

FIGURE 24.19 The electric flux is the same through *every* sphere centered on a point charge.



The permittivity and permeability constants

In this model the flux can also be regarded as 1/(√ϵ×√μ) as the permittivity and permeability constants respectively. Here √ϵ is inverted, it would be proportional to e𝕪 and √μ as 1/-𝕠d. The square roots give the inertial velocity of light according to Maxwell as e𝕧/-𝕚d, so e𝕪 is proportional to e𝕧 as length and √μ to -𝕚d as inertial time.

A constant change in force as a square

Here these are not actually constants, the ϵ kinetic flux is measured in Newtons which has a square with -𝕆D×e𝕪 kinetic work. This changes according to the e𝕒 altitude over a positive charge, the e𝕪 negative charge has no force as the -𝕠d×e𝕪/-𝕠d kinetic momentum. When this e𝕒 altitude is changed, the Coulomb value changes as an inverse square which is in the Newtons measurement. Here then ϵ and μ represent the strength of the forces from the kinetic electric charge and the kinetic magnetic field.

Gravitational and inertial constants with c

Inversely to this they also represent the potential electric charge and the potential magnetic field, that is because the limit of c is also found in general relativity. They would be proportional to gravity and inertia, if not then there would be conflicting forces between the gravitational mass of a proton and the potential electric charge. The electron has a lower -𝕚d inertial mass so this proportion is maintained.

Gravitational constant as a square

With gravity for example there is a constant 9.8 meters/second^2 but this could also be regarded as a constant 9.8 meters/second then measured by squaring the seconds. This works for any height above a planet excluding general relativistic effects. This can be including using the constant area of the +𝕚d and e𝕙 Pythagorean Triangle, with more Pythagorean Triangles this acceleration increases. That allows for a gravitational constant G to be calculated.

Relative constants in gravity, inertia and electromagnetism

In this model then 1/(√ϵ×√μ) can change with slower speeds and velocities, that would be a squared deceleration from c to this slower value. Substituting e𝕪 for 1/√ϵ and -𝕠d for √μ this allows them to change with different values of d and e. Here then ϵ and μ are not used because they are already contained in e𝕪 and -𝕠d, e𝕒 and +𝕠d. The relative strengths of their forces come from c which in turn comes from α as $e^{-𝕠d}$ in Roy electromagnetism. In Biv space-time it comes from the tangent of an angle θ ≈ 1/137 which is also α. These two versions of α gives the relative strengths of the forces.

The number of Pythagorean Triangles does not change

The electric flux is independent of r because the e𝕒 altitude or e𝕙 height above the positive charge is part of the same Pythagorean Triangle. As the Gaussian surface spreads out, e𝕒 and e𝕙 increase linearly but each comes from the same protons. The flux is the same, only the ratios of the e𝕒/+𝕠d potential speed and the e𝕙/+𝕚d gravitational speed changes. The fields contained in each circle are the same, in the sense that +𝕠d×e𝕒 and +𝕚d×e𝕙 are constants from the constant Pythagorean Triangle areas.

Electric Flux Is Independent of Surface Shape and Radius

Notice something interesting about Equation 24.13. The electric flux depends on the amount of charge but *not* on the radius of the sphere. Although this may seem a bit surprising, it's really a direct consequence of what we *mean* by flux. Think of the fluid analogy with which we introduced the term "flux." If fluid flows outward from a central point, all the fluid crossing a small-radius spherical surface will, at some later time, cross a large-radius spherical surface. No fluid is lost along the way, and no new fluid is created. Similarly, the point charge in **FIGURE 24.19** is the only source of electric field. Every electric field line passing through a small-radius spherical surface also passes through a large-radius spherical surface. Hence the electric flux is independent of *r*.

Pythagorean Triangles sweeping an integral area

Here the radial surfaces are like +𝕠d and e𝕒 Pythagorean Triangles for the positive charge. The circular arc would be the +𝕠d spin Pythagorean Triangle sides, connected with a right angle to e𝕒. This contains an integral area of the same Pythagorean Triangle by varying the e𝕒 altitude. They can form a complete sphere by rotating the Pythagorean Triangle, also an ellipse for example by adding the -𝕠d and e𝕪 Pythagorean Triangle as a rotating negative charge with a inertial -𝕚d and e𝕧 Pythagorean Triangle.

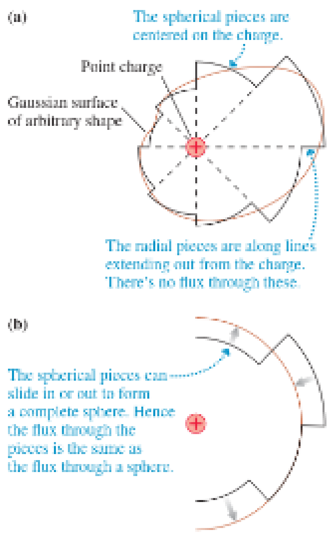
A wider arc

When the angles do not change the derivative slope of the flux is the same, in this model that would be a constant speed relative to the center. Instead here the reduction of the e𝕒 altitude and e𝕙 height would cause the angle θ to widen as the +𝕠d potential magnetic field and +𝕚d gravitational field increase inversely. They also represent the inverse square law, as the +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work increase then there is a greater +𝕆D potential and +𝕀D gravitational probability of a negative charge moving downwards towards the center.

Inverse square law and flux

This model gives the same answer as (24.14), this is because the diagram below does not include the inverse square law. The flux is assumed to be constant because the number of Pythagorean Triangles is constant. While the areas of these Pythagorean Triangles is also constant, here the angle θ changes.

FIGURE 24.20 An arbitrary Gaussian surface can be approximated with spherical and radial pieces.



This conclusion about the flux has an extremely important generalization. **FIGURE 24.20a** shows a point charge and a closed Gaussian surface of arbitrary shape and dimensions. All we know is that the charge is *inside* the surface. What is the electric flux through this arbitrary surface?

One way to answer the question is to approximate the surface as a patchwork of spherical and radial pieces. The spherical pieces are centered on the charge and the radial pieces lie along lines extending outward from the charge. (Figure 24.20 is a two-dimensional drawing so you need to imagine these arcs as actually being pieces of a spherical shell.) The figure, of necessity, shows fairly large pieces that don't match the actual surface all that well. However, we can make this approximation as good as we want by letting the pieces become sufficiently small.

The electric field is everywhere tangent to the radial pieces. Hence the electric flux through the radial pieces is zero. The spherical pieces, although at varying distances from the charge, form a *complete sphere*. That is, any line drawn radially outward from the charge will pass through exactly one spherical piece, and no radial lines can avoid passing through a spherical piece. You could even imagine, as **FIGURE 24.20b** shows, sliding the spherical pieces in and out *without changing the angle they subtend* until they come together to form a complete sphere.

Consequently, the electric flux through these spherical pieces that, when assembled, form a complete sphere must be exactly the same as the flux q/ϵ_0 through a spherical Gaussian surface. In other words, **the flux through *any* closed surface surrounding a point charge q is**

$$\Phi_e = \oint \vec{E} \cdot d\vec{A} = \frac{q}{\epsilon_0} \qquad (24.14)$$

This surprisingly simple result is a consequence of the fact that Coulomb's law is an inverse-square force law. Even so, the reasoning that got us to Equation 24.14 is rather subtle and well worth reviewing.

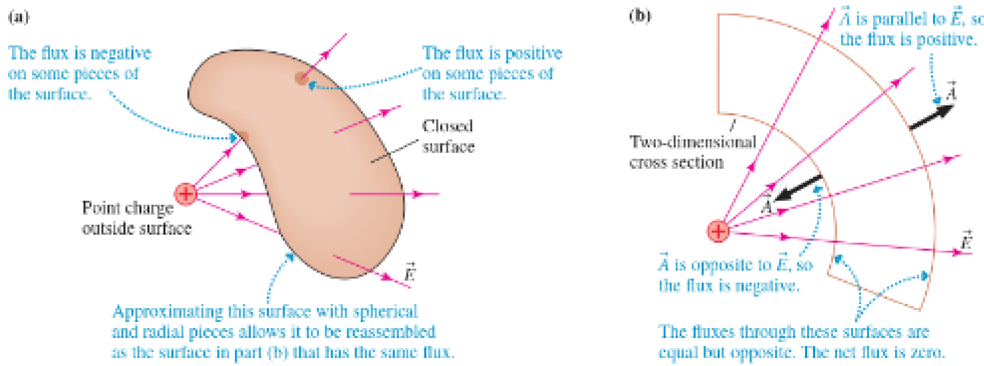
Same number of Pythagorean Triangles

Here the flux is the e𝕒 altitude and e𝕙 height only, because of this the same number of straight Pythagorean Triangle sides go through the areas. This is because there would be a fixed number of protons with their potential electric charge and e𝕙 heights.

Charge Outside the Surface

The closed surface shown in **FIGURE 24.21a** has a point charge q outside the surface but no charges inside. Now what can we say about the flux? By approximating this surface with spherical and radial pieces *centered on the charge*, as we did in Figure 24.20, we can reassemble the surface into the equivalent surface of **FIGURE 24.21b**. This closed

FIGURE 24.21 A point charge outside a Gaussian surface.



No net flow

There is no net flow because the e𝕒 altitude or e𝕙 height is a distance on a scale or ruler. With Pythagorean Triangles nothing is actually flowing, it is only when there are other Pythagorean Triangles that they can interact with a force. A e𝕙/+𝕚d gravitational speed is static unless there is matter falling towards a gravitational source. Otherwise it forms a geodesic, different +𝕚d and e𝕙 ratios at different heights.

surface consists of sections of two spherical shells, and it is equivalent in the sense that the electric flux through this surface is the same as the electric flux through the original surface of Figure 24.21a.

If the electric field were a fluid flowing outward from the charge, all the fluid *entering* the closed region through the first spherical surface would later *exit* the region through the second spherical surface. There is no *net* flow into or out of the closed region. Similarly, every electric field line entering this closed volume through one spherical surface exits through the other spherical surface.

Vector subtraction

This would be through vector subtraction of e𝕒 and e𝕪, these sum to zero because the vector magnitude in is the same as out.

Mathematically, the electric fluxes through the two spherical surfaces have the same magnitude because Φ_e is independent of r. But they have *opposite signs* because the outward-pointing area vector $\vec{A}$ is parallel to $\vec{E}$ on one surface but opposite to $\vec{E}$ on the other. The sum of the fluxes through the two surfaces is zero, and we are led to the conclusion that **the net electric flux is zero through a closed surface that does not contain any net charge.** Charges outside the surface do not produce a net flux through the surface.

This isn't to say that the flux through a small piece of the surface is zero. In fact, as Figure 24.21a shows, nearly every piece of the surface has an electric field either entering or leaving and thus has a nonzero flux. But some of these are positive and some are negative. When summed over the *entire* surface, the positive and negative contributions exactly cancel to give no *net* flux.

Adding integrals

Here the integrals are adding up individual +𝕕d and e𝕒 Pythagorean Triangles as the positive charge and -𝕕d and e𝕪 Pythagorean Triangles as the negative charge. A positive ion can have some positive and negative charges with electrons missing, a negative ion has an excess of -𝕕d and e𝕪 Pythagorean Triangles as electrons.

Unequal numbers of Pythagorean Triangles

Inside this surface there can be an unequal number of +𝕕d and e𝕒 Pythagorean Triangles and -𝕕d and e𝕪 Pythagorean Triangles as protons and electrons. If outside is also unequal this can give a net imbalance between the +𝕕d and e𝕒 Pythagorean Triangles and -𝕕d and e𝕪 Pythagorean Triangles, for example with more protons in the surface it would do more +𝔻D×e𝕒 potential work like a positive ion or nucleus. That can also contain neutrons with a combination of +𝕕d and -𝕕d canceling each other as +𝕕d-𝕕d=0.

Magnetic flux

The outside of the surface has more -𝕕d and e𝕪 Pythagorean Triangles as electrons, this can act like negative ions with the other +𝕕d and e𝕒 Pythagorean Triangle protons. That makes them do -𝔻D×e𝕪 kinetic work so that they are attracted to the surface. The individual charges are +𝕕d×e𝕒/+𝕕d potential Coulombs or momentum, also -𝕕d×e𝕪/-𝕕d kinetic Coulombs or momentum. An integral is only used with a magnetic flux in this model.

Multiple Charges

Finally, consider an arbitrary Gaussian surface and a group of charges $q_1, q_2, q_3, \ldots$ such as those shown in **FIGURE 24.22**. What is the net electric flux through the surface?

By definition, the net flux is

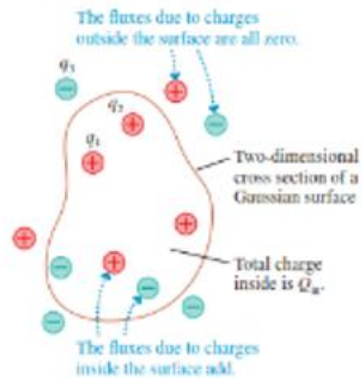
$$\Phi_e = \oint \vec{E} \cdot d\vec{A}$$

From the principle of superposition, the electric field is $\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \cdots$, where $\vec{E}_1, \vec{E}_2, \vec{E}_3, \ldots$ are the fields of the individual charges. Thus the flux is

$$\Phi_e = \oint \vec{E}_1 \cdot d\vec{A} + \oint \vec{E}_2 \cdot d\vec{A} + \oint \vec{E}_3 \cdot d\vec{A} + \cdots \qquad (24.15)$$
$$= \Phi_1 + \Phi_2 + \Phi_3 + \cdots$$

where $\Phi_1, \Phi_2, \Phi_3, \ldots$ are the fluxes through the Gaussian surface due to the individual charges. That is, the net flux is the sum of the fluxes due to individual charges. But we know what those are: q/ϵ_0 for the charges inside the surface and zero for the charges outside. Thus

FIGURE 24.22 Charges both inside and outside a Gaussian surface.



Electric flux and Planck's constant

Here the electric flux is added as +𝕕d×E𝔸/+𝕕d, this is an observation of the E𝔸/+𝕕d potential impulse as with Planck's constant. In this model it is not an integral, it is a second derivative going from e𝕒 to E𝔸. The difference is this becomes the E𝔸/+𝕕d potential impulse, as an integral it would be a field of work but there is no squared probability.

Vector addition

These charges can be added up as e𝕒 altitude or straight-line Pythagorean Triangle sides for the positive charges, as well as e𝕪 kinetic electric charges as straight-line Pythagorean Triangle sides. They can be added as vectors because in this model they have no positive and negative signs, if a vector goes through a Gaussian surface then there is no change. These vectors cannot be broken up because they are each part of one Pythagorean Triangle. If the vector addition inside the surface is overall e𝕒 then the vector addition of e𝕪 outside leads to an attraction. This is because the vectors would point overall towards the positive charges, e𝕒 would be stronger.

Electric and magnetic flux

The added charges would be the E𝔸/+𝕕d potential impulse inside the surface and the E𝕐/-𝕕d kinetic impulse outside it towards each other. When measured as the proton's +𝕕d potential magnetic field and the electron's kinetic magnetic field, this would be a magnetic flux. The imbalance is the same because each Pythagorean Triangle has both a straight and spin Pythagorean Triangle side, so the ratio of this imbalance is the same for both. The magnetic flux would be measured as +𝔻D×e𝕒 potential work and -𝔻D×e𝕪 kinetic work between them.

$$\Phi_e = \left(\frac{q_1}{\epsilon_0} + \frac{q_2}{\epsilon_0} + \cdots + \frac{q_i}{\epsilon_0} \text{ for all charges inside the surface}\right) + (0 + 0 + \cdots + 0 \text{ for all charges outside the surface}) \quad (24.16)$$

We define

$$Q_{in} = q_1 + q_2 + \cdots + q_i \text{ for all charges inside the surface} \quad (24.17)$$

as the total charge enclosed *within* the surface. With this definition, we can write our result for the net electric flux in a very neat and compact fashion. For any *closed* surface enclosing total charge Q_{in}, the net electric flux through the surface is

$$\Phi_e = \oint \vec{E} \cdot d\vec{A} = \frac{Q_{in}}{\epsilon_0} \quad (24.18)$$

This result for the electric flux is known as **Gauss's law.**

A closed Gaussian surface

The surface is closed because the Pythagorean Triangles are themselves closed, the boundary comes from using different e𝕒 altitudes and e𝕪 yards to define it. Because the number of Pythagorean Triangles is conserved this a charge imbalance cannot be changed by altering this surface. A closed surface contains a field, this is the inverse of the impulse vectors. That also comes from the enclosed Pythagorean Triangle areas.

24.5 Using Gauss's Law

In this section, we'll use Gauss's law to determine the electric fields of several important charge distributions. Some of these you already know, from Chapter 23; others will be new. Three important observations can be made about using Gauss's law:

1. Gauss's law applies only to a *closed* surface, called a Gaussian surface.
2. A Gaussian surface is not a physical surface. It need not coincide with the boundary of any physical object (although it could if we wished). It is an imaginary, mathematical surface in the space surrounding one or more charges.
3. We can't find the electric field from Gauss's law alone. We need to apply Gauss's law in situations where, from symmetry and superposition, we already can guess the *shape* of the field.

These observations and our previous discussion of symmetry and flux lead to the following strategy for solving electric field problems with Gauss's law.

Inside a conductor

Inside a conductor some -𝕠d and e𝕪 Pythagorean Triangle electrons can move freely outside the atoms. They act as particles with a E𝕐/-𝕠d kinetic impulse, the protons in the atoms attract them with a E𝔸/+𝕠d potential impulse, this is calculated with vector addition and subtraction. Because of destructive interference the electron repel each other, they can also collide as particles with a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse.

Random distribution

That causes them to spread out, the destructive interference gives normal curve distributions according to Boltzmann's constant. That means their e𝕪 positions are random, with no improbable concentrations in some parts of the conductor.

24.6 Conductors in Electrostatic Equilibrium

Consider a charged conductor, such as a charged metal electrode, in electrostatic equilibrium. That is, there is no current through the conductor and the charges are all stationary. One very important conclusion is that **the electric field is zero at all points within a conductor in electrostatic equilibrium.** That is, $\vec{E}_{in} = \vec{0}$. If this weren't true, the electric field would cause the charge carriers to move and thus violate the assumption that all the charges are at rest. Let's use Gauss's law to see what else we can learn.

Destructive interference

The excess electrons would have destructive interference on each other, that reduces the -𝕆D kinetic probability they would be measured near each other. When the electrons are observed as particles with E𝕐/-𝕠d kinetic impulse, they collide with each other chaotically spreading themselves on the surface. Positive ions also have destructive interference and a E𝔸/+𝕠d potential impulse spreading out on the surface. This is where they are furthest apart.

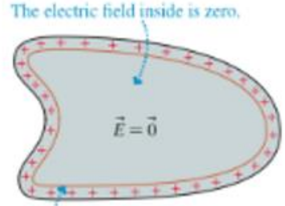
At the Surface of a Conductor

FIGURE 24.28 shows a Gaussian surface just barely inside the physical surface of a conductor that's in electrostatic equilibrium. The electric field is zero at all points within the conductor, hence the electric flux Φ_e through this Gaussian surface must be zero. But if $\Phi_e = 0$, Gauss's law tells us that $Q_{in} = 0$. That is, there's no net charge within this surface. There are charges—electrons and positive ions—but no *net* charge.

If there's no net charge in the interior of a conductor in electrostatic equilibrium, then **all the excess charge on a charged conductor resides on the exterior surface of the conductor.** Any charges added to a conductor quickly spread across the surface until reaching positions of electrostatic equilibrium, but there is no net charge *within* the conductor.

There may be no electric field within a charged conductor, but the presence of net charge requires an exterior electric field in the space outside the conductor. FIGURE 24.29 shows that **the electric field right at the surface of the conductor has**

FIGURE 24.28 A Gaussian surface just inside a conductor's surface.



Charge perpendicular to the surface

The charge is perpendicular to the surface because the +𝕠d and e𝕒 Pythagorean Triangles or -𝕠d and e𝕪 Pythagorean Triangles, with a positive or negative charge respectively, point outwards. The e𝕒 altitude is proportional to the e𝕙 height of the proton's gravity, it points outwards because there is destructive interference when it points more towards other protons. When +𝕆D×e𝕒 potential work is done, this would be directed at other protons, their +𝕆D×e𝕒 potential work would give this potential destructive interference.

Work points away from like charges

With -𝕠d and e𝕪 Pythagorean Triangle electrons, these also point outwards because -𝕆D×e𝕪 kinetic work directed at each other creates a -𝕆D kinetic destructive interference. Because the protons are repelled by each other, their paths are away from each other. When spread out, the path to further away is directly outwards. This also applies to electrons.

Charge cannot point inwards

The net flux in (24.19) is e𝕒 for protons and e𝕪 for electrons. This cannot point inwards because there would again be destructive interference with +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, as particles they would collide with a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

to be perpendicular to the surface. To see that this is so, suppose $E_{surface}$ had a component tangent to the surface. This component of $\vec{E}_{surface}$ would exert a force on the surface charges and cause a surface current, thus violating the assumption that all charges are at rest. The only exterior electric field consistent with electrostatic equilibrium is one that is perpendicular to the surface.

We can use Gauss's law to relate the field strength at the surface to the charge density on the surface. FIGURE 24.30 shows a small Gaussian cylinder with faces very slightly above and below the surface of a charged conductor. The charge inside this Gaussian cylinder is ηA, where η is the surface charge density at this point on the conductor. There's a flux $\Phi = AE_{surface}$ through the outside face of this cylinder but, unlike Example 24.6 for the plane of charge, *no* flux through the inside face because $\vec{E}_{in} = \vec{0}$ within the conductor. Furthermore, there's no flux through the wall of the cylinder because $\vec{E}_{surface}$ is perpendicular to the surface. Thus the net flux is $\Phi_e = AE_{surface}$. Gauss's law is

$$\Phi_e = AE_{surface} = \frac{Q_{in}}{\epsilon_0} = \frac{\eta A}{\epsilon_0} \qquad (24.19)$$

FIGURE 24.29 The electric field at the surface of a charged conductor.

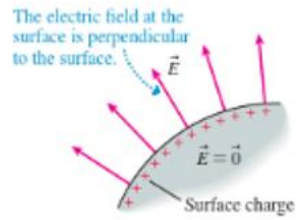


FIGURE 24.30 A Gaussian surface extending through the surface has a flux only through the outer face.

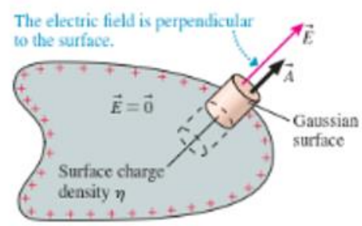
Moving to convex areas

The surface charge density is not constant because of the shape, some e𝕒 or e𝕪 vectors cannot point directly outwards where the surface is concave. That causes destructive interference making protons or electrons move to the convex areas where they can point outwards more.

from which we can conclude that the electric field at the surface of a charged conductor is

$$\vec{E}_{surface} = \left(\frac{\eta}{\epsilon_0}, \text{ perpendicular to surface}\right) \qquad (24.20)$$

In general, the surface charge density η is *not* constant on the surface of a conductor but depends on the shape of the conductor. If we can determine η, by either calculating it or measuring it, then Equation 24.20 tells us the electric field at that point on the surface. Alternatively, we can use Equation 24.20 to deduce the charge density on the conductor's surface if we know the electric field just outside the conductor.



Destructive interference around the hole

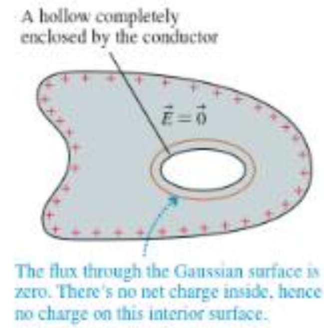
In this model there can be no charge in the hole, there is more destructive interference with +𝕆D×e𝕒 potential work or -𝕆D×e𝕪 kinetic work here. Also positive ions would collide more with E𝔸/+𝕠d potential impulse, the negative ions would collide with a E𝕐/-𝕠d kinetic impulse.

Charges and Fields Within a Conductor

FIGURE 24.31 shows a charged conductor with a hole inside. Can there be charge on this interior surface? To find out, we place a Gaussian surface around the hole, infinitesimally close but entirely within the conductor. The electric flux Φ_e through this Gaussian surface is zero because the electric field is zero everywhere inside the conductor. Thus we must conclude that $Q_{in} = 0$. There's no net charge inside this Gaussian surface and thus no charge on the surface of the hole. Any excess charge resides on the *exterior* surface of the conductor, not on any interior surfaces.

Furthermore, because there's no electric field inside the conductor and no charge inside the hole, the electric field inside the hole must also be zero. This conclusion has an important practical application. For example, suppose we need to exclude the electric field from the region in FIGURE 24.32a on the next page enclosed within dashed lines. We can do so by surrounding this region with the neutral conducting box of FIGURE 24.32b.

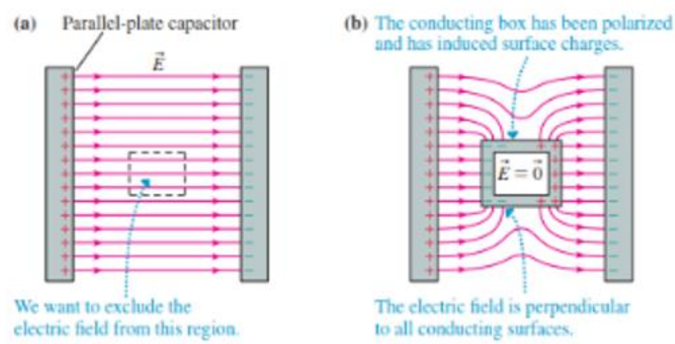
FIGURE 24.31 A Gaussian surface surrounding a hole inside a conductor.



Work in the capacitor

When the conducting box is placed in a capacitor, this has more +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work being done on the left and right sides. There is constructive interference with the nearest plate, so the excess charges move to the sides as there is a higher probability of their being measured there.

FIGURE 24.32 The electric field can be excluded from a region of space by surrounding it with a conducting box.



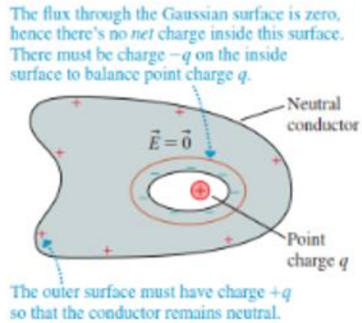
Hole surface like an orbital

When a positive charge is moved into the hole, this does +𝕆D×e𝕒 potential work. That makes it more -𝕆D kinetically probable an electron will be measured there with -𝕆D×e𝕪 kinetic work. The hole's surface acts like an orbital, the electrons here would do -𝕆D×e𝕪 kinetic work as in an atom. With a E𝔸/+𝕠d potential impulse the electrons actively move towards the positive charge with a E𝕐/-𝕠d kinetic impulse.

Action/reaction pairs

This is like gravity, but there the Eℍ/+𝕚d gravitational impulse is the active force while the E𝔸/+𝕠d potential impulse is only reactive. The active E𝕐/-𝕠d kinetic impulse from the electrons is proportional to their E𝕍/-𝕚d inertial impulse which is reactive only. That gives action/reaction pairs between the positive and negative charges.

FIGURE 24.33 A charge in the hole causes a net charge on the interior and exterior surfaces.



This region of space is now a hole inside a conductor, thus the interior electric field is zero. The use of a conducting box to exclude electric fields from a region of space is called **screening.** Solid metal walls are ideal, but in practice wire screen or wire mesh—sometimes called a *Faraday cage*—provides sufficient screening for all but the most sensitive applications. The price we pay is that the exterior field is now very complicated.

Finally, FIGURE 24.33 shows a charge q inside a hole within a neutral conductor. The electric field *within* the conductor is still zero, hence the electric flux through the Gaussian surface is zero. But $\Phi_e = 0$ requires $Q_{in} = 0$. Consequently, the charge inside the hole attracts an equal charge of opposite sign, and charge $-q$ now lines the inner surface of the hole.

The conductor as a whole is neutral, so moving $-q$ to the surface of the hole must leave $+q$ behind somewhere else. Where is it? It can't be in the interior of the conductor, as we've seen, and that leaves only the exterior surface. In essence, an internal charge polarizes the conductor just as an external charge would. Net charge $-q$ moves to the inner surface and net charge $+q$ is left behind on the exterior surface.

In summary, conductors in electrostatic equilibrium have the properties described in Tactics Box 24.3.

Newtons and work

In this model N/kg is equal to meters/second^2 or eⅆ/+𝕀D from the +ⅈd and eⅆ Pythagorean Triangle. Newtons comes from F=ma as +ⅈd×eⅆ/+𝕀D, this is a combination of a +ⅈd×eⅆ gravitational integral field and eⅆ/+𝕀D as +𝕀D×eⅆ gravitational work. Here y is the eⅆ height. Then mg is the +ⅈd gravitational mass times eⅆ/+𝕀D in meters/second^2. With y as h this gives the ½×+ⅈd ×eℍ/+𝕀d rotational gravitation without the ½ factor.

Gravitational potential

In conventional physics this is referred to as a potential gravitational energy, in this model it is proportional to the ½×+e𝔸/+𝕆d ×+ⓞd rotational potential energy. Gravity is an active force while the potential of the proton is reactive only.

Arbitrary heights not allowed

The eⅆ height in the ½×+ⅈd ×eℍ/+𝕀d rotational gravitation comes from the center of the matter, such as with a planet. Then the +ⅈd and eⅆ Pythagorean Triangles are compatible with general relativity. If this was an event horizon for example, then this eⅆ height would contract closer to it. When an arbitrary eⅆ height is set at zero this implies there can be an +ⅈd and eⅆ Pythagorean Triangle with a zero height. That would mean it has no area, so that is not allowed in this model.

A Gravitational Analogy

Gravity, like electricity, is a long-range force. Much as we defined the electric field $\vec{E} = \vec{F}_{\text{on } q}/q$, we can also define a *gravitational field*—the agent that exerts gravitational forces on masses—as $\vec{F}_{\text{on } m}/m$. But $\vec{F}_{\text{on } m} = m\vec{g}$ near the earth's surface; thus the familiar $\vec{g}$ = (9.80 N/kg, down) is really the gravitational field! Notice how we've written the units of $\vec{g}$ as N/kg, but you can easily show that N/kg = m/s^2. The gravitational field near the earth's surface is a *uniform* field in the downward direction.

FIGURE 25.2 shows a particle of mass m falling in the gravitational field. The gravitational force is in the same direction as the particle's displacement, so the gravitational field does a *positive* amount of work on the particle. The gravitational force is constant, hence the work done by the gravitational field is

$$W_G = F_G \Delta r \cos 0° = mg|y_f - y_i| = mgy_i - mgy_f \tag{25.5}$$

We have to be careful with signs because Δr, the magnitude of the displacement vector, must be a positive number.

Now we can see how the definition of ΔU in Equation 25.2 makes sense. The *change* in gravitational potential energy is

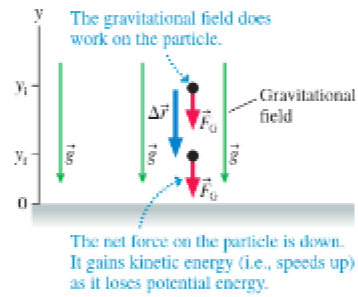
$$\Delta U_G = U_f - U_i = -W_G(\text{i} \rightarrow \text{f}) = mgy_f - mgy_i \tag{25.6}$$

Comparing the initial and final terms on the two sides of the equation, we see that the gravitational potential energy near the earth is the familiar quantity

$$U_G = U_0 + mgy \tag{25.7}$$

where U_0 is the value of U_G at $y = 0$. We usually choose $U_0 = 0$, in which case $U_G = mgy$, but such a choice is not necessary.

FIGURE 25.2 Potential energy is transformed into kinetic energy as a particle moves in a gravitational field.



Straight-line forces

In this model the negative charge would be falling towards the positive charge, that is proportional to its inertia falling towards the proton's gravitational mass. When this is a straight-line force, it is mainly a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. The constant force F=qE here is the -𝕠d×e𝕪/-𝕠d kinetic momentum or Coulombs times e𝕪 as the kinetic electric charge. Because this is the inverse of 1/-𝕠d that can be substituted to give -𝕠d×e𝕪/-𝕆D.

Particle/wave duality in energy

If it remains as -𝕠d×e𝕪/-𝕠d × e𝕪 this is -𝕠d×E𝕐/-𝕠d which contains the E𝕐/-𝕠d kinetic impulse for a given -𝕠d kinetic mass proportional to the -𝕚d inertial mass. Because this can be expressed as -𝕆D×e𝕪 kinetic work or a E𝕐/-𝕠d kinetic impulse, this gives a particle/wave duality. Both are contained in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. The positive charge can be +𝕠d×e𝕒/+𝕆D or +𝕠d×E𝔸/+𝕠d by the same process.

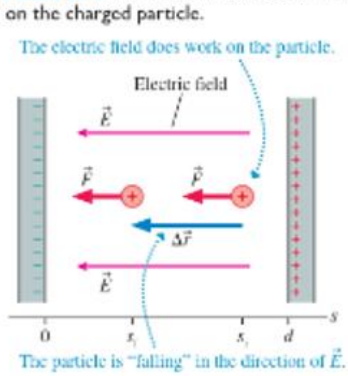
A Uniform Electric Field

FIGURE 25.3 shows a charged particle inside a parallel-plate capacitor with electrode spacing d. This is a uniform electric field, and the situation looks very much like Figure 25.2 for a mass in a uniform gravitational field. The one difference is that $\vec{g}$ always points down whereas the positive-to-negative electric field can point in any direction. To deal with this, let's define a coordinate axis s that points *from* the negative plate, which we define to be $s = 0$, *toward* the positive plate. The electric field $\vec{E}$ then points in the negative s-direction, just as the gravitational field $\vec{g}$ points in the negative y-direction. This s-axis, which is valid no matter how the capacitor is oriented, is analogous to the y-axis used for gravitational potential energy.

A positive charge q inside the capacitor speeds up and gains kinetic energy as it "falls" toward the negative plate. Is the charge losing potential energy as it gains kinetic energy? Indeed it is, and the calculation of the potential energy is just like the calculation of gravitational potential energy. The electric field exerts a *constant* force $F = qE$ on the charge in the direction of motion; thus the work done on the charge by the electric field is

$$W_{\text{elec}} = F \Delta r \cos 0° = qE|s_f - s_i| = qEs_i - qEs_f \tag{25.8}$$

FIGURE 25.3 The electric field does work on the charged particle.



Electric and magnetic flux as inverses

The electric potential energy U here would be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, this is added to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy which is negative. The change here is qEs which is +𝕠d×e𝕒/+𝕠d in potential Coulombs, then multiplied by s as an e𝕒 distance or altitude. The E flux here is 1/+𝕠d to give the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. Because the 1/+𝕠d potential magnetic flux is the inverse of the e𝕒 potential electric flux, this makes electromagnetism composed of electricity and magnetism as inverses.

where we again have to be careful with the signs because $s_f < s_i$.

The work done by the electric field causes the *electric* potential energy to change by

$$\Delta U_{elec} = U_f - U_i = -W_{elec}(i \rightarrow f) = qEs_f - qEs_i \qquad (25.9)$$

Comparing the initial and final terms on the two sides of the equation, we see that the **electric potential energy** of charge q in a uniform electric field is

$$U_{elec} = U_0 + qEs \qquad (25.10)$$

where s is measured from the negative plate and U_0 is the potential energy at the negative plate ($s = 0$). It will often be convenient to choose $U_0 = 0$, but the choice has no physical consequences because it doesn't affect ΔU_{elec}. Equation 25.10 was derived with the assumption that q is positive, but it is valid for either sign of q.

The potential moves downhill

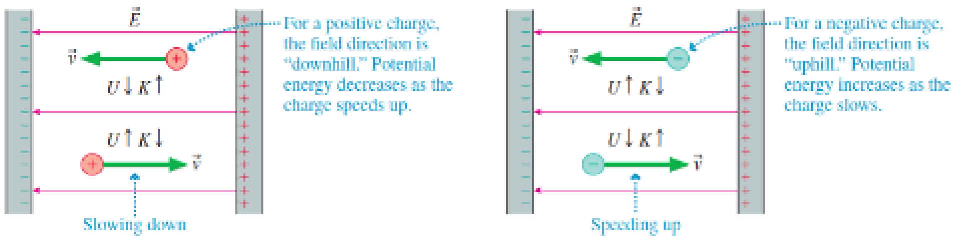
In this model the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy moves downhill towards ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, that is proportional to downhill with ½×+𝕚d ×eℍ/+𝕀d rotational gravitation. When it moves uphill it is proportional to its ½×e𝕍/-𝕀d ×-𝕚d linear inertia, then it can leave the atom as electrons.

Summing and vector addition

It does not change potential and kinetic energy in this model. The +𝕆D×e𝕒 potential work is positive and the -𝕆D×e𝕪 kinetic work is negative, when these are summed the overall work is measured. When the -𝕆D×e𝕪 kinetic work of an electron is larger than the +𝕆D×e𝕒 potential work in an atom, then the electron can leave the atom into free space. When the E𝕐/-𝕠d kinetic impulse and E𝔸/+𝕠d potential impulse are observed, then the electrons and protons are particles. Their motion uses vector addition and subtraction to give their motion. When an electron leaves an atom, it is observed mainly with a E𝕐/-𝕠d kinetic impulse rather than -𝕆D×e𝕪 kinetic work.

FIGURE 25.4 shows positive and negative charged particles moving inside a parallel-plate capacitor. For a positive charge, U_{elec} decreases and K increases as the charge moves toward the negative plate (decreasing s). Thus a positive charge is going "downhill" if it moves in the direction of the electric field. A positive charge moving opposite the field direction is going "uphill," slowing as it transforms kinetic energy into electric potential energy.

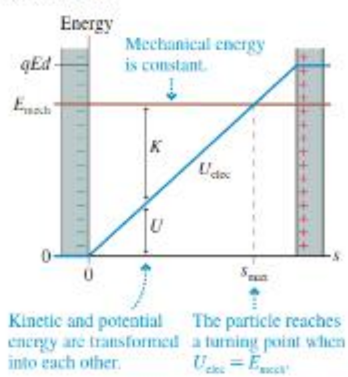
FIGURE 25.4 A charged particle exchanges kinetic and potential energy as it moves in an electric field.



Inverse energies

In this model uphill can be linear, the positive charge changes with the e𝕒/+𝕠d potential speed and the negative charge with the e𝕪/-𝕠d kinetic velocity. This is proportional to Biv space-time where a ramp would have a gravitational speed of e𝕙/+𝕚d and an inertial velocity of e𝕧/-𝕚d. The motion in the diagram has a ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and a ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. The E𝔸 and E𝕐 factors change inversely to each other, so do the +𝕆D and -𝕆D factors. The +𝕠d and -𝕠d are inverses, so the changes are linear using constant Pythagorean Triangle areas.

FIGURE 25.5 The energy diagram for a positively charged particle in a uniform electric field.



If we choose $U_0 = 0$, so that potential energy is zero at the negative plate, then a negative charged particle has *negative* potential energy. You learned in Chapter 10 that there's nothing wrong with negative potential energy—it's simply less than the potential energy at some arbitrarily chosen reference location. The more important point, from Equation 25.10, is that the potential energy *increases* (becomes less negative) as a negative charge moves toward the negative plate. A negative charge moving in the field direction is going "uphill," transforming kinetic energy into electric potential energy as it slows.

FIGURE 25.5 is an *energy diagram* for a positively charged particle in an electric field. Recall that an energy diagram is a graphical representation of how kinetic and potential energies are transformed as a particle moves. For positive q, the electric potential energy given by Equation 25.10 increases linearly from 0 at the negative plate (with $U_0 = 0$) to qEd at the positive plate. The total mechanical energy—which is under your control—is constant. If $E_{mech} < qEd$, as shown here, a positively charged particle projected from the negative plate will gradually slow (transforming kinetic energy into potential energy) until it reaches a *turning point* where $U_{elec} = E_{mech}$. But if you project the particle with greater speed, such that $E_{mech} > qEd$, it will be able to cross the gap to collide with the positive plate.

Repelling with destructive interference

In this model the like charges repel with destructive interference, for positive charges as a +𝕆D potential probability and negative charges with a -𝕆D kinetic probability. This is doing +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work respectively, they are then integrals.

Integrating derivatives

In (25.11) a work equation comes from the inverse square law, in this model that would be changing the E𝔸/+𝕠d potential impulse for example into +𝕆D×e𝕒 potential work. The derivatives of a Pythagorean Triangle begin with no division or multiplication, the first derivative gives e𝕒/+𝕠d as the potential speed. A second derivative, all derivatives are with respect to the straight Pythagorean Triangle side, gives the E𝔸/+𝕠d potential impulse because equation is a square.

Infinitesimals and fluxions

The first initial state of the +𝕠d and e𝕒 Pythagorean Triangle can be regarded as e𝕒^0 and +𝕠d, this is where the straight Pythagorean Triangle side is like an infinitesimal. The second initial state would be e𝕒 and +𝕠d^0 where the spin Pythagorean Triangle side is like a fluxion or instant of time. Each exists as a Pythagorean Triangle side but they have no size, in conventional algebra that would be regarded as 1 and +i respectively.

The Pascal's Triangle calculus

Here this is not done, they remain as e𝕒^0 and +𝕠d^0, then they work in the Pascal's Triangle calculus as described earlier. With +𝕠d^0×e𝕒 as the zeroth integral this would have e𝕒 as a potential position on a ruler and the instant +𝕠d^0 is not being measured because there is no force. That allows for +𝕠d^0 to be an intermediate state, with a first integral it becomes +𝕠d×e𝕒. Alternatively, the derivative of +𝕠d^0×e𝕒 with respect to +𝕠d gives e𝕒/+𝕠d as the first derivative.

Conventions for derivatives

With +𝕠d/e𝕒^0 this is also an intermediate state, the convention for derivatives is in changing the denominator. In this model e𝕒^0/+𝕠d can be flipped because it is the conventional format for meters/second. With the first derivative this becomes +𝕠d/e𝕒, or using a convention that derivatives change the numerator, it becomes e𝕒/+𝕠d.

Moving from the numerator to the denominator

With e𝕒^0/+𝕠d an integral with respect to e𝕒 would give e𝕒$^{-1}$×+𝕠d or 1/(+𝕠d×e𝕒) as an inverted integral which would be equal to -𝕠d×e𝕪 as the kinetic integral. An integral of +𝕠d/e𝕒^0 would give +𝕠d×e𝕒 as the potential field. This is the opposite of the multiplied factor +𝕠d^0 going to the denominator as +𝕠d^{-1}, beginning in the denominator as +𝕠d^0 then +𝕠d goes to the numerator.

25.2 The Potential Energy of Point Charges

FIGURE 25.7a shows two charges q_1 and q_2, which we will assume to be like charges. These two charges interact, and the energy of their interaction can be found by calculating the work done by the electric field of q_1 on q_2 as q_2 moves from position x_i to position x_f. We'll assume that q_1 has been glued down and is unable to move, as shown in **FIGURE 25.7b**.

The force is entirely in the direction of motion, so $\cos\theta = 1$. Thus

$$W_{elec} = \int_{x_i}^{x_f} F_{1\,on\,2}\,dx = \int_{x_i}^{x_f} \frac{Kq_1q_2}{x^2}\,dx = Kq_1q_2 \frac{-1}{x}\bigg|_{x_i}^{x_f} = -\frac{Kq_1q_2}{x_f} + \frac{Kq_1q_2}{x_i} \quad (25.11)$$

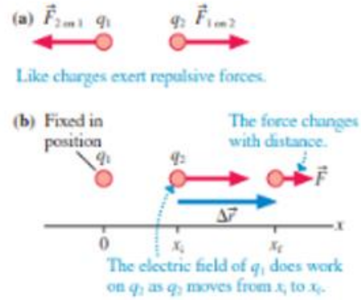
The potential energy of the two charges is related to the work done by

$$\Delta U_{elec} = U_f - U_i = -W_{elec}(i \to f) = \frac{Kq_1q_2}{x_f} - \frac{Kq_1q_2}{x_i} \quad (25.12)$$

By comparing the left and right sides of the equation we see that the potential energy of the two-point-charge system is

$$U_{elec} = \frac{Kq_1q_2}{x} \quad (25.13)$$

FIGURE 25.7 The interaction between two point charges.



Zeroth derivative and integral

The distance between the charges would be the straight Pythagorean Triangle side, with two positive charges each can have a +𝕠d×e𝕒/+𝕠d potential momentum in Coulombs. Then an integral of this gives +𝕆D×e𝕒 potential work, the momentum can be regarded as a state like an integral and derivative combined. In this model that would not exist, instead the zeroth integral and derivative are used. The answers are the same, the +𝕆D×e𝕒 potential work of each positive charge has +𝕆D destructive interference which makes it less likely for the two positive charges to be close to each other.

We could include a constant U_0, as we did in Equation 25.10, for the potential energy of a charge in a uniform electric field, but it is customary to set $U_0 = 0$.

We chose to integrate along the x-axis for convenience, but all that matters is the *distance* between the charges. Thus a general expression for the electric potential energy is

$$U_{elec} = \frac{Kq_1q_2}{r} = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r} \quad \text{(two point charges)} \quad (25.14)$$

This is explicitly the energy *of the system*, not the energy of just q_1 or q_2.

Two like charges as a hyperbola

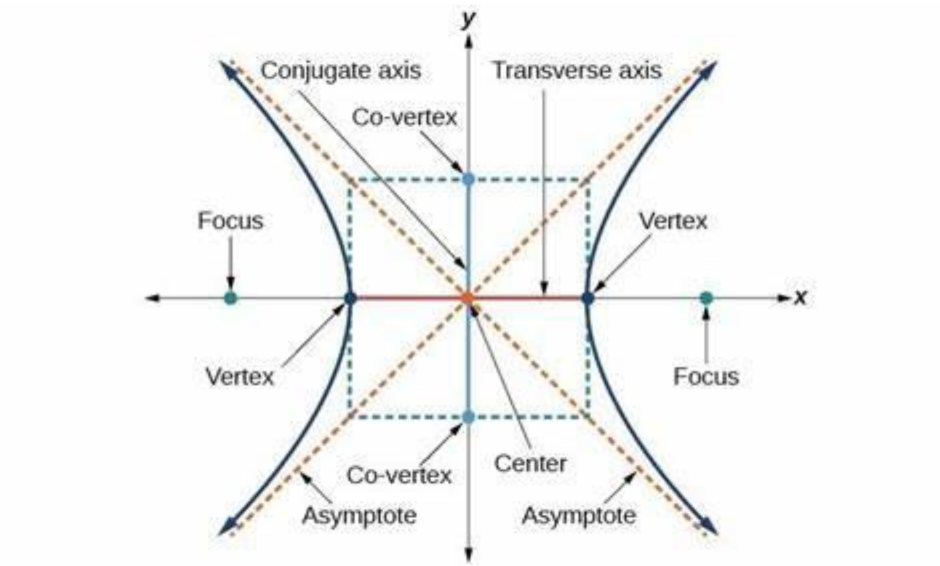
In this model two like charges separate as a hyperbola, this is because they are moving apart in hyperbolic geometry. Two unlike charges would be in circular geometry such as in a Hydrogen atom. Two +𝕠d and e𝕒 Pythagorean Triangles would do +𝕆D×e𝕒 potential work on each other, then the +𝕠d and e𝕒 Pythagorean Triangle can be drawn tangent to the hyperbola with its right angle at the origin.

Constant Pythagorean Triangle with the tangent

This has a constant Pythagorean Triangle area with this tangent, the e𝕒 altitude of the proton can then increase with the +𝕆D potential probability decreasing as a square. This still fits under the hyperbola, the +𝕠d Pythagorean Triangle side has a square area or integral attached to it.

Two hyperbolas as repulsion

That allows for the repulsion of two like charges to be represented by two hyperbolas as in the diagram below. The blue vertical dotted lines would be the hypotenuse of each +𝕠d and e𝕒 Pythagorean Triangle, it is connected to two red dotted lines which would be the e𝕒 and +𝕠d Pythagorean Triangle sides.



Equations for circles and hyperbolas

With the -𝕠d and e𝕪 Pythagorean Triangle in hyperbolic geometry this gives the equation for a hyperbola. Here E𝕐-𝕆D=k as a constant, this is $a^2-b^2=k$ in conventional math. With the +𝕠d and e𝕒 Pythagorean Triangle there is E𝔸+𝕆D=k as a circle or $a^2+b^2=k$. This is not consistent with the constant Pythagorean Triangle areas, so the -𝕠d and e𝕪 Pythagorean Triangle is a tangent to the hyperbola not conforming to this equation. For example if E𝕐 doubles then -𝕆D halves, but this deviates from the constant.

Work and impulse related to a hyperbola

That is why work and impulse are different, with the hyperbola there can be a E𝕐/-𝕠d kinetic impulse where the E𝕐 kinetic displacement is observed. There can also be -𝕆D×e𝕪 kinetic work where the -𝕆D kinetic torque or probability is measured. These are inverses using multiplication and division not plus and minus.

Pythagorean Triangles are not conic sections

The minus sign in E𝕐-𝕆D is not a subtraction of the two squared Pythagorean Triangle sides here. Instead E𝕐 has no sign, it is added and subtracted as vectors. -𝕆D has a sign but it cannot be subtracted from a vector. These two Pythagorean Triangle sides can be used in a hyperbolic equation, but they are not inverses with subtraction.

Conic sections from Pythagorean Triangles

With E𝔸+𝕆D the same applies, E𝔸 uses vector addition and subtraction with no sign. +𝕆D is not adding to E𝔸, it means it is positive here. This can give a circle, but the inverse relationship comes from E𝕐+𝕆D as the circle and E𝔸-𝕆D as the hyperbola. That is because these pairs change at the same rate, if E𝕐 doubles then so does +𝕆D from the inverse law. This allows for E𝔸-𝕆D giving a hyperbola so that E𝔸 can double and -𝕆D can halve, it means that they deviate from each other.

Leaving an atom and returning

The -𝕠d and e𝕪 Pythagorean Triangle can absorb enough photons to leave an atom in a hyperbolic trajectory. This appears as E𝔸 doubling for example, then -𝕆D halving to equal a constant k. for this hyperbolic trajectory to occur, the -𝕠d and e𝕪 Pythagorean Triangle separates from the +𝕠d and e𝕒 Pythagorean Triangle with this photon absorption. Conversely for an electron to be captured into circular geometry it loses E𝕐/-𝕠d kinetic impulse.

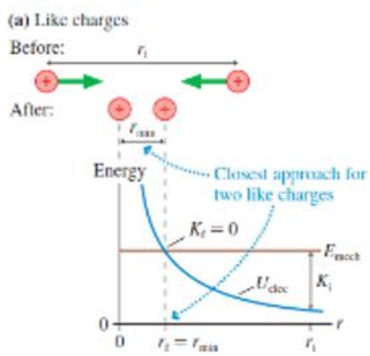
Uncertainty and conic sections

The circle and hyperbola are then observed and measured by impulse and work, not from both sides of a Pythagorean Triangle at the same time and position. This leads to the uncertainty principle, only one Pythagorean Triangle side can be squared so an observation leads to uncertainty with probabilities. A measurement leads to uncertainty of position and impulse.

Sweeping out conic sections

The +𝕠d and e𝕒 Pythagorean Triangle is in circular geometry, it can sweep out a circle by rotating. The -𝕠d and e𝕪 Pythagorean Triangle is in hyperbolic geometry, it can sweep out a hyperbola with its tangent as the Pythagorean Triangle sides change inversely to each other. Together they have ellipses and parabolas as paths between them.

FIGURE 25.8 The potential-energy diagrams for two like charges and two opposite charges.



Charged-Particle Interactions

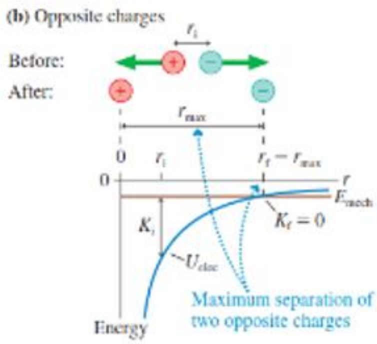
FIGURE 25.8a shows the potential-energy curve—a hyperbola—for two like charges as a function of the distance r between them. Also shown is the total energy line for two charged particles shot toward each other with equal but opposite momenta.

You can see that the total energy line crosses the potential-energy curve at r_{min}. This is a turning point. The two charges gradually slow down, because of the repulsive force between them, until the distance separating them is r_{min}. At this point, the kinetic energy is zero and both particles are instantaneously at rest. Both then reverse direction and move apart, speeding up as they go. r_{min} is the *distance of closest approach.*

Two opposite charges are a little trickier because of the negative energies. Negative total energies seem troubling at first, but they characterize *bound systems.* **FIGURE 25.8b** shows two oppositely charged particles shot apart from each other with equal but opposite momenta. If $E_{mech} < 0$, as shown, then their total energy line crosses the potential-energy curve at r_{max}. That is, the particles slow down, lose kinetic energy, reverse directions at *maximum separation* r_{max}, and then "fall" back together. They cannot escape from each other. Although moving in three dimensions rather than one,

Like charge hyperbolas

In this model the attraction of the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle is also a hyperbola, then they go into circular geometry where the electron orbits the proton. Conversely to this the electron might absorb enough photons to go into a hyperbolic trajectory away from the proton.



the electron and proton of a hydrogen atom are a realistic example of a bound system, and their mechanical energy is negative.

Two oppositely charged particles *can* escape from each other if $E_{mech} > 0$. They'll slow down, but eventually the potential energy vanishes and the particles still have kinetic energy. The threshold condition for escape is $E_{mech} = 0$, which will allow the particles to reach infinite separation $(U \rightarrow 0)$ at infinitesimally slow speed $(K \rightarrow 0)$. The initial speed that gives $E_{mech} = 0$ is called the *escape speed*.

NOTE Real particles can't be infinitely far apart, but because U_{elec} decreases with distance, there comes a point when $U_{elec} = 0$ is an excellent approximation. Two charged particles for which $U_{elec} \approx 0$ are sometimes described as "far apart" or "far away."

Work is conserved from Pythagorean Triangle areas

In this model work is conservative because the Pythagorean Triangle areas are conserved. With an e𝕒 altitude path as a series of e𝕒 potential positions, the +𝕆D probability decreases as a square on both sides. Because these alternate paths can be paired as symmetric on both sides, these cancel out destructively. That leaves the most +𝕆D potentially probable path as a straight-line.

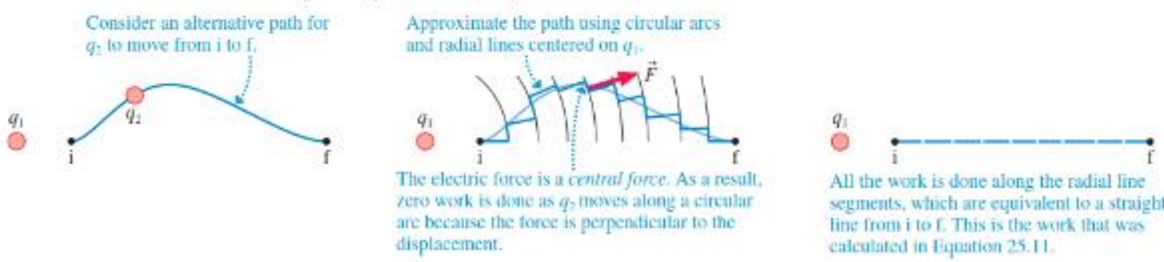
Spin cancels destructively

This can be broken up into arcs as below, the e𝕒 potential positions have an associate +𝕠d potential spin to either side. When this is measured as a +𝕆D potential probability it cancels destructively leaving the straight-line e𝕒. This also happens because a straight Pythagorean Triangle ruler or scale might be straight. If it was curved then it would not be a ruler only, or it would be a spin Pythagorean Triangle side.

The Electric Force Is a Conservative Force

Potential energy can be defined only if the force is *conservative*, meaning that the work done on the particle as it moves from position i to position f is independent of the path followed between i and f. **FIGURE 25.9** demonstrates that electric force is indeed conservative.

FIGURE 25.9 The work done on q_2 is independent of the path from i to f.



Adding spin to give circular or hyperbolic paths

In this model potential energy from the +𝕠d and e𝕒 Pythagorean Triangle is reactive only, with the kinetic energy from the -𝕠d and e𝕪 Pythagorean Triangle being active. When compared they are added together, when the addition is positive then a negative charge is in an orbital. When negative the electron is in free space, if it has enough e𝕪/-𝕠d kinetic velocity it can remain away from the proton in a hyperbolic trajectory. If not then it returns to the positive charge in circular geometry.

Multiple point charges

Multiple points charges can be measured with +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, they can also be observed as collisions with the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

Multiple Point Charges

If more than two charges are present, their potential energy is the sum of the potential energies due to all pairs of charges:

$$U_{\text{elec}} = \sum_{i<j} \frac{Kq_i q_j}{r_{ij}} \qquad (25.15)$$

where r_{ij} is the distance between q_i and q_j. The summation contains the $i < j$ restriction to ensure that each pair of charges is counted only once.

NOTE For energy conservation problems, it's necessary to calculate only the potential energy for those pairs of charges for which the distance r_{ij} changes. The potential energy of any pair that doesn't move is an additive constant with no physical consequences.

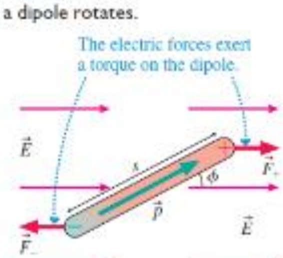
Torque as hands on a clock gauge

In this model work is associated with torque, +𝕆D×e𝕒 potential work has a +𝕆D potential probability that can be measured with changes in e𝕒 positions. The +𝕆D potential torque is like the turning of hands on a potential clock gauge. A time on this gauge would be used to observe time in the E𝔸/+𝕠d potential impulse.

Duration and moments

The duration between a starting and final instant would be from the +𝕆D potential torque, the hand must accelerate with torque to move and then decelerate to a final +𝕠d potential time. That can also be referred to as a +𝕆D potential moment, similar to the use in conventional physics.

FIGURE 25.13 The electric field does work as a dipole rotates.



25.3 The Potential Energy of a Dipole

The electric dipole has been our model for understanding how charged objects interact with neutral objects. In Chapter 23 we found that an electric field exerts a *torque* on a dipole. We can complete the picture by calculating the potential energy of an electric dipole in a uniform electric field.

FIGURE 25.13 shows a dipole in an electric field $\vec{E}$. Recall that the dipole moment $\vec{p}$ is a vector that points from $-q$ to q with magnitude $p = qs$. The forces $\vec{F}_+$ and $\vec{F}_-$ exert a torque on the dipole, but now we're interested in calculating the *work* done by these forces as the dipole rotates from angle ϕ_i to angle ϕ_f.

Angular displacement as torque

In this model displacement refers to a straight-line change such as E𝔸 in the E𝔸/+𝕠d potential impulse. An angular displacement would be the potential or gravitational torque, this angular change occurs in circular geometry. The +𝕆D×e𝕒 potential work here is through sinθ because θ is opposite the spin Pythagorean Triangle side. This would not use cosθ because that is with impulse, it is the inverse of sinθ when the Pythagorean Triangle area is constant for a given angle θ. The term angular displacement would not be used here, angular implies spin and displacement here impies straight-line motion.

When a force component F_s acts through a small displacement ds, the force does work $dW = F_s ds$. If we exploit the rotational-linear motion analogy from Chapter 12, where torque τ is the analog of force and angular displacement $\Delta\phi$ is the analog of linear displacement, then a torque acting through a small angular displacement $d\phi$ does work $dW = \tau\, d\phi$. From Chapter 23, the torque on the dipole in Figure 25.13 is $\tau = -pE\sin\phi$, where the minus sign is due to the torque trying to cause a clockwise rotation. Thus the work done by the electric field on the dipole as it rotates through the small angle $d\phi$ is

$$dW_{elec} = -pE\sin\phi\, d\phi \qquad (25.16)$$

The total work done by the electric field as the dipole turns from ϕ_i to ϕ_f is

$$W_{elec} = -pE\int_{\phi_i}^{\phi_f}\sin\phi\, d\phi = pE\cos\phi_f - pE\cos\phi_i \qquad (25.17)$$

The rolling wheel and sine waves

In this model the +𝕆D×e𝕒 potential work is not the same as the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, though it is contained in the formula. The rolling wheel model gives a sine wave as the dipole turns, that is traced out by a point on the rolling wheel at the end of the e𝕒 spoke.

The potential energy associated with the work done on the dipole is

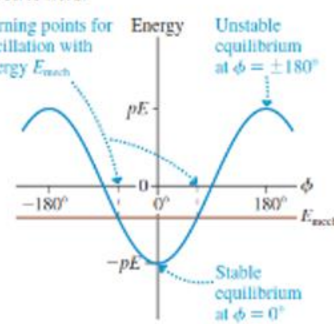
$$\Delta U_{dipole} = U_f - U_i = -W_{elec}(i \to f) = -pE\cos\phi_f + pE\cos\phi_i \qquad (25.18)$$

By comparing the left and right sides of Equation 25.18, we see that the potential energy of an electric dipole $\vec{p}$ in a uniform electric field $\vec{E}$ is

$$U_{dipole} = -pE\cos\phi = -\vec{p}\cdot\vec{E} \qquad (25.19)$$

FIGURE 25.14 shows the energy diagram of a dipole. The potential energy is minimum at $\phi = 0°$ where the dipole is aligned with the electric field. This is a point of stable equilibrium. A dipole exactly opposite $\vec{E}$, at $\phi = \pm 180°$, is at a point of unstable equilibrium. Any disturbance will cause it to flip around. A frictionless dipole with mechanical energy E_{mech} will oscillate back and forth between turning points on either side of $\phi = 0°$.

FIGURE 25.14 The energy of a dipole in an electric field.



The electric potential

In this model the electric field is e𝕒 straight-line vectors, they measure the +𝕠d potential magnetic field which makes the actual integral field. This is a multiplication, division only occurs with impulse. The E⃗ is the e𝕒 altitude, this is multiplied by the charge in +𝕠d×e𝕒/+𝕠d potential Coulombs to give +𝕠d×E𝔸/+𝕠d which contains the E𝔸/+𝕠d potential impulse. When the inverse of e𝕒 is used as the +𝕠d potential magnetic field, this gives +𝕠d×e𝕒/+𝕆D in Newtons.

25.4 The Electric Potential

We introduced the concept of the *electric field* in Chapter 22 because action at a distance raised concerns and difficulties. The field provides an intermediary through which two charges exert forces on each other. Charge q_1 somehow alters the space around it by creating an electric field $\vec{E}_1$. Charge q_2 then responds to the field, experiencing force $\vec{F} = q_2\vec{E}_1$.

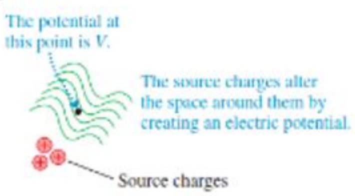
In defining the electric field, we separated the charges that are the *source* of the field from the charge *in* the field. The force on charge q is related to the electric field of the source charges by

force on q by sources = [charge q] × [alteration of space by the source charges]

The potential is reactive

The potential energy here comes from the positive charge, it is a potential because it does not have active forces. This electric potential is in volts, that comes from the +𝕆D potential difference in this model. Here this would be 1/+𝕠d because it weakens further from the positive charge and is not being measured as a force. The potential energy would be +𝕠d×e𝕒/+𝕆D in Newtons, when q as +𝕠d×e𝕒/+𝕠d is divided into this it gives 1/+𝕠d.

FIGURE 25.15 Source charges alter the space around them by creating an electric potential.



Let's try a similar procedure for the potential energy. The electric potential energy is due to the interaction of charge q with other charges, so let's write

potential energy of q + sources

= [charge q] × [*potential* for interaction with the source charges]

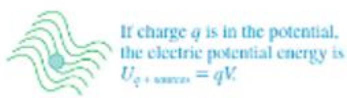
FIGURE 25.15 shows this idea schematically.

In analogy with the electric field, we will define the **electric potential** V (or, for brevity, just *the potential*) as

$$V = \frac{U_{q + \text{sources}}}{q} \qquad (25.20)$$

Potential magnetic field

The +𝕠d potential magnetic field is the potential in conventional physics, it is a property of the source positive charge because the +𝕠d and e𝕒 Pythagorean Triangle has an e𝕒 potential electric flux and the +𝕠d potential.



Charge q is used as a probe to determine the electric potential, but the value of V is *independent of q*. **The electric potential, like the electric field, is a property of the source charges.** And, like the electric field, the electric potential fills the space around the source charges. It is there whether or not another charge is there to experience it.

In practice, we're usually more interested in knowing the potential energy if a charge q happens to be at a point in space where the electric potential of the source charges is V. Turning Equation 25.20 around, we see that the electric potential energy is

$$U_{q+\text{sources}} = qV \tag{25.21}$$

The potential volt

In this model that would be the 1/+𝕠d potential volt, when measured this is the 1/+𝕆D potential difference as it weakens with a higher e𝕒 altitude according to the inverse square law. The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy is in joules, when divided by the +𝕠d×e𝕒/+𝕠d potential Coulombs this gives e𝕒/+𝕠d, the potential 1/+𝕠d is measured in +𝕆D×e𝕒 potential work as a square.

Joules and energy

Joules as the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy are not used here, they are a combination of +𝕆D×e𝕒 potential work and the E𝔸/+𝕠d potential impulse. From the +𝕠d×e𝕒/+𝕠d potential momentum or Coulombs, this 1/+𝕠d gives a force=ma in Newtons as +𝕠d×e𝕒/+𝕆D. The force here is 1/+𝕆D as the potential difference in a circuit, according to this model.

Potential electric flux

The electric potential is like the e𝕒 potential electric flux as a single Pythagorean Triangle side. The spin Pythagorean Triangle side is the potential, together that gives the e𝕒/+𝕠d potential speed of a charge when there is no force.

Once the potential has been determined, it's very easy to find the potential energy.

The unit of electric potential is the joule per coulomb, which is called the **volt** V:

$$1 \text{ volt} = 1 \text{ V} \equiv 1 \text{ J/C}$$

This unit is named for Alessandro Volta, who invented the electric battery in the year 1800. Microvolts (μV), millivolts (mV), and kilovolts (kV) are commonly used units.

The potential and kinetic difference

In this model the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy is named from the +𝕠d and e𝕒 Pythagorean Triangle associated with the potential. The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy is named in association with kinetics. It is used to measure a charged particle accelerating or decelerating with +𝕆D×e𝕒 potential work here, the +𝕆D potential difference in a battery's positive terminal accelerates charges in a circuit with the -𝕆D kinetic difference.

Potential and kinetic energies are inverses

The ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy are inverses of each other, the motion of a charge causes one to increase and the other to inversely decrease. When a positive charge moves into an area of higher electric potential as 1/+𝕠d it potentially decelerates as e𝕒/+𝕆D.

Using the Electric Potential

The electric potential is an abstract idea, and it will take some practice to see just what it means and how it is useful. We'll use multiple representations—words, pictures, graphs, and analogies—to explain and describe the electric potential.

NOTE It is unfortunate that the terms *potential* and *potential energy* are so much alike. Despite the similar names, they are very different concepts and are not interchangeable. TABLE 25.1 will help you to distinguish between the two.

TABLE 25.1 Distinguishing electric potential and potential energy

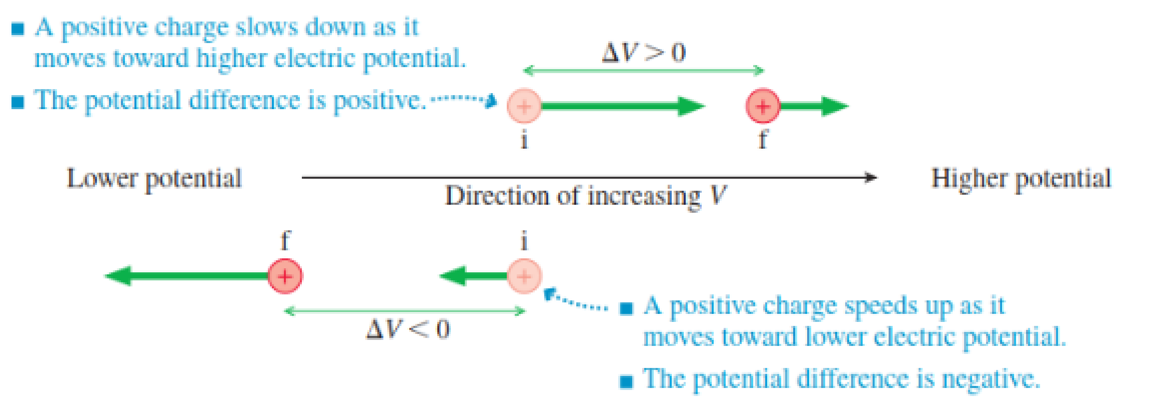
The *electric potential* is a property of the source charges and, as you'll soon see, is related to the electric field. The electric potential is present whether or not a charged particle is there to experience it. Potential is measured in J/C, or V.
The *electric potential energy* is the interaction energy of a charged particle with the source charges. Potential energy is measured in J.

Basically, knowing the electric potential in a region of space allows us to determine whether a charged particle speeds up or slows down as it moves through that region. FIGURE 25.16 illustrates this idea. Here a group of source charges, which remains hidden offstage, has created an electric potential V that increases from left to right. A charged particle q, which for now we'll assume to be positive, has electric potential energy $U = qV$. If the particle moves to the right, its potential energy increases and so, by energy conservation, its kinetic energy must decrease. **A positive charge slows down as it moves into a region of higher electric potential.**

The potential difference and acceleration

The positive charge does +𝕆D×e𝕒 potential work in in moving through the +𝕆D potential difference and -𝕆D kinetic difference. This gives a potential acceleration in Newtons from F=ma, with +𝕠d×e𝕒/+𝕆D proportional to +𝕚d×e𝕙/+𝕀D. Because +𝕚d is the gravitational mass, this is proportional to +𝕠d as the kinetic mass here as m in F=ma.

FIGURE 25.16 A charged particle speeds up or slows down as it moves through a potential difference.



No transformation of potential to kinetic energy

In this model there is not a transformation of potential to kinetic energy. Instead the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle are inverses, one increases with work for example and the other inversely decreases. When the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy are used, the numerators and denominators are inverses. That is because if the -𝕆D kinetic difference increases then the E𝕐 kinetic displacement decreases, the +𝕆D potential difference decreases but the E𝔸 potential displacement increases. This balances the change in work with a change in impulse.

It is customary to say that the particle moves through a **potential difference** $\Delta V = V_f - V_i$. The potential difference between two points is often called the **voltage.** The particle moving to the right moves through a positive potential difference ($\Delta V > 0$ because $V_f > V_i$), so we can say that a positively charged particle slows down as it moves through a positive potential difference.

The particle moving to the left in Figure 25.16 travels in the direction of decreasing electric potential—through a negative potential difference—and is losing potential energy. It speeds up as it transforms potential energy into kinetic energy. A negatively charged particle would slow down because its potential energy qV would increase as V decreases. TABLE 25.2 summarizes these ideas.

If a particle moves through a potential difference ΔV, its electric potential energy changes by $\Delta U = q\Delta V$. We can write the conservation of energy equation in terms of the electric potential as $\Delta K + \Delta U = \Delta K + q\Delta V = 0$ or, as is often more practical,

$$K_f + qV_f = K_i + qV_i \qquad (25.22)$$

Conservation of energy is the basis of a powerful problem-solving strategy.

TABLE 25.2 Charged particles moving in an electric potential

	Electric potential	
	Increasing ($\Delta V > 0$)	Decreasing ($\Delta V < 0$)
+ charge	Slows down	Speeds up
− charge	Speeds up	Slows down

Magnetic flux

In this model the $\vec{E}$ flux is e𝕒 with the positive charge and e𝕪 with the negative charge. This is changed to use a magnetic flux here, according to this model. Newtons are +𝕠d×e𝕒/+𝕆D so that when divided by the potential Coulombs or potential momentum +𝕠d×e𝕒/+𝕠d this leaves 1/+𝕠d. Because e𝕒 and 1/+𝕠d are inverses they are interchangeable as electricity and magnetism, this allows F=ma to measure a field with +𝕆D×e𝕒 potential work.

Potential mass

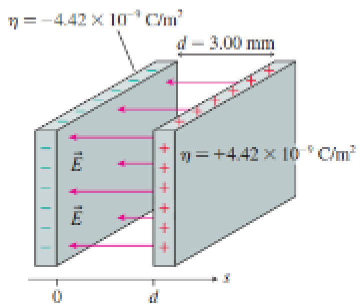
The potential surface charge density is +𝕠d×e𝕒/+𝕠d ×1/E𝔸, times e𝕒 as ϵ gives +𝕠d/+𝕠d, that is a ratio of the +𝕠d potential mass to the potential magnetic flux. This gives 1/+𝕠d because the potential mass is a constant here. As this surface charge changes in density the potential mass would also change here with the different numbers of protons, but this is assumed to be constant in the diagram. With Newtons per Coulomb the +𝕠d potential mass is factored out.

Energy changes with work and impulse

Here s changes as the e𝕒 altitude from the positive plate, this causes the E𝔸/+𝕠d potential impulse to change as a square and the +𝕆D×e𝕒 potential work to change inversely as a square. That makes the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy change according to the equation.

25.5 The Electric Potential Inside a Parallel-Plate Capacitor

FIGURE 25.18 A parallel-plate capacitor.



We began this chapter with the potential energy of a charge inside a parallel-plate capacitor. Now let's investigate the electric potential. FIGURE 25.18 shows two parallel electrodes, separated by distance d, with surface charge density $\pm\eta$. As a specific example, we'll let $d = 3.00$ mm and $\eta = 4.42 \times 10^{-9}$ C/m^2. The electric field inside the capacitor, as you learned in Chapter 23, is

$$\vec{E} = \left(\frac{\eta}{\epsilon_0}, \text{ from positive toward negative}\right) = (500 \text{ N/C, from right to left}) \qquad (25.23)$$

This electric field is due to the *source charges* on the capacitor plates.

The electric potential at all points

In this model qEs is +𝕠d×e𝕒/+𝕠d × e𝕒/+𝕠d because the electric flux is now the magnetic flux as a field. This gives the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy without the ½ factor. The e𝕒 altitude and e𝕪 kinetic electric charge or yard exist at all positions or points in the capacitor, they are measured as +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work.

In Section 25.1, we found that the electric potential energy of a charge q in the uniform electric field of a parallel-plate capacitor is

$$U_{elec} = U_{q + \text{sources}} = qEs \qquad (25.24)$$

We've set the constant term U_0 to zero. U_{elec} is the energy of q interacting with the source charges on the capacitor plates.

Our new view of the interaction is to separate the role of charge q from the role of the source charges by defining the electric potential $V = U_{q + \text{sources}}/q$. Thus the electric potential inside a parallel-plate capacitor is

$$V = Es \qquad \text{(electric potential inside a parallel-plate capacitor)} \qquad (25.25)$$

where s **is the distance from the *negative* electrode.** The electric potential, like the electric field, exists at *all points* inside the capacitor. The electric potential is created by the source charges on the capacitor plates and exists whether or not charge q is inside the capacitor.

Potential speed and kinetic velocity

In this model the +𝕆D potential difference, and the -𝕆D kinetic difference is between the two plates. This allows +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work to be done. Here E is 1/+𝕠d and 1/-𝕠d as the potential magnetic field and the kinetic magnetic field respectively. The motion from the negative plate to the positive plate is e𝕒/+𝕠d as the potential speed and e𝕪/-𝕠d as the kinetic velocity.

Linear change between the voltage

Because these are the potential and kinetic difference, they can have e𝕒 and e𝕪 inverted to give 1/+𝕆D and 1/-𝕆D. This gives a linear change between them because the +𝕆D potential difference or probability is the inverse of the -𝕆D kinetic difference or probability. This also occurs if they are again inverted to give the E𝔸 potential displacement and the E𝕐 kinetic displacement in the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

A current is not a force

It is also linear if they remain as the e𝕒/+𝕠d potential speed and e𝕪/-𝕠d kinetic velocity. This is why a current in a wire has a e𝕪/-𝕠d kinetic velocity not an accelerating force.

FIGURE 25.19 illustrates the important point that the electric potential increases linearly from the negative plate, where $V_- = 0$, to the positive plate, where $V_+ = Ed$. Let's define the *potential difference* ΔV_C between the two capacitor plates to be

$$\Delta V_C = V_+ - V_- = Ed \qquad (25.26)$$

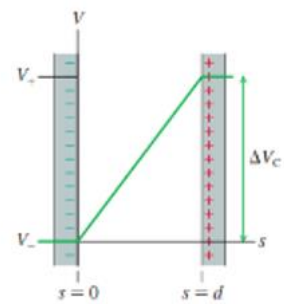
In our specific example, $\Delta V_C = (500\ \text{N/C})(0.0030\ \text{m}) = 1.5\ \text{V}$. The units work out because $1.5\ (\text{N m})/\text{C} = 1.5\ \text{J/C} = 1.5\ \text{V}$.

NOTE People who work with circuits would call ΔV_C "the voltage across the capacitor" or simply "the capacitor voltage."

Equation 25.26 has an interesting implication. Thus far, we've determined the electric field inside a capacitor by specifying the surface charge density η on the plates. Alternatively, we could specify the capacitor voltage ΔV_C (i.e., the potential difference between the capacitor plates) and then determine the electric field strength as

$$E = \frac{\Delta V_C}{d} \qquad (25.27)$$

FIGURE 25.19 The electric potential of a parallel-plate capacitor increases linearly from the negative to the positive plate.



Work and voltage

In (25.27) above, E comes from +𝕆D and -𝕆D, the d distance is e𝕒 in +𝕆D×e𝕒 potential work and e𝕪 in -𝕆D×e𝕪 kinetic work as volts per meter. The e𝕒 and e𝕪 positions can be inverted with a change of scale, for example if they were numerators as millimeters then they would be in the denominator as meters. Also millimeters can be defined as 1/1,000,000m so this is the same with for example volts per millimeter.

Duality of slopes and areas

The +𝕆D×e𝕒 potential work can be rewritten as +𝕆D/+𝕠d to give +𝕠d, that is the same as Newtons per Coulomb. The Pythagorean Triangle sides are inverted because the electromagnetic flux is referred to as electric in some areas, but is a magnetic flux with Newtons. It also becomes +𝕠d potential time in e𝕒/+𝕆D as meters/second^2. In this model Pythagorean Triangles are derivatives and integrals when not measured or observed, this duality comes from a Pythagorean Triangle having a slope and an area.

Numerators and denominators

That means +𝕠d×e𝕒 is an integral area while e𝕒/+𝕠d is a derivative slope, the +𝕠d Pythagorean Triangle side changed from the numerator to the denominator with no difference in the Pythagorean Triangle itself. When the +𝕆D potential difference is measured as +𝕆D×e𝕒 potential work, this comes from +𝕠d×e𝕒 here as an integral, but in conventional physics it comes from e𝕒/+𝕆D as the acceleration in F=ma. Here this can be rewritten so that 1/+𝕆D is E𝔸, and e𝕒 is

1/+𝕠d so that E𝔸/+𝕠d has a particle/wave duality with e𝕒/+𝕆D. This is like e𝕒/+𝕆D in meters/second^2 being equivalent to E𝔸/+𝕠d in meters^2/second.

Electromagnetism as work and impulse

The forces are equivalent but different because one is the E𝔸/+𝕠d potential impulse observed in +𝕠d potential time. The other is +𝕆D×e𝕒 potential work measured on an e𝕒 ruler or scale. Together they make a potential electromagnetism.

In fact, this is how E is determined in practical applications because it's easy to measure ΔV_C with a voltmeter but difficult, in practice, to know the value of η.

Equation 25.27 implies that the units of electric field are volts per meter, or V/m. We have been using electric field units of newtons per coulomb. In fact, as you can show as a homework problem, these units are equivalent to each other. That is,

$$1 \text{ N/C} = 1 \text{ V/m}$$

The potential changes linearly

The electric potential is the +𝕆D potential difference and the -𝕆D kinetic difference, that is the changing distances as e𝕒/e𝕪 × +𝕆D/-𝕆D. This is the +𝕆D×e𝕒 potential work divided by the -𝕆D×e𝕪 kinetic work which are inverses, the two probabilities or differences are inverses to give a linear change.

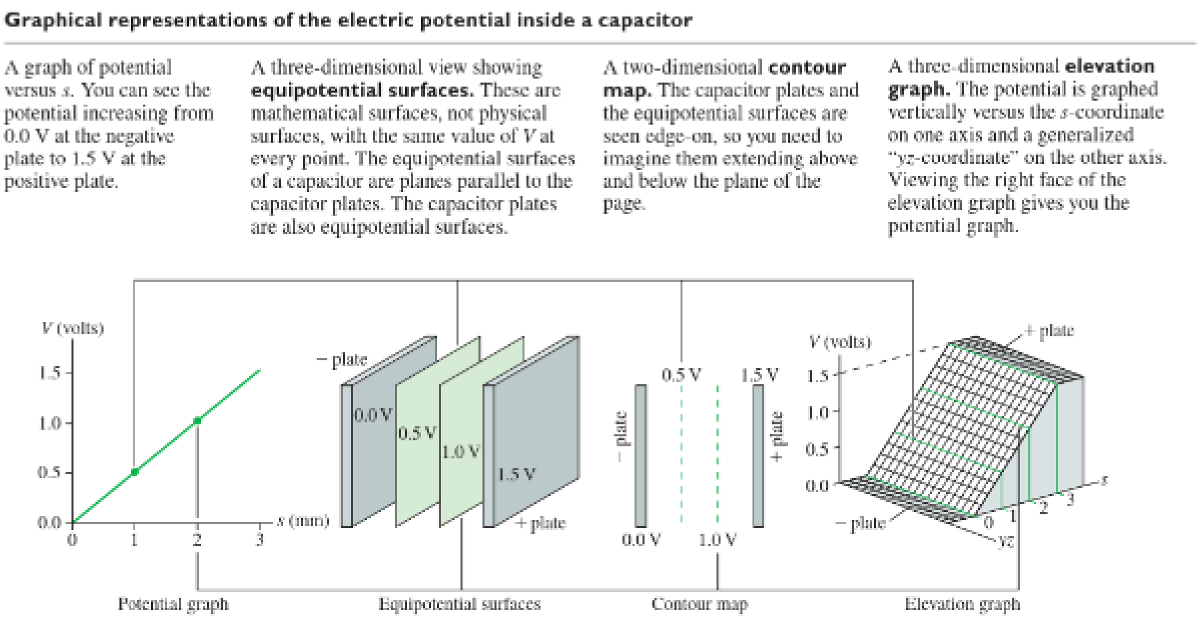
Returning to the electric potential, we can substitute Equation 25.27 for E into Equation 25.25 for V. Thus the electric potential inside the capacitor is

$$V = Es = \frac{s}{d}\Delta V_C \qquad (25.28)$$

The potential increases linearly from $V_- = 0$ V at the negative plate ($s = 0$) to $V_+ = \Delta V_C$ at the positive plate ($s = d$).

Voltage as a probability

The graph below shows s changing on one axis, this would be e𝕒 for the +𝕠d and e𝕒 Pythagorean Triangle. The vertical axis is the +𝕠d potential magnetic field which is being measured as the +𝕆D potential difference or probability. Voltage in this model is the same as a probability, if a positive charge is more likely to change its e𝕒 position then it moves with a +𝕆D squared force. That means its wave function is measured as a +𝕆D potential probability. When this collapses into a particle the inverse E𝔸/+𝕠d potential impulse is observed.



One dimensional contours

In this model a straight Pythagorean Triangle side is one dimensional not three dimensional. A squared spin Pythagorean Triangle side is two dimensional as an area, but this has no straight dimensions so an area is not the same as a field. E𝔸 would be a force vector in one dimension, it would not be an area as meters^2, so here one dimension per Pythagorean Triangle side gives all changes and forces.

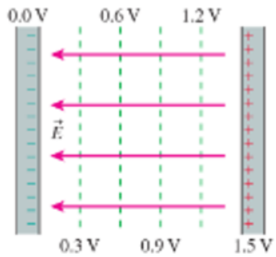
Two straight-line dimensions

There are two dimensions because e𝕪 as a straight Pythagorean Triangle side is the inverse of e𝕒 when they interact. In Biv space-time the proportional dimensions are the e𝕙 height and the e𝕧 length. These are orthogonal because if not then e𝕒 would contain part of e𝕙, for example an elliptical orbit would not have a e𝕧 length changing at a non-right angle to the e𝕙 height. Instead, the e𝕙 height changes from the middle of a planet, the e𝕧 length orthogonal to this changes inversely so the ellipse is traced out.

Points as positions

The +𝕆D potential voltage is measured every .3 volts here on an e𝕒 scale, inversely to this is -𝕆D kinetic voltage is measured on a e𝕪 scale. Here every point would be a position.

FIGURE 25.20 Equipotentials and electric field vectors inside a parallel-plate capacitor.



These four graphical representations show the same information from different perspectives, and the connecting lines help you see how they are related. If you think of the elevation graph as a "mountain," then the contour lines on the contour map are like the lines of a topographic map.

The potential graph and the contour map are the two representations most widely used in practice because they are easy to draw. Their limitation is that they are trying to convey three-dimensional information in a two-dimensional presentation. When you see graphs or contour maps, you need to imagine the three-dimensional equipotential surfaces or the three-dimensional elevation graph.

There's nothing special about showing equipotential surfaces or contour lines every 0.5 V. We chose these intervals because they were convenient. As an alternative, **FIGURE 25.20** shows how the contour map looks if the contour lines are spaced every 0.3 V. Contour lines and equipotential surfaces are *imaginary* lines and surfaces drawn to help us visualize how the potential changes in space. Drawing the map more than one way reinforces the idea that there is an electric potential at *every* point inside the capacitor, not just at the points where we happened to draw a contour line or an equi-

Potential proportional to gravity

In this model the positive charge would be downhill from the negative charge. This makes it proportional to gravity as downhill and inertia as uphill. With Coulombs/meter^2 this means there are different numbers of protons and electrons on the positive and negative plates respectively.

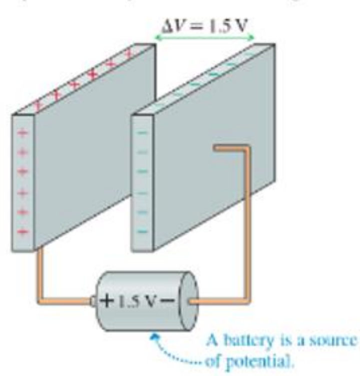
No areas of probability

Here this is given as an area, but in this model there are no areas bound by straight-line vectors. Instead +𝕆D would be the potential probability, with more charge there would be a squared increase in probability proportional to the area.

Changing areas as probability

If the area increased by doubling each side there would be 4 times the area. This would be an increase of +𝕠d being doubled on each side with more room for protons, then there would be a +𝕆D potential difference 4 times larger as well.

FIGURE 25.21 Using a battery to charge a capacitor to a precise value of ΔV_C.



potential surface.

Figure 25.20 also shows the electric field vectors. Notice that

- The electric field vectors are perpendicular to the equipotential surfaces.
- The electric field points in the direction of decreasing potential. In other words, the electric field points "downhill" on a graph or map of the electric potential.

Chapter 26 will present a more in-depth exploration of the connection between the electric field and the electric potential. There you will find that these observations are always true. They are not unique to the parallel-plate capacitor.

Finally, you might wonder how we can arrange a capacitor to have a surface charge density of precisely 4.42×10^{-9} C/m^2. Simple! As **FIGURE 25.21** shows, we use wires to attach 3.00-mm-spaced capacitor plates to a 1.5 V battery. This is another topic that we'll explore in Chapter 26, but it's worth noting now that **a battery is a source of potential.** That's why batteries are labeled in volts, and it's a major reason we need to thoroughly understand the concept of potential.

Difference ratios

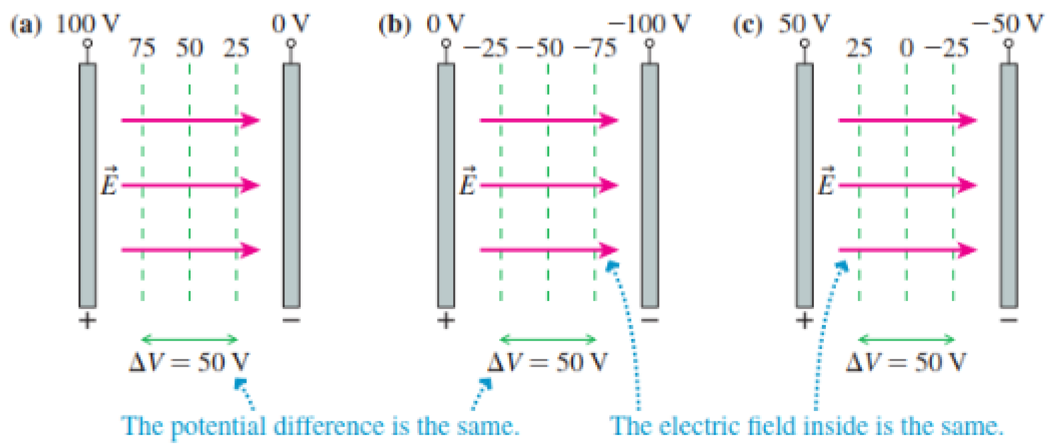
In this model there is no zero point, that would mean a Pythagorean Triangle had a zero sized straight Pythagorean Triangle side at some point between the plates. The +𝕠d and e𝕒 Pythagorean Triangle comes from the center of the proton, the -𝕠d and e𝕪 Pythagorean Triangle from the point sized electron. Instead of 100V and 0V, here this would be +𝕆50 and -𝕆50 where each has an equivalent difference to the other in the middle. It could also be for example +𝕆75 and -𝕆25.

In writing the electric potential inside a parallel-plate capacitor, we made the choice that $V_- = 0$ V at the negative plate. But that is not the only possible choice. **FIGURE 25.24** on the next page shows three parallel-plate capacitors, each having the same capacitor voltage $\Delta V_C = V_+ - V_- = 100$ V, but each with a different choice for the location of the zero point of the electric potential. Notice the *terminal symbols* (lines with small circles at the end) showing how the potential, from a battery or a power supply, is applied to each plate; these symbols are common in electronics.

Difference as duration

The +𝕆D potential difference and the -𝕆D kinetic differences are the same, when this is measured at different e𝕒 and e𝕪 positions these change as squares. That is because a difference here is a duration in between a starting and final spin Pythagorean Triangle side instant. The duration between the examples below is the same though the +𝕠d and -𝕠d values change as instants.

FIGURE 25.24 These three choices for $V = 0$ represent the same physical situation. These are contour maps, showing the edges of the equipotential surfaces.



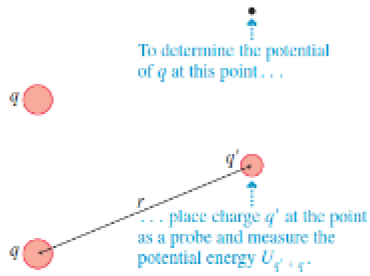
The important thing to notice is that the three contour maps in Figure 25.24 represent the *same physical situation*. The potential difference between any two points is the same in all three maps. The electric field is the same in all three. We may *prefer* one of these figures over the others, but there is no measurable physical difference between them.

Measuring the electric potential as work

In this model the electric potential would be q/r or +𝕠d×e𝕒/+𝕠d ×1/e𝕒 for the positive charge. That gives e𝕒 as the constant potential mass, this is ignored as a change when the charge fluctuates in the diagram below. That leaves e𝕒/+𝕠d or 1/+𝕆D as the potential difference. This would also be +𝕆D if it began from r/q because the potential momentum can be inverted as well. E𝕒/+𝕠d is proportional to e𝕙/+𝕚d or meters/second, this is the same when inverted as seconds/meter. As r changes here with 1/+𝕆D this changes as a square giving the inverse square law.

25.6 The Electric Potential of a Point Charge

FIGURE 25.25 Measuring the electric potential of charge q.



Another important electric potential is that of a point charge. Let q in **FIGURE 25.25** be the source charge, and let a second charge q' probe the electric potential of q. The potential energy of the two point charges is

$$U_{q'+q} = \frac{1}{4\pi\epsilon_0}\frac{qq'}{r} \tag{25.29}$$

Thus, by definition, the electric potential of charge q is

$$V = \frac{U_{q'+q}}{q'} = \frac{1}{4\pi\epsilon_0}\frac{q}{r} \quad \text{(electric potential of a point charge)} \tag{25.30}$$

The potential of Equation 25.30 extends through all of space, showing the influence of charge q, but it weakens with distance as $1/r$. This expression for V assumes that we have chosen $V = 0$ V to be at $r = \infty$. This is the most logical choice for a point charge because the influence of charge q ends at infinity.

The expression for the electric potential of charge q is similar to that for the electric field of charge q. The difference most quickly seen is that V depends on $1/r$ whereas $\vec{E}$ depends on $1/r^2$. But it is also important to notice that **the potential is a scalar** whereas the field is a vector. Thus the mathematics of using the potential are much easier than the vector mathematics using the electric field requires.

For example, the electric potential 1.0 cm from a +1.0 nC charge is

$$V_{1\,\text{cm}} = \frac{1}{4\pi\epsilon_0}\frac{q}{r} = (9.0 \times 10^9\ \text{N m}^2/\text{C}^2)\,\frac{1.0 \times 10^{-9}\ \text{C}}{0.010\ \text{m}} = 900\ \text{V}$$

1 nC is typical of the electrostatic charge produced by rubbing, and you can see that such a charge creates a fairly large potential nearby. Why are we not shocked and injured

Elevation as a square

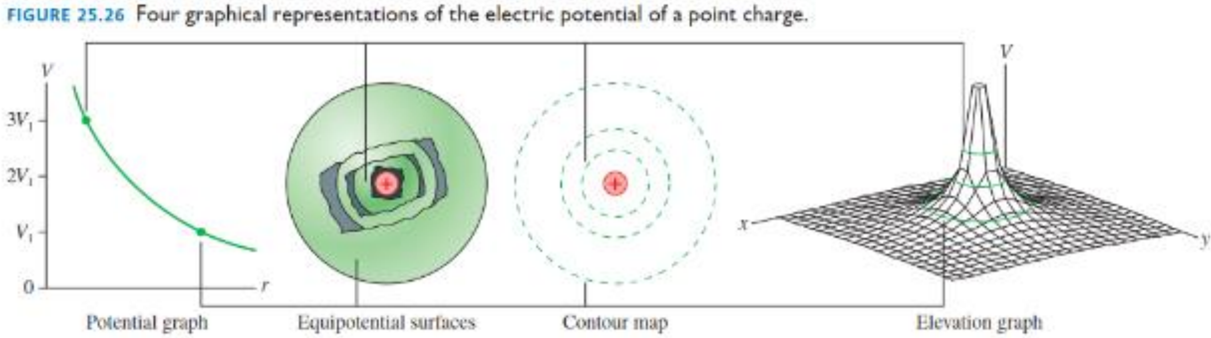
In this model the elevation changes as a +𝕆D square when the eⓐ altitude changes inversely to it. Closer to the center the eⓐ altitude is horizontal here not vertical, that means the +𝕆D potential probability increases as a square as eⓐ decreases linearly. This makes it more potentially probable for an electron to move closer to a proton with an inverse square law.

when working with the "high voltages" of such charges? The sensation of being shocked is a result of current, not potential. Some high-potential sources simply do not have the ability to generate much current. We will look at this issue in Chapter 28.

Visualizing the Potential of a Point Charge

FIGURE 25.26 shows four graphical representations of the electric potential of a point charge. These match the four representations of the electric potential inside a capacitor, and a comparison of the two is worthwhile. This figure assumes that q is positive; you may want to think about how the representations would change if q were negative.

FIGURE 25.26 Four graphical representations of the electric potential of a point charge.



The radius as the altitude

Here the radius R is the e𝕒 altitude of the positive charge, because of destructive interference this appears to come from the center. This has a total charge of +𝕆D×e𝕒 potential work as +𝕆D is the potential difference and e𝕒 is R.

The Electric Potential of a Charged Sphere

In practice, you are more likely to work with a charged sphere, of radius R and total charge Q, than with a point charge. Outside a uniformly charged sphere, the electric potential is identical to that of a point charge Q at the center. That is,

$$V = \frac{1}{4\pi\epsilon_0}\frac{Q}{r} \quad \text{(sphere of charge, } r \geq R\text{)} \qquad (25.31)$$

We can cast this result in a more useful form. It is customary to speak of charging an electrode, such as a sphere, "to" a certain potential, as in "Bob charged the sphere to a potential of 3000 volts." This potential, which we will call V_0, is the potential right on the surface of the sphere. We can see from Equation 25.31 that

$$V_0 = V(\text{at } r = R) = \frac{Q}{4\pi\epsilon_0 R} \qquad (25.32)$$

Consequently, a sphere of radius R that is charged to potential V_0 has total charge

$$Q = 4\pi\epsilon_0 R V_0 \qquad (25.33)$$

If we substitute this expression for Q into Equation 25.31, we can write the potential outside a sphere that is charged to potential V_0 as

$$V = \frac{R}{r}V_0 \quad \text{(sphere charged to potential } V_0\text{)} \qquad (25.34)$$

Equation 25.34 tells us that the potential of a sphere is V_0 on the surface and decreases inversely with the distance. The potential at $r = 3R$ is $\frac{1}{3}V_0$.

A *plasma ball* consists of a small metal ball charged to a potential of about 2000 V inside a hollow glass sphere. The electric field of the high-voltage ball is sufficient to cause a gas breakdown at this pressure, creating "lightning bolts" between the ball and the glass sphere.

Voltage and superposition

In this model the electric potential obeys superposition, this is because the +𝕆D and -𝕆D probabilities constructively and destructively interfere. When there is constructive interference between two unlike charges, that makes them more likely to come together as an opposing +𝕆D potential and -𝕆D kinetic difference. When there is destructive interference with like charges, they are more likely to separate. These would be summed as fields or probabilities, not as segments or areas. They would remain and integral ∫ not a sum of segments as Σ.

25.7 The Electric Potential of Many Charges

Suppose there are many source charges $q_1, q_2, \ldots$. The electric potential V at a point in space is the sum of the potentials due to each charge:

$$V = \sum_i \frac{1}{4\pi\epsilon_0} \frac{q_i}{r_i} \quad (25.35)$$

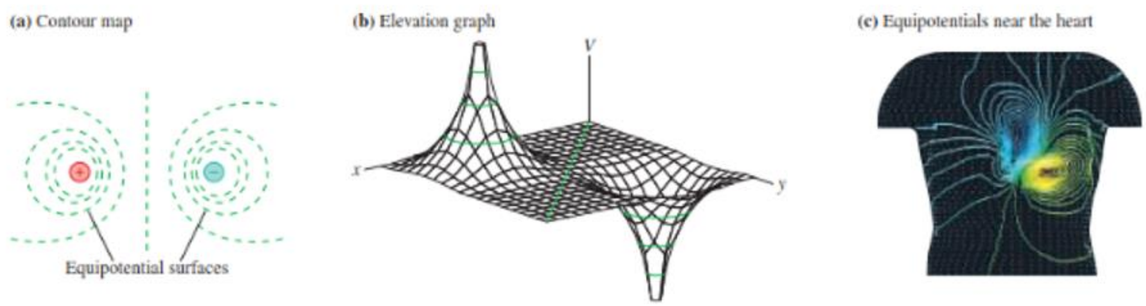
where r_i is the distance from charge q_i to the point in space where the potential is being calculated. In other words, **the electric potential, like the electric field, obeys the principle of superposition.**

As an example, the contour map and elevation graph in FIGURE 25.28 show that the potential of an electric dipole is the sum of the potentials of the positive and negative charges. Potentials such as these have many practical applications. For example, electrical activity within the body can be monitored by measuring equipotential lines on the skin. Figure 25.28c shows that the equipotentials near the heart are a slightly distorted but recognizable electric dipole.

Reversed elevation graph

The elevation graph below would be reversed in this model, the positive charge would be downhill as for example with an electron falling into a potential well to join an atom. It would move uphill to go to higher orbitals and leave the atom. In between there is constructive interference so the electron is attracted to the proton. As they get closer the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work give a +𝕆D potential torque and -𝕆D kinetic torque. This causes them to orbit each other, if they collided that would be the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

FIGURE 25.28 The electric potential of an electric dipole.



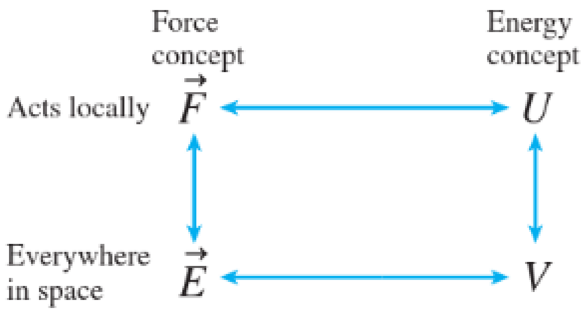
Potential and Field

Local and everywhere

In this model locally refers to a point of position from a straight Pythagorean Triangle side, everywhere from a spin Pythagorean Triangle side. Energy combines both in this model, the

½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy for example contains both the E𝕐/-𝕠d kinetic impulse as a local force and -𝕆D×e𝕪 kinetic work as an everywhere force.

FIGURE 26.1 The four key ideas.



The potential as e𝕪

In this model the force is F=ma as Newtons, that is -𝕠d×e𝕪/-𝕆D. Potential energy is reactive only, this would be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. The difference is 1/+𝕠d as the kinetic magnetic field or potential in (26.1).

Calculating the potential

The electric potential in (26.1) would be +𝕠d×e𝕒/-𝕆D in potential Newtons, when divided by q as +𝕠d×e𝕒/+𝕠d in potential Coulombs this gives 1/+𝕠d. This is also e𝕪 as the inverse, the two make an electromagnetic flux. In this model then the potential is e𝕪 when measured with -𝕆D×e𝕪 kinetic work, it is the E𝕐/-𝕠d kinetic impulse when observed.

The potential difference as torque

When 1/+𝕠d is measured this is the +𝕆D potential difference, the e𝕒 altitude is s below. That is the same as the integral in (26.2), the initial position here is instead an initial time and the final position is a final time. This motion can then be regarded as in between instants as a duration, that is a +𝕆D potential torque like in between the initial and final instant. Illustrating with a moving hand on a clock gauge, there is an initial instant then a torque accelerating and decelerating to the final instant.

26.1 Connecting Potential and Field

FIGURE 26.1 shows the four key ideas of force, field, potential energy, and potential. The electric field and the electric potential were based on force and potential energy. We know, from Chapters 9 and 10, that force and potential energy are closely related. The focus of this chapter is to establish a similar relationship between the electric field and the electric potential. **The electric potential and electric field are not two distinct entities but, instead, two different perspectives or two different mathematical representations of how source charges alter the space around them.**

If this is true, we should be able to find the electric potential from the electric field. Chapter 25 introduced all the pieces we need to do so. We used the potential energy of charge q and the source charges to define the electric potential as

$$V \equiv \frac{U_{q + \text{sources}}}{q} \tag{26.1}$$

Energy formulae

Here there is the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy which is U in conventional physics, in (26.2) ΔU is defined as initial and final values of +𝕆D×e𝕒 potential work. To change the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy to +𝕆D×e𝕒 potential work in this model, the E𝔸 kinetic displacement would be an infinitesimal. In this model all energy formulae are in the same format so they are proportional to each other. When ΔU is the potential as 1/+𝕠d then this can be the initial instant i to the final instant f.

Changing the potential

That can then be V_f- as 1/+𝕠d_f to 1/+𝕠d_i, in this model they are not subtracted because both have positive signs. Instead the change is a square 1/+𝕆D as there must be a force to change from the initial to the final instant. If not then there can be no work done as there is no force.

Potential energy is defined in terms of the work done by force $\vec{F}$ on charge q as it moves from position i to position f:

$$\Delta U = -W(\mathrm{i} \rightarrow \mathrm{f}) = -\int_{s_i}^{s_f} F_s\, ds = -\int_{\mathrm{i}}^{\mathrm{f}} \vec{F} \cdot d\vec{s} \tag{26.2}$$

But the force exerted on charge q by the electric field is $\vec{F} = q\vec{E}$. Putting these three pieces together, you can see that the charge q cancels out and the potential difference between two points in space is

$$\Delta V = V_{\mathrm{f}} - V_{\mathrm{i}} = -\int_{s_i}^{s_f} E_s\, ds = -\int_{\mathrm{i}}^{\mathrm{f}} \vec{E} \cdot d\vec{s} \tag{26.3}$$

where s is the position along a line from point i to point f. That is, **we can find the potential difference between two points if we know the electric field.**

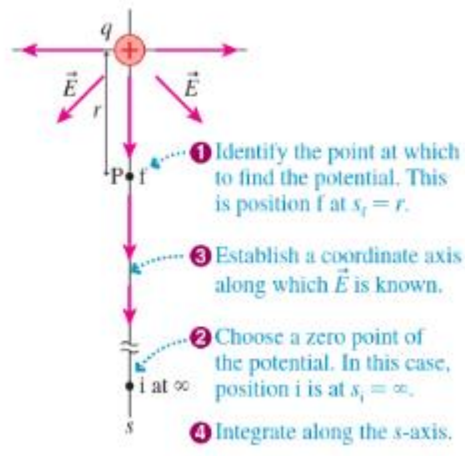
No infinite distances

In this model there is no infinite s, that would be incompatible with a Pythagorean Triangle's constant area. Here s is proportional to e𝕒 as the positive charge $\vec{E}$. That means it changes linearly like the distance s. The minimum distance s would be at the proton where e𝕒 is smallest and +𝕠d as the potential magnetic field is largest.

A zero point is not relativistic

The zero point of the potential cannot be used here, this model also conforms to general and special relativity. Some +𝕆D×e𝕒 potential work would be affected by a e𝕒 altitude contraction such as near an event horizon. The constant squared force from the +𝕠d×e𝕒/+𝕠d potential Coulomb changes under relativity.

FIGURE 26.4 Finding the potential of a point charge.



The potential and integrals

In this model the area under a curve is an integral, that is proportional to a changing Pythagorean Triangle angle θ with its constant area. There is no subtraction because 1/+𝕠d is always positive, the change of an integral area under a curve is measured by a change in the e𝕒 altitude. The force between these e𝕒 positions is an E𝔸 potential duration because it comes from the +𝕚d potential time.

Observing and measuring the potential

Here then the potential can be observed as a time with the E𝔸/+𝕠d potential impulse, then it determines an acceleration over time. When it is measured as an integral with +𝕆D×e𝕒 potential work, then it is a torque or a probability.

Work at one position

This work is measured at a single position s or e𝕒, not in between two positions. That is because the force is a duration between two instants, that has happened and then its size is measured at e𝕒. For example, an ocean wave might hit a boat, the work is the force of the wave between two instants at a single position.

Energy as two positions at two times

Otherwise there would also be a force in between the two positions as well as in between two times. That gives the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy as a ratio of two forces. In this model the forces are separate, each is a square but is observed or measured on a linear scale that is not changing.

A starting and final kinetic velocity

That is in the definitions of kinetic energy for example, there is a starting velocity and a final kinetic velocity. The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy would be the average between them. It assumes that a kinetic velocity is certain, the acceleration between the two is ignored, then it arrives at a certain kinetic velocity. In this model that violates the uncertainty principle, this is overcome in Schrodinger's equation by using h as a quantized observation coming from the E𝕐/-𝕠d kinetic impulse.

The uncertainty principle

This is the difference between energy in conventional physics compared to the work and impulse used here. Energy must include uncertainty, Heisenberg's uncertainty principle implies it is possible to measure the E𝔸 displacement and the +𝕆D potential torque or probability in the same position and time. This is known to be impossible with the uncertainty principle, it is also a contradiction in the equation itself.

A graphical interpretation of Equation 26.3 is

$$V_f = V_i - (\text{area under the } E_s\text{-versus-}s \text{ curve between } s_i \text{ and } s_f) \qquad (26.4)$$

Notice, because of the minus sign in Equation 26.3, that the area is *subtracted* from V_i.

The limit of V

In this model there is not V(∞) because there could be no constant Pythagorean Triangle area. The limit of V in Roy electromagnetism is where the angle θ gives c as e𝕒/+𝕠d. The E_s here is +𝕠d×e𝕒/+𝕠d × 1/E𝔸 × e𝕒 to give +𝕠d×E𝔸/+𝕠d as Planck's constant. That is a constant force not a constant linear value, it gives the strength of the E𝔸/+𝕠d potential impulse in Roy electromagnetism.

Work is measured, then observed as impulse

In (26.5) E_s would be +𝕆D as the potential probability in this model, it can be observed as +𝕠d × e𝔸/+𝕠d. The change in units would come from a measurement of work, then this is observed as impulse.

Dimensional analysis

Sometimes the units do no correspond exactly in this model, that is because in some cases a definition like the potential as 1/+𝕠d is linear but when measured is 1/+𝕆D. When there is a duality between electricity and magnetism there can be a change from measurement to observation as well. The answers are the same with the actual changes here. For example $1/s^2$ means the potential force weakens as a square further from the positive charge.

To see how this works, let's use the electric field of a point charge to find its electric potential. **FIGURE 26.4** identifies a point P at $s_f = r$ at which we want to know the potential and calls this position f. We've chosen position i to be at $s_i = \infty$ and identified that as the zero point of the potential. The integration of Equation 26.3 is straight inward along the radial line from i to f:

$$\Delta V = V(r) - V(\infty) = -\int_{\infty}^{r} E_s\, ds = \int_{r}^{\infty} E_s\, ds \qquad (26.5)$$

The electric field is radially outward. Its s-component is

$$E_s = \frac{1}{4\pi\epsilon_0}\frac{q}{s^2}$$

The potential and momentum

In (26.6) the potential is q as the +𝕠d×e𝕒/+𝕠d potential momentum in Coulombs. That varies according to a distance r as the e𝕒 altitude. Now e𝕒 is in the numerator but the potential early was 1/+𝕠d in the denominator, these are inverses of each other, so they are equivalent. The potential becomes a value in Coulombs, the potential momentum is not changing with a force so the extra terms are not being observed and measured.

Thus the potential at distance r from a point charge q is

$$V(r) = V(\infty) + \frac{q}{4\pi\epsilon_0}\int_{r}^{\infty}\frac{ds}{s^2} = V(\infty) + \frac{q}{4\pi\epsilon_0}\frac{-1}{s}\bigg|_{r}^{\infty} = 0 + \frac{1}{4\pi\epsilon_0}\frac{q}{r} \qquad (26.6)$$

We've rediscovered the potential of a point charge that you learned in Chapter 25:

$$V_{\text{point charge}} = \frac{1}{4\pi\epsilon_0}\frac{q}{r} \qquad (26.7)$$

Potential difference

In this model with work the time between i and f is on a linear scale, this can also use +𝕠d^0_i and +𝕠d^0_f as infinitesimal points. The ΔV term would mean 1/+𝕠d which is an instant here. Work as W here would be positive like +𝕠d, the -𝕆D×e𝕪 kinetic work would be negative. Written as e𝕒/+𝕆D then dividing this by +𝕠d×e𝕒/+𝕠d, without the +𝕠d potential mass constant, gives 1/+𝕠d. Here the potential difference is +𝕆D or 1/+𝕆D depending on the application, the potential difference between two instants would be a square because a force is needed to move between them.

26.2 Finding the Electric Field from the Potential

FIGURE 26.6 shows two points i and f separated by a very small distance Δs, so small that the electric field is essentially constant over this very short distance. The work done by the electric field as a charge q moves through this small distance is $W = F_s \Delta s = qE_s \Delta s$. Consequently, the potential difference between these two points is

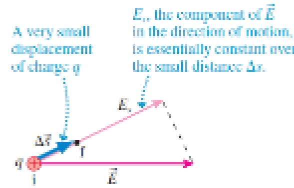
$$\Delta V = \frac{\Delta U_{q+\text{sources}}}{q} = \frac{-W}{q} = -E_s \Delta s \qquad (26.8)$$

In terms of the potential, the component of the electric field in the s-direction is $E_s = -\Delta V/\Delta s$. In the limit $\Delta s \to 0$,

$$E_s = -\frac{dV}{ds} \qquad (26.9)$$

Now we have reversed Equation 26.3 and can find the electric field from the potential. We'll begin with examples where the field is parallel to a coordinate axis, then we'll look at what Equation 26.9 tells us about the geometry of the field and the potential.

FIGURE 26.6 The electric field does work on charge q.



The electric field of a point charge

Here E_r is +𝕆D/e𝕒, q is the potential momentum as +𝕠d×e𝕒/+𝕠d, divided by E𝔸 (as r^2) and multiplied by ϵ as e𝕒 to give +𝕠d×1/(+𝕠d), with +𝕠d in the numerator removed as the potential mass, to leave 1/+𝕠d. The inverse of this is e𝕒 which is referred to as the electric field in conventional physics. The potential as 1/+𝕠d would then be the inverse of the electric field, that would be the magnetic/electric duality in electromagnetism.

Field Parallel to a Coordinate Axis

The derivative in Equation 26.9 gives E_s, the component of the electric field parallel to the displacement $\Delta\vec{s}$. It doesn't tell us about the electric field component perpendicular to $\Delta\vec{s}$. Thus Equation 26.9 is most useful if we can use symmetry to select a coordinate axis that is parallel to $\vec{E}$ and along which the perpendicular component of $\vec{E}$ is known to be zero.

For example, suppose we knew the potential of a point charge to be $V = q/4\pi\epsilon_0 r$ but didn't remember the electric field. Symmetry requires that the field point straight outward from the charge, with only a radial component E_r. If we choose the s-axis to be in the radial direction, parallel to $\vec{E}$, we can use Equation 26.9 to find

$$E_r = -\frac{dV}{dr} = -\frac{d}{dr}\left(\frac{q}{4\pi\epsilon_0 r}\right) = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2} \qquad (26.10)$$

This is, indeed, the well-known electric field of a point charge.

Equation 26.9 is especially useful for a continuous distribution of charge because calculating V, which is a scalar, is usually much easier than calculating the vector $\vec{E}$ directly from the charge. Once V is known, $\vec{E}$ is found simply by taking a derivative.

Electric field as a slope

The electric field is a slope of the +𝕠d and e𝕒 Pythagorean Triangle as e𝕒/+𝕠d, V would be 1/+𝕠d and s is e𝕒 as the altitude.

A geometric interpretation of Equation 26.9 is that the electric field is the negative of the *slope* of the V-versus-s graph. This interpretation should be familiar. You learned in Chapter 10 that the force on a particle is the negative of the slope of the

Potential energy and the potential

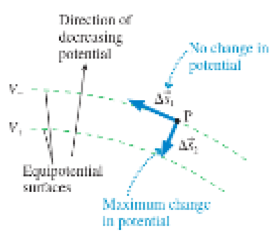
Here U would be F=ma as +𝕕d×e𝕒/+𝔻D, that can also be the ½×+e𝔸/+𝔻d ×+𝕕d rotational potential energy with a derivative dU/ds removing s as e𝕒 from the numerator to leave +𝕕d×e𝕒/+𝔻D. When this is divided by q it gives 1/+𝕕d and the inverse is e𝕒, these go together in the one +𝕕d and e𝕒 Pythagorean Triangle.

potential-energy graph: $F = -dU/ds$. In fact, Equation 26.9 is simply $F = -dU/ds$ with both sides divided by q to yield E and V. This geometric interpretation is an important step in developing an understanding of potential.

Potential as geometry

Here E_s is +𝔻D/e𝕒, this can be regarded as (+𝕕d_i - +𝕕d_f)/e𝕒. The initial and final instants of +𝕕d potential time give a duration or torque, the time is uncertain between them which gives a probability. In this model a field is geometric, defined here as +𝕕d×e𝕒 which is the area of the +𝕕d and e𝕒 Pythagorean Triangle. When e𝕒 is constant like a Gaussian surface then there is no +𝔻D×e𝕒 potential work done, the +𝕕d value remains unchanged as V. These equipotential surfaces would be quantized in an atom as orbitals.

FIGURE 26.9 The electric field at P is related to the shape of the equipotential surfaces.



The Geometry of Potential and Field

Equations 26.3 for V in terms of E_s and 26.9 for E_s in terms of V have profound implications for the geometry of the potential and the field. **FIGURE 26.9** shows two equipotential surfaces, with V_+ positive relative to V_-. To learn about the electric field $\vec{E}$ at point P, allow a charge to move through the two displacements $\Delta\vec{s}_1$ and $\Delta\vec{s}_2$. Displacement $\Delta\vec{s}_1$ is *tangent* to the equipotential surface, hence a charge moving in this direction experiences *no* potential difference. According to Equation 26.9, the electric field component along a direction of *constant* potential is $E_s = -dV/ds = 0$. In other words, **the electric field component tangent to the equipotential is $E_\parallel = 0$.**

Displacement $\Delta\vec{s}_2$ is *perpendicular* to the equipotential surface. There is a potential difference along $\Delta\vec{s}_2$, hence the electric field component is

$$E_\perp = -\frac{dV}{ds} \approx -\frac{\Delta V}{\Delta s} = -\frac{V_+ - V_-}{\Delta s_2}$$

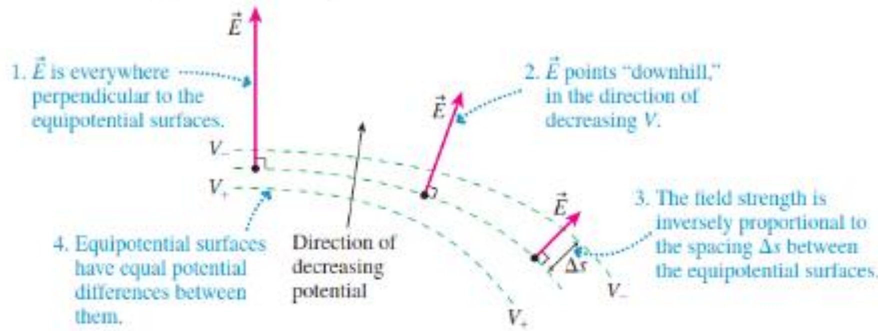
The potential as downhill

The decreasing potential is where as e𝕒 increases the +𝕕d potential magnetic field decreases. When downhill refers to the straight Pythagorean Triangle side, this is e𝕒 as the altitude. It points outward from the positive charge but e𝕒 as a vector would point down not up. It is orthogonal to V as 1/+𝕕d which makes the electric field a slope e𝕒/+𝕕d where e𝕒 is electric and 1/+𝕕d is the field.

You can see that the electric field is inversely proportional to Δs_2, the spacing between the equipotential surfaces. Furthermore, because $(V_+ - V_-) > 0$, the minus sign tells us that the electric field is *opposite* in direction to $\Delta \vec{s}_2$. In other words, **$\vec{E}$ is perpendicular to the equipotential surfaces and points "downhill" in the direction of *decreasing* potential.**

These important ideas are summarized in FIGURE 26.10.

FIGURE 26.10 The geometry of the potential and the field.



Quarks and orthogonal Pythagorean Triangles

The +𝕠d and e𝕒 Pythagorean Triangle can be regarded as three orthogonal Pythagorean Triangles, these can be written where e𝕒 is ∂x, ∂y, and ∂z. The spin directions of +𝕠d can then be î, ĵ, and k̂. Each would do +𝕆D×e𝕒 potential work in orthogonal directions. With this model that gives different quark and gluon combinations with three colors and generations in a proton each orthogonal Pythagorean Triangle would have one quark.

Component vectors

As an approximation any direction can be broken up into these three +𝕠d and e𝕒 Pythagorean Triangles. Here there is a partial derivative of +𝕠d$_i$/∂e𝕒$_x$, that would give +𝕠d/e𝕒 which is the same electric field as e𝕒/+𝕠d. $\vec{E}$ as e𝕒=ΔV which is +𝕠d so $\vec{E}$/+𝕠d is the electric field. In this model +𝕠d×e𝕒 is a constant Pythagorean Triangle area. This does not change the slope values, instead of the hypotenuse in cosθ for example being a constant the area is. The ang'e θ of the slope remains the same.

Mathematically, we can calculate the individual components of $\vec{E}$ at any point by extending Equation 26.9 to three dimensions:

$$\vec{E} = E_x\,\hat{\imath} + E_y\,\hat{\jmath} + E_z\,\hat{k} = -\left(\frac{\partial V}{\partial x}\hat{\imath} + \frac{\partial V}{\partial y}\hat{\jmath} + \frac{\partial V}{\partial z}\hat{k}\right) \qquad (26.11)$$

where $\partial V/\partial x$ is the partial derivative of V with respect to x while y and z are held constant. You may recognize from calculus that the expression in parentheses is the *gradient* of V, written ∇V. Thus, $\vec{E} = -\nabla V$. More advanced treatments of the electric field make extensive use of this mathematical relationship, but for the most part we'll limit our investigations to those we can analyze graphically.

Kirchoff's loop law

The change of the +𝕆D×e𝕒 potential work here is zero because there is no overall change in the e𝕒 position, the different directions and changes to +𝕆D as potential probabilities cancel with destructive interference. Here U is +𝕠d×e𝕒/+𝕆D so the difference between this and +𝕠d

×e𝕒/+𝕆D as qV is zero. These are not subtracted because that would be a change between on 1/+𝕠d value and another. In this model that only happens with a force as 1/+𝕆D. A subtraction can occur with +𝕠d and -𝕠d as the potential magnetic field minus the kinetic magnetic field.

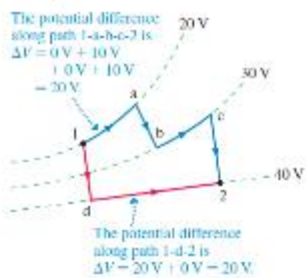


FIGURE 26.13 The potential difference between points 1 and 2 is the same along either path.

Kirchhoff's Loop Law

FIGURE 26.13 shows two points, 1 and 2, in a region of electric field and potential. You learned in Chapter 25 that the work done in moving a charge between points 1 and 2 is *independent of the path*. Consequently, the potential difference between points 1 and 2 along any two paths that join them is $\Delta V = 20$ V. This must be true in order for the idea of an equipotential surface to make sense.

Now consider the path 1–a–b–c–2–d–1 that ends where it started. What is the potential difference "around" this closed path? The potential increases by 20 V in moving from 1 to 2, but then decreases by 20 V in moving from 2 back to 1. Thus $\Delta V = 0$ V around the closed path.

The numbers are specific to this example, but the idea applies to any loop (i.e., a closed path) through an electric field. The situation is analogous to hiking on the side of a mountain. You may walk uphill during parts of your hike and downhill during other parts, but if you return to your starting point your *net* change of elevation is zero. So for any path that starts and ends at the same point, we can conclude that

$$\Delta V_{loop} = \sum_i (\Delta V)_i = 0 \qquad (26.12)$$

Stated in words, **the sum of all the potential differences encountered while moving around a loop or closed path is zero.** This statement is known as **Kirchhoff's loop law.**

Kirchhoff's loop law is a statement of energy conservation because a charge that moves around a loop and returns to its starting point has $\Delta U = q\Delta V = 0$. Kirchhoff's loop law and a second Kirchhoff's law you'll meet in the next chapter will turn out to be the two fundamental principles of circuit analysis.

Electrostatic equilibrium

When the electric field is at zero this is e𝕒/+𝕠d, the potential momentum in Coulombs includes another +𝕠d as the potential mass. That is the duality of the +𝕠d×e𝕒 potential field combined with the potential slope e𝕒/+𝕠d which is called the electric field here. There is no actual multiplication or division because there is no observation or measurement, it means there is an +𝕠d and e𝕒 Pythagorean Triangle as a proton or positive charge.

Moving charges in a current

$\vec{F}$ here is q$\vec{E}$ which is +𝕠d×E𝔸/+𝕠d, that is different from F=ma as +𝕠d×e𝕒/+𝕆D in Newtons. $\vec{F}$ would then be a motion from the E𝔸/+𝕠d potential impulse and the slope of the electric field. With F=ma that is +𝕆D×e𝕒 potential work, but the two are inverses of each other. The motion of the e𝕒/+𝕠d potential current depends on the slope of the +𝕠d and e𝕒 Pythagorean Triangle, when the positive charges are observed as particles they move with a E𝔸/+𝕠d potential impulse.

26.3 A Conductor in Electrostatic Equilibrium

The basic relationships between potential and field allow us to draw some interesting and important conclusions about conductors. Consider a conductor, such as a metal, that is in electrostatic equilibrium. The conductor may be charged, but all the charges are at rest.

You learned in Chapter 22 that any excess charges on a conductor in electrostatic equilibrium are always located on the *surface* of the conductor. Using similar reasoning, we can conclude that **the electric field is zero at any interior point of a conductor in electrostatic equilibrium**. Why? If the field were other than zero, then there would be a force $\vec{F} = q\vec{E}$ on the charge carriers and they would move, creating a current. But there are no currents in a conductor in electrostatic equilibrium, so it must be that $\vec{E} = \vec{0}$ at all interior points.

The two points inside the conductor in FIGURE 26.14 are connected by a line that remains entirely inside the conductor. We can find the potential difference $\Delta V = V_2 - V_1$

Equal work and no motion

In this model when two eà potential positions are equal, then the +𝕆D potential probability is also equal. That means no work is being done in between these positions, also there is no probable motion from one eà potential position to another. Here E⃗ is eà as the potential electric charge, or positive charge.

Electrostatic equilibrium

In this model electrostatic equilibrium means there are no forces. The entire conductor has the same potential, if not then there would be +𝕆D×eà potential work and -𝕆D×eẙ kinetic work moving electrons to different positions. The external E⃗ or eà potential electric charge is perpendicular to the surface, in other directions the +𝕆D×eà potential work has destructive interference which cancels them out.

Smallest eà is the strongest work

The smallest radii of curvature is the smallest eà altitude in circular geometry, this gives the largest +𝕆D potential probability so the +𝕆D×eà potential work is strongest there.

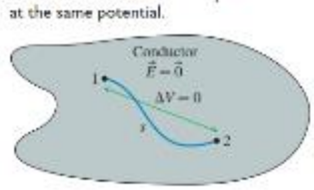
between these points by using Equation 26.3 to integrate E_s along the line from 1 to 2. But $E_s = 0$ at all points along the line, because $\vec{E} = \vec{0}$; thus the value of the integral is zero and $\Delta V = 0$. In other words, **any two points inside a conductor in electrostatic equilibrium are at the same potential.**

When a conductor is in electrostatic equilibrium, the *entire conductor* is at the same potential. If we charge a metal sphere, then the entire sphere is at a single potential. Similarly, a charged metal rod or wire is at a single potential *if* it is in electrostatic equilibrium.

If $\vec{E} = \vec{0}$ inside a charged conductor but $\vec{E} \neq \vec{0}$ outside, what happens right at the surface? If the entire conductor is at the same potential, then the surface is an equipotential surface. You have seen that the electric field is always perpendicular to an equipotential surface, hence **the exterior electric field $\vec{E}$ of a charged conductor is perpendicular to the surface.**

We can also conclude that the electric field, and thus the surface charge density, is largest at sharp points. This follows from our earlier discovery that the field at the surface of a sphere of radius R can be written $E = V_0/R$. If we approximate the rounded corners of a conductor with sections of spheres, all of which are at the same potential V_0, the field strength will be largest at the corners with the smallest radii of curvature—the sharpest points.

FIGURE 26.14 All points inside a conductor in electrostatic equilibrium are at the same potential.



Two charged conductors

The e𝕪 directions change with a -𝕆D kinetic torque turning the straight Pythagorean Triangle sides. If they are both negative then there is a -𝕆D kinetic probability between them, this interferes destructively so they repel each other. In the left diagram there are positive charges, the +𝕆D potential probability interferes destructively so they repel each other. The e𝕪 positions comes from a straight Pythagorean Triangle side, when measuring -𝕆D×e𝕪 kinetic work they are points and so they can turn. With a E𝕐/-𝕠d kinetic impulse these would have E𝕐 kinetic displacement vectors in straight lines, for a curvature there would be +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work.

FIGURE 26.15 Properties of a conductor in electrostatic equilibrium.

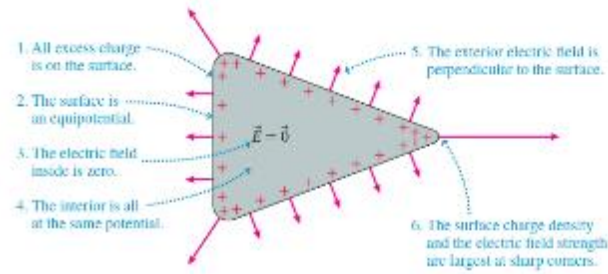
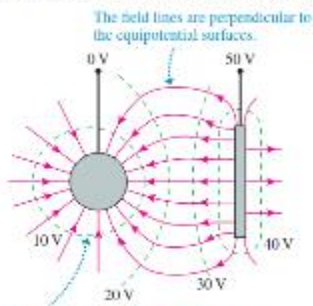


FIGURE 26.15 summarizes what we know about conductors in electrostatic equilibrium. These are important and practical conclusions because conductors are the primary components of electrical devices.

We can use similar reasoning to estimate the electric field and potential between two charged conductors. As an example, **FIGURE 26.16** shows a negatively charged metal sphere near a flat metal plate. The surfaces of the sphere and the flat plate are equipotentials, hence the electric field must be perpendicular to both. Close to a surface, the electric field is still *nearly* perpendicular to the surface. Consequently, **an equipotential surface close to an electrode must roughly match the shape of the electrode.**

In between, the equipotential surfaces *gradually* change as they "morph" from one electrode shape to the other. It's not hard to sketch a contour map showing a plausible set of equipotential surfaces. You can then draw electric field lines (field lines are easier to draw than field vectors) that are perpendicular to the equipotentials, point "downhill," and are closer together where the contour line spacing is smaller.

FIGURE 26.16 Estimating the field and potential between two charged conductors.



Potential and kinetic difference

In this model the +𝕠d and e𝕒 Pythagorean Triangles as positive charges have a +𝕆D potential difference. The -𝕠d and e𝕪 Pythagorean Triangles as electrons have a -𝕆D kinetic difference. These allows for them to be added to give the overall difference, they attract each other with constructive interference. That gives an integral below where +𝕆D and -𝕆D are integral fields, that change according to a distance s which is e𝕒 and e𝕪 respectively. Here $E^{\rightarrow}$ would then be e𝕒 as well as e𝕪, they would use vector addition and subtraction.

Van de Graff generator

When the charges are separated a distance in a Van de Graff generator, there is +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work done with the change in position. The e𝕪 electrons are the active force, this is reacted against by the e𝕒 protons. They use a needle, as a small point this has smaller e𝕒 altitudes so the +𝕆D potential probabilities are stronger there.

26.4 Sources of Electric Potential

We've now studied many properties of the electric potential and seen how potential and field are connected, but we've not said much about how an electric potential is created. Simply put, **an electric potential difference is created by separating positive and negative charge**. Shuffling your feet on the carpet transfers electrons from the carpet to you, creating a potential difference between you and a doorknob that causes a spark and a shock as you touch it. Charging a capacitor by moving electrons from one plate to the other creates a potential difference across the capacitor.

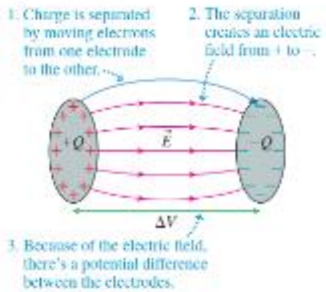
As FIGURE 26.17 shows, moving charge from one electrode to another creates an electric field $\vec{E}$ pointing from the positive toward the negative electrode. As a consequence, there is a potential difference between the electrodes that is given by

$$\Delta V = V_{pos} - V_{neg} = -\int_{neg}^{pos} E_s \, ds$$

where the integral runs from any point on the negative electrode to any point on the positive. The *net* charge is zero, but pulling the positive and negative charge apart creates a potential difference.

Now electric forces try to bring positive and negative charges together, so a **nonelectrical process is needed to separate charge**. As an example, the **Van de Graaff generator** shown in FIGURE 26.18a separates charges mechanically. A moving plastic or leather belt is charged, then the charge is mechanically transported via the conveyor belt to the spherical electrode at the top of the insulating column. The charging of the belt could be done by friction, but in practice a *corona discharge* created by the strong electric field at the tip of a needle is more efficient and reliable.

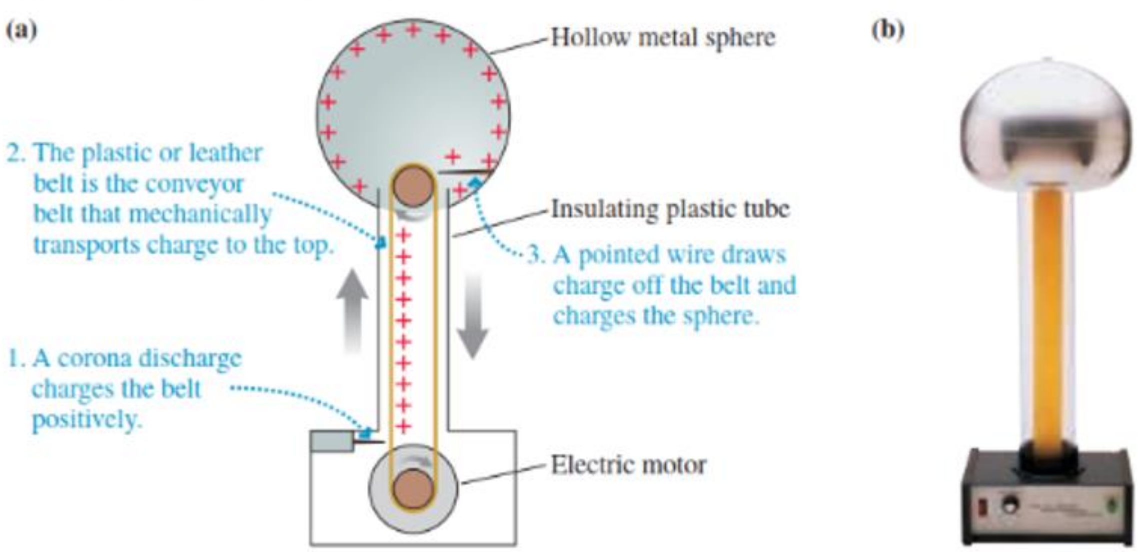
FIGURE 26.17 A charge separation creates a potential difference.



The pointed needle

The pointed needle does more +𝕆D×e𝕒 potential work, this moves more charge to the sphere. As a straight-line, the needle also has a stronger E𝔸/+𝕠d potential impulse so the protons move along it more onto the sphere. It is like a pipe, the positive charges have a stronger pressure on the left, on the right they are more spread out on the sphere. The motion of the belt towards the needle imparts an E𝔸 potential displacement like a pump.

FIGURE 26.18 A Van de Graaff generator.



Work moves the positive charges

In this model there is +𝕆D×e𝕒 potential work done to move the positive charges, the belt rotates so the +𝕆D potential torque moves the +𝕆D potential difference a distance e𝕒.

A Van de Graaff generator has two noteworthy features:

- Charge is *mechanically* transported from the negative side to the positive side. This charge separation creates a potential difference between the spherical electrode and its surroundings.
- The electric field of the spherical electrode exerts a downward force on the positive charges moving up the belt. Consequently, *work must be done* to "lift" the positive charges. The work is done by the electric motor that runs the belt.

A classroom-demonstration Van de Graaff generator like the one shown in **FIGURE 26.18b** creates a potential difference of several hundred thousand volts between the upper sphere and its surroundings. The maximum potential is reached when the electric field near the sphere becomes large enough to cause a breakdown of the air. This produces a spark and temporarily discharges the sphere. A large Van de Graaff generator surrounded by vacuum can reach a potential of 20 MV or more. These generators are used to accelerate protons for nuclear physics experiments.

A battery

In this model the positive terminal has a +𝕆D potential difference, the negative terminal has a -𝕆D kinetic difference. The charge escalator does work moving the charges over a distance. This is similar to moving the positive charges in a Van de Graff generator, except that the negative charges would be moved with -𝕆D×e𝕪 kinetic work.

Batteries and emf

The most common source of electric potential is a **battery,** which uses *chemical reactions* to separate charge. A battery consists of chemicals, called *electrolytes,* sandwiched between two electrodes made of different metals. Chemical reactions in the electrolytes transport ions (i.e., charges) from one electrode to the other. This chemical process pulls positive and negative charges apart, creating a potential difference between the terminals of the battery. When the chemicals are used up, the reactions cease and the battery is dead.

We can sidestep the chemistry details by introducing the **charge escalator model** of a battery.

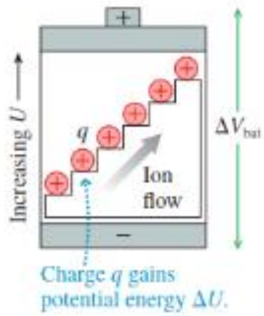
The emf $\mathcal{E}$

Here the emf $\mathcal{E}$ would be in between the +𝕆D potential difference and the -𝕆D kinetic difference. That is per charge, in this model that would mean the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work done on each individual Pythagorean Triangles.

MODEL 26.1

Charge escalator model of a battery

A battery uses chemical reactions to separate charge.



- The charge escalator "lifts" positive charges from the negative terminal to the positive terminal. This requires *work*, with the energy being supplied by the chemical reactions.
- The work done *per charge* is called the **emf** of the battery: $\mathcal{E} = W_{chem}/q$.
- The charge separation creates a potential difference ΔV_{bat} between the terminals. An *ideal battery* has $\Delta V_{bat} = \mathcal{E}$.
- Limitations: $\Delta V_{bat} < \mathcal{E}$ if current flows through the battery. In most cases, the difference is small and a battery can be considered ideal.

Adding the differences

Here B_{bat} is +𝕆D added to -𝕆D, it is addition rather than subtraction because only the -𝕆D kinetic difference can be measured. The potential cannot be directly measured in this model like with the -𝕆D inertial probability as inertia. That is joules/Coulomb or volts. Here the potential joules would be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, when divided by Coulombs as +𝕠d×e𝕒/+𝕠d this leaves e𝕒/+𝕠d as the potential current. Measuring this gives +𝕆D×e𝕒 potential work and the +𝕆D potential difference.

Mechanical and magnetic work

This work can be done mechanically with +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work in Biv space-time. It also comes from magnetic forces which here is the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. The potential's +𝕠d potential magnetic field cannot be directly observed or measured.

Emf is pronounced as the sequence of letters e-m-f. The symbol for emf is $\mathcal{E}$, a script E, and the units of emf are joules per coulomb, or volts. The rating of a battery, such as 1.5 V or 9 V, is the battery's emf.

The key idea is that **emf is work,** specifically the work done *per charge* to pull positive and negative charges apart. This work can be done by mechanical forces, chemical reactions, or—as you'll see later—magnetic forces. *Because* work is done, charges gain potential energy and their separation creates a potential difference ΔV_{bat} between the positive and negative terminals of the battery. This is called the **terminal voltage.**

In an **ideal battery,** which has no internal energy losses, the work W_{chem} done to move charge q from the negative to the positive terminal goes entirely to increasing the potential energy of the charge, and so $\Delta V_{bat} = \mathcal{E}$. In practice, the terminal voltage is slightly less than the emf when current flows through a battery—we'll discuss this in Chapter 28—but the difference usually small and in most cases we can model batteries as being ideal.

Batteries in series

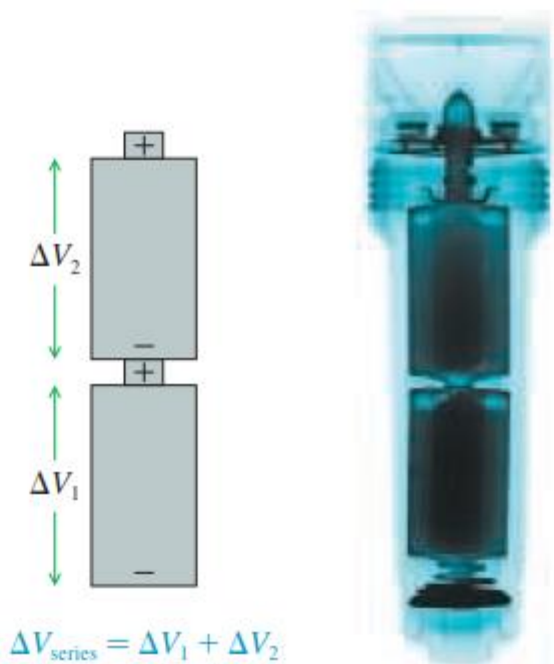
Putting three +𝕆D potential differences and -𝕆D kinetic differences in series, that adds the probabilities with constructive interference between them. There is also three times the +𝕆D potential probability with destructive interference between the positive charges, three times the -𝕆D kinetic difference with destructive interference between the negative charges. Because this is probabilities it extends over the three batteries as a probability density.

Batteries in Series

Many consumer goods, from flashlights to digital cameras, use more than one battery. Why? A particular type of battery, such as an AA or AAA battery, produces a fixed emf determined by the chemical reactions inside. The emf of one battery, often 1.5 V, is not sufficient to light a lightbulb or power a camera. But just as you can reach the third floor of a building by taking three escalators in succession, we can produce a larger potential difference by placing two or more batteries *in series*.

FIGURE 26.19 shows two batteries with the positive terminal of one literally touching the negative terminal of the next. Flashlight batteries usually are arranged like this.

FIGURE 26.19 Batteries in series.



The terminal voltage

In this model the +𝕆D potential differences of the positive terminals are added to the -𝕆D kinetic differences of the negative terminals. This gives three times the emf $\mathcal{E}$ or terminal voltage.

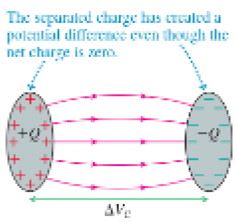
Other devices, such as cameras, achieve the same effect by using conducting metal wires between one battery and the next. Either way, the total potential difference of batteries in series is simply the sum of their individual terminal voltages:

$$\Delta V_{\text{series}} = \Delta V_1 + \Delta V_2 + \cdots \qquad \text{(batteries in series)} \qquad (26.13)$$

Capacitance

In this model a +𝕆D potential difference comes from +𝕆D×e𝕒 potential work being done. That can be moving a +𝕠d×e𝕒/+𝕠d charge in potential Coulombs. The capacitor voltage is the potential and kinetic difference between the two plates, like the emf $\mathcal{E}$ in a battery. When Q as +𝕠d×e𝕒/+𝕠d is divided by ΔV as 1/+𝕠d it gives +𝕠d×e𝕒/+𝕆D which is F=ma. That would be measuring the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work between the two plates.

FIGURE 26.20 Two equally but oppositely charged electrodes form a capacitor.



26.5 Capacitance and Capacitors

FIGURE 26.20 shows two electrodes that have been charged to $\pm Q$. Their net charge is zero, but something has separated positive and negative charges. Consequently, there is a potential difference ΔV between the electrodes.

It seems plausible that ΔV is directly proportional to Q. That is, doubling the amount of charge on the electrodes will double the potential difference. We can write this as $Q = C\Delta V$, where the proportionality constant

$$C = \frac{Q}{\Delta V_C} \qquad (26.14)$$

is called the **capacitance** of the two electrodes. The two electrodes themselves form a **capacitor**, so we've written a subscript C on ΔV_C to indicate that this is the **capacitor voltage**, the potential difference between the positive and negative electrodes.

Charge and capacitance

Here is the charge in Coulombs or the potential momentum is +𝕠d×e𝕒/+𝕆D × +𝕠d to give +𝕠d×e𝕒/+𝕠d. When ΔV is used this is not a force, the capacitor is charged but there is no longer any work being done. The capacitance like the emf $\mathcal{E}$ is the +𝕆D potential difference added to the -𝕆D kinetic difference.

The SI unit of capacitance is the **farad,** named in honor of Michael Faraday. One farad is defined as

$$1 \text{ farad} = 1 \text{ F} = 1 \text{ C/V}$$

One farad turns out to be an enormous amount of capacitance. Practical capacitors are usually measured in units of microfarads (μF) or picofarads ($1 \text{ pF} = 10^{-12}$ F).

Turning Equation 26.14 around, we see that the amount of charge on a capacitor that has been charged to ΔV_C is

$$Q = C\Delta V_C \qquad \text{(charge on a capacitor)} \qquad (26.15)$$

The amount of charge is determined jointly by the potential difference *and* by a property of the electrodes called capacitance. As we'll see, **capacitance depends only on the geometry of the electrodes.**

The parallel plate capacitor

Here the electric field is e𝕒/+𝕠d as E, $\vec{E}$ is e𝕒. ΔV_c is +𝕠d = Ed so +𝕠d/e𝕒 as d =E. Being inverted does not change its nature, for example e𝕧/-𝕠d is meters per second and -𝕠d/e𝕧 as seconds/meter is the same inertial velocity. In (26.16) E = +𝕠d×e𝕒/+𝕠d × E𝔸 (as 1/ϵ) × 1/E𝔸 to give +𝕠d (this can be ignored as the potential mass) × e𝕒/+𝕠d as the electric field.

Charge is proportional to the potential difference

In (26.17) Q is +𝕠d×e𝕒/+𝕠d, ϵ is a constant force. When d is constant as e𝕒 and the area of the plates is constant as E𝔸, then Q is proportional to ΔV_c as 1/+𝕠d. This is because the potential momentum in Coulombs has no forces, when 1/+𝕆D is squared it becomes F=ma. Then 1/+𝕆D is also proportional as the potential difference.

The Parallel-Plate Capacitor

A parallel-plate capacitor consists of two flat electrodes (the plates) facing each other with a plate separation d that is small compared to the sizes of the plates. You learned in Chapter 25 that the potential difference across a parallel-plate capacitor is related to the electric field inside by $\Delta V_C = Ed$. And you know from Chapter 23 that the electric field inside a parallel-plate capacitor is

$$E = \frac{Q}{\epsilon_0 A} \qquad (26.16)$$

Area and distance

In (26.18) ϵ×A/d is 1/E𝔸 × E𝔸 × 1/e𝕒. This means that the capacitance as +𝕠d×e𝕒/+𝕆D changes with the squared area, the +𝕆D×e𝕒 potential work changes with the d distance as e𝕒, and the force between the plates is 1/E𝔸 as ϵ. It refers to the changes not as dimensional analysis, ϵ as 1/E𝔸 comes from the E𝔸/+𝕠d potential impulse so this is referring to an electric displacement. The inverse of this is +𝕆D as the potential difference, then divided by d as e𝕒 is +𝕆D×e𝕒 potential work.

where A is the surface area of the plates. Combining these gives

$$Q = \frac{\epsilon_0 A}{d} \Delta V_C \qquad (26.17)$$

You can see that the charge is proportional to the potential difference, as expected. So from the definition of capacitance, Equation 26.14, we find that the capacitance of a parallel-plate capacitor is

$$C = \frac{Q}{\Delta V_C} = \frac{\epsilon_0 A}{d} \qquad \text{(parallel-plate capacitor)} \qquad (26.18)$$

The capacitance is a purely *geometric* property of the electrodes, depending only on their surface area and spacing. Capacitors of other shapes will have different formulas for their capacitance, but all will depend entirely on geometry. A cylindrical capacitor is the topic of Challenge Example 26.11, and a homework problem will let you analyze a spherical capacitor.

Batteries, capacitors and resistors

Connecting to a battery causes the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work to move to opposite plates in the capacitor. This can also act like a battery, being charged and discharged in some electric cars. A resistor also acts like a battery and capacitor, there can be a buildup of the +𝕆D potential and -𝕆D kinetic difference on its ends. An inefficient battery has some +𝕆D×e𝕒 potential work as resistance, a capacitor can have a resistor as a dielectric between the plates to increase its capacity.

Action/reaction pairs

In this model there are action/reaction pairs, an ideal battery has a +𝕆D kinetic difference. The +𝕆D potential difference has little resistance inside it, a negative charge can move with -𝕆D×e𝕪 kinetic work to the negative plate. This change is reacted against by +𝕆D×e𝕒 potential work, that means the -𝕆D×e𝕪 kinetic work tends to move across the capacitor back to its former e𝕪 position.

The resistor as an uncharged battery

The resistor is like an uncharged battery or capacitor, doing -𝕆D×e𝕪 kinetic work through it causes a -𝕆D kinetic difference on one end. That can be regarded as charged, then this quickly discharges like a battery or capacitor losing their charge by themselves.

Gravity and inertia as a battery

When water is escalated up to a water tank, that is a -𝕀D inertial difference, proportional to a -𝕆D kinetic difference being created. The -𝕆D×e𝕪 kinetic work is active, the -𝕀D×e𝕧 inertial work is reactive like the +𝕆D×e𝕒 potential work of the positive charges. Gravity does +𝕀D×e𝕙 gravitational work in urging the water tank to empty, that is like a battery and capacitor tending to discharge themselves. A shallow stream has a -𝕆D inertial resistance as -𝕀D×e𝕧 inertial work, that reacts against the +𝕀D×e𝕙 gravitational work. Gravity is proportional to the +𝕆D×e𝕒 potential work of the positive charge.

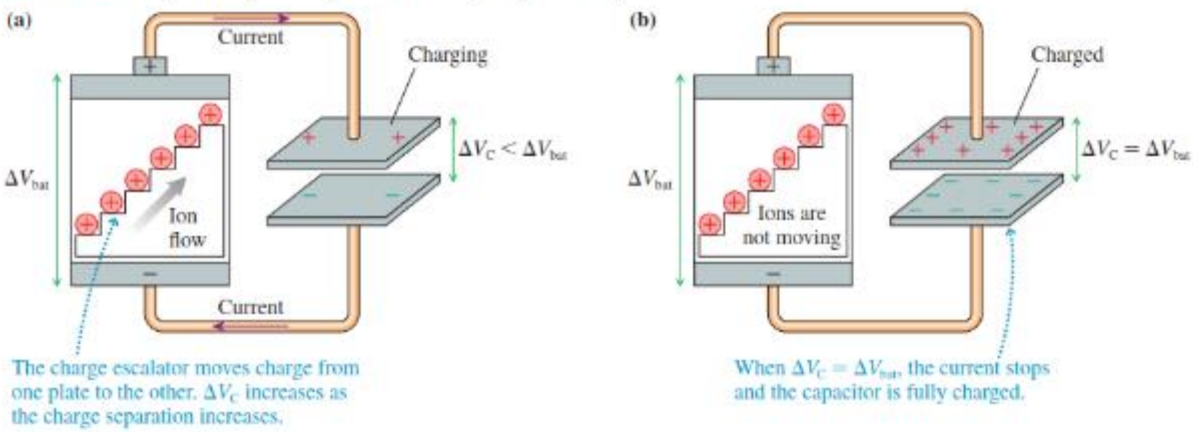
Discharging a gravitational and inertial battery or capacitor

Because of this, hydroelectric generators can convert the gravitational potential as e𝕙 into -𝕆D×e𝕪 kinetic work as the water tank empties. A circuit can be a pipe going through a generator, when the tank is emptied the -𝕆D potential difference and +𝕆D gravitational differences are equalized and no more work can be done. If the pipe is narrower in one part that is like a resistor, the -𝕀D×e𝕧 inertial work reacts more against the +𝕀D×e𝕙 gravitational work pulling the water down.

Charging a Capacitor

All well and good, but *how* does a capacitor get charged? By connecting it to a battery! **FIGURE 26.21a** shows the two plates of a capacitor shortly after two conducting wires have connected them to the two terminals of a battery. At this instant, the battery's charge escalator is moving charge from one capacitor plate to the other, and it is this work done by the battery that charges the capacitor. (The connecting wires are conductors, and you learned in Chapter 22 that charges can move through conductors as a *current*.) The capacitor voltage ΔV_C steadily increases as the charge separation continues.

FIGURE 26.21 A parallel-plate capacitor is charged by a battery.



Constructive interference in batteries and capacitors

As the battery and capacitor charge, there is a constructive interference between the positive and negative terminals and plates. That can lead to a discharge through an alternate path such as a wire, the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work find a different path some a probability as in path integrals.

Destructive interference in batteries and capacitors

When they charge there is a destructive interference in each terminal and plate, the positive charges repel each other as do the negative charges. In a resistor the electrons are more bound in atoms, they have a destructive interference with electrons trying to pass through it. That slows down the electrons, the protons have a constructive interference with their own electrons. This prevents its electrons being removed from the atoms like in a metal reducing the resistance.

But this process cannot continue forever. The growing positive charge on the upper capacitor plate exerts a repulsive force on new charges coming up the escalator, and eventually the capacitor charge gets so large that no new charges can arrive. The capacitor in FIGURE 26.21b is now *fully charged*. In Chapter 28 we'll analyze how long the charging process takes, but it is typically less than a nanosecond for a capacitor connected directly to a battery with copper wires.

Once the capacitor is fully charged, with charges no longer in motion, the positive capacitor plate, the upper wire, and the positive terminal of the battery form a single conductor in electrostatic equilibrium. This is an important idea, and it wasn't true while the capacitor was charging. As you just learned, any two points in a conductor in electrostatic equilibrium are at the same potential. **Thus the positive plate of a fully charged capacitor is at the same potential as the positive terminal of the battery.**

Maintaining charge in a capacitor

The capacitor charges to the same level as the battery, then the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work has no probability of moving into or out of the battery. Time is not a factor in an ideal capacitor, this is because there is only +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work with no path across the plates. If a spark jumped across that would come from the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

Similarly, the negative plate of a fully charged capacitor is at the same potential as the negative terminal of the battery. Consequently, the potential difference ΔV_C between the capacitor plates exactly matches the potential difference ΔV_{bat} between the battery terminals. **A capacitor attached to a battery charges until $\Delta V_C = \Delta V_{bat}$.** Once the capacitor is charged, you can disconnect it from the battery; it will maintain this charge and potential difference until and unless something—a current—allows positive charge to move back to the negative plate. An ideal capacitor in vacuum would stay charged forever.

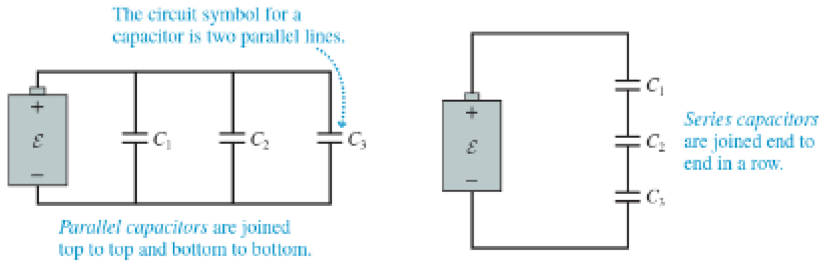
Series and parallel

Capacitors can be connected in series or parallel, the active -𝕆D×e𝕪 kinetic work seeks a path to discharge them. A resistor is the inverse of the capacitor, when connected in series or parallel it reacts against the -𝕆D×e𝕪 kinetic work discharging it.

Combinations of Capacitors

Two or more capacitors are often joined together. FIGURE 26.22 illustrates two basic combinations: **parallel capacitors** and **series capacitors.** Notice that a capacitor, no matter what its actual geometric shape, is represented in *circuit diagrams* by two parallel lines.

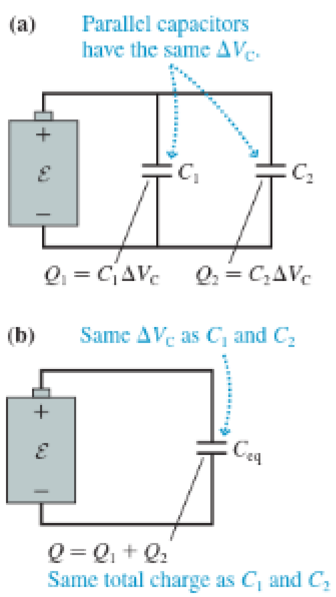
FIGURE 26.22 Parallel and series capacitors.



Adding capacitors

In this model the -𝕆D×e𝕪 kinetic work seeks a path, the most -𝕆D kinetically probable position of the electrons is where the e𝕒 and e𝕒 paths are narrowest. The -𝕆D kinetic difference then concentrates on the plates whether in series or parallel. When the two capacitors add together the e𝕪 path must be the same, then the -𝕆D kinetic difference is the same in one or two capacitors. Their capacitor in farads must then be the same as with one or two of them.

FIGURE 26.23 Replacing two parallel capacitors with an equivalent capacitor.



Adding kinetic voltages

When the -𝕆D_1 and -𝕆D_2 kinetic differences are added together, the kinetic voltage is the same in both cases. If each capacitor has the same -𝕆D kinetic difference, then these can be added in series to give a higher kinetic voltage like with the batteries.

As we'll show, parallel or series capacitors (or, as is sometimes said, capacitors "in parallel" or "in series") can be represented by a single **equivalent capacitance.** We'll demonstrate this first with the two parallel capacitors C_1 and C_2 of FIGURE 26.23a. Because the two top electrodes are connected by a conducting wire, they form a single conductor in electrostatic equilibrium. Thus the two top electrodes are at the same potential. Similarly, the two connected bottom electrodes are at the same potential. Consequently, two (or more) capacitors in parallel each have the *same* potential difference ΔV_C between the two electrodes.

The charges on the two capacitors are $Q_1 = C_1 \Delta V_C$ and $Q_2 = C_2 \Delta V_C$. Altogether, the battery's charge escalator moved total charge $Q = Q_1 + Q_2$ from the negative

Adding kinetic charges

Here the capacitance is the kinetic charge Q as -𝕠d×e𝕪/-𝕠d times $1/\Delta V_C$ as 1/-𝕠d. That gives a capacitance as a force F=ma. The charge can then accelerate if the capacitor is discharged. When two kinetic charges are added together, this doubles the e𝕪 kinetic electric charge while the 1/-𝕆D denominator remains the same. The number of -𝕠d and e𝕪 Pythagorean Triangles doubles and so the e𝕪 kinetic electric charge doubles.

electrodes to the positive electrodes. Suppose, as in FIGURE 26.23b, we replaced the two capacitors with a single capacitor having charge $Q = Q_1 + Q_2$ and potential difference ΔV_C. This capacitor is equivalent to the original two in the sense that the battery can't tell the difference. In either case, the battery has to establish the same potential difference and move the same amount of charge.

By definition, the capacitance of this equivalent capacitor is

$$C_{eq} = \frac{Q}{\Delta V_C} = \frac{Q_1 + Q_2}{\Delta V_C} = \frac{Q_1}{\Delta V_C} + \frac{Q_2}{\Delta V_C} = C_1 + C_2 \qquad (26.19)$$

This analysis hinges on the fact that **parallel capacitors each have the same potential difference ΔV_C.** We could easily extend this analysis to more than two capacitors. If capacitors $C_1, C_2, C_3, \ldots$ are in parallel, their equivalent capacitance is

$$C_{eq} = C_1 + C_2 + C_3 + \cdots \quad \text{(parallel capacitors)} \qquad (26.20)$$

Capacitors in parallel as impulse

In this model, when the capacitors are added in series, the -𝕆D kinetic difference is added together as constructive interference. When parallel it inverts the force F equation as -𝕠d×1/(-𝕠d×e𝕪/-𝕠d), the force F is inverted because a straight-line force is now the E𝕐/-𝕠d kinetic impulse as the inverse of -𝕆D×e𝕪 kinetic work. Across the three capacitors there is -𝕠d×E𝕐/-𝕠d, three times the force is 3 times the E𝕐/-𝕠d kinetic impulse. That is 1/3 the -𝕆D×e𝕪 kinetic work, 3 is inverted to 1/3.

Capacitor paths in series and parallel

Alternatively, when there are three paths in series then each e𝕪 path is the same as before with the same -𝕆D×e𝕪 kinetic work. So that increases the -𝕆D -𝕆D×e𝕪 kinetic work by three times. When the three paths are in parallel then the path is three times larger because the -𝕆D×e𝕪 kinetic work must move across all three capacitors. That makes the -𝕆D kinetic difference three times smaller, it changes from three in series to 1/3 in parallel.

Neither the battery nor any other part of a circuit can tell if the parallel capacitors are replaced by a single capacitor having capacitance C_{eq}.

Now consider the two series capacitors in **FIGURE 26.24a**. The center section, consisting of the bottom plate of C_1, the top plate of C_2, and the connecting wire, is electrically isolated. The battery cannot remove charge from or add charge to this section. If it starts out with no net charge, it must end up with no net charge. As a consequence, the two capacitors in series have equal charges $\pm Q$. The battery transfers Q from the bottom of C_2 to the top of C_1. This transfer polarizes the center section, as shown, but it still has $Q_{net} = 0$.

The potential differences across the two capacitors are $\Delta V_1 = Q/C_1$ and $\Delta V_2 = Q/C_2$. The total potential difference across both capacitors is $\Delta V_C = \Delta V_1 + \Delta V_2$. Suppose, as in **FIGURE 26.24b**, we replaced the two capacitors with a single capacitor having charge Q and potential difference $\Delta V_C = \Delta V_1 + \Delta V_2$. This capacitor is equivalent to the original two because the battery has to establish the same potential difference and move the same amount of charge in either case.

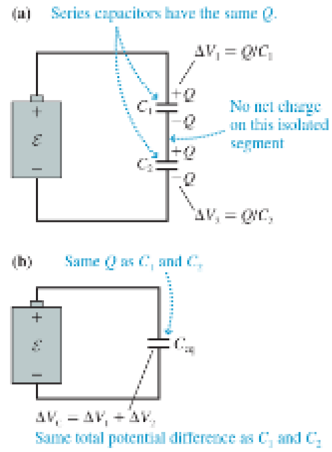
By definition, the capacitance of this equivalent capacitor is $C_{eq} = Q/\Delta V_C$. The inverse of the equivalent capacitance is thus

$$\frac{1}{C_{eq}} = \frac{\Delta V_C}{Q} = \frac{\Delta V_1 + \Delta V_2}{Q} = \frac{\Delta V_1}{Q} + \frac{\Delta V_2}{Q} = \frac{1}{C_1} + \frac{1}{C_2} \qquad (26.21)$$

This analysis hinges on the fact that **series capacitors each have the same charge** Q. We could easily extend this analysis to more than two capacitors. If capacitors $C_1, C_2, C_3, \ldots$ are in series, their equivalent capacitance is

$$C_{eq} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots\right)^{-1} \quad \text{(series capacitors)} \qquad (26.22)$$

FIGURE 26.24 Replacing two series capacitors with an equivalent capacitor.



Dimensions of energy

In this model the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy has the same dimensions as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, the ½×+𝕚d ×eℍ/+𝕀d rotational gravitation and the ½×e𝕍/-𝕀d ×-𝕚d linear inertia have the same proportional dimensions. This means the kinetic and inertial energies are proportional to each other, they are the inverses of the proportional potential and gravitational energies.

Potential energy

Here dU is +𝕠d×e𝕒/+𝕆D, using e𝕒 instead of E𝔸. This is dq×ΔV_C or +𝕠d×e𝕒/+𝕆D where ΔV_C is 1/+𝕠d. It represents a force, unlike this the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy has the E𝔸/+𝕠d potential impulse and +𝕆D×e𝕒 potential work in it as inverses. That makes energy stable rather than being a force. dU is taking the derivative of q with respect to +𝕠d, that is not allowed in this model except as an approximation.

Potential energy as a force

Instead with this model the +𝕆D×e𝕒 potential work is arrived at directly with integration. This potential energy is different to the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy which is not a force in conventional physics. The potential energy here has a force F=ma.

Integrating to F=ma

In (26.24) this is an integral as +𝕆D×e𝕒 potential work, (+𝕠d×e𝕒/+𝕠d)(+𝕠d×e𝕒/+𝕠d)/(2×+𝕠d×e𝕒/+𝕆D). This gives 1/2 ×(+𝕠d×e𝕒/+𝕆D) which is half of dU. This potential energy would be the same as the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy if the integral was with respect to e𝕒/+𝕠d, it would square this as E𝔸/+𝕆D and include the ½ factor. Instead it reduces down to the +𝕆D×e𝕒 potential work as in this model.

26.6 The Energy Stored in a Capacitor

Capacitors are important elements in electric circuits because of their ability to store energy. **FIGURE 26.27** shows a capacitor being charged. The instantaneous value of the charge on the two plates is $\pm q$, and this charge separation has established a potential difference $\Delta V = q/C$ between the two electrodes.

An additional charge dq is in the process of being transferred from the negative to the positive electrode. The battery's charge escalator must do work to lift charge dq "uphill" to a higher potential. Consequently, the potential energy of dq + capacitor increases by

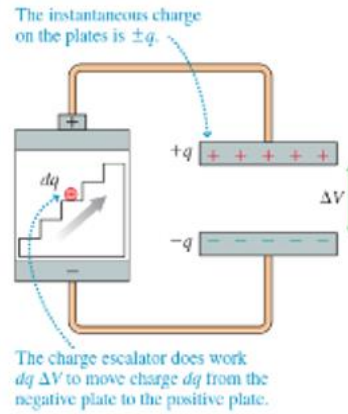
$$dU = dq\,\Delta V = \frac{q\,dq}{C} \qquad (26.23)$$

NOTE Energy must be conserved. This increase in the capacitor's potential energy is provided by the battery.

The total energy transferred from the battery to the capacitor is found by integrating Equation 26.23 from the start of charging, when $q = 0$, until the end, when $q = Q$. Thus we find that the energy stored in a charged capacitor is

$$U_C = \frac{1}{C}\int_0^Q q\,dq = \frac{Q^2}{2C} \qquad (26.24)$$

FIGURE 26.27 The charge escalator does work on charge dq as the capacitor is being charged.

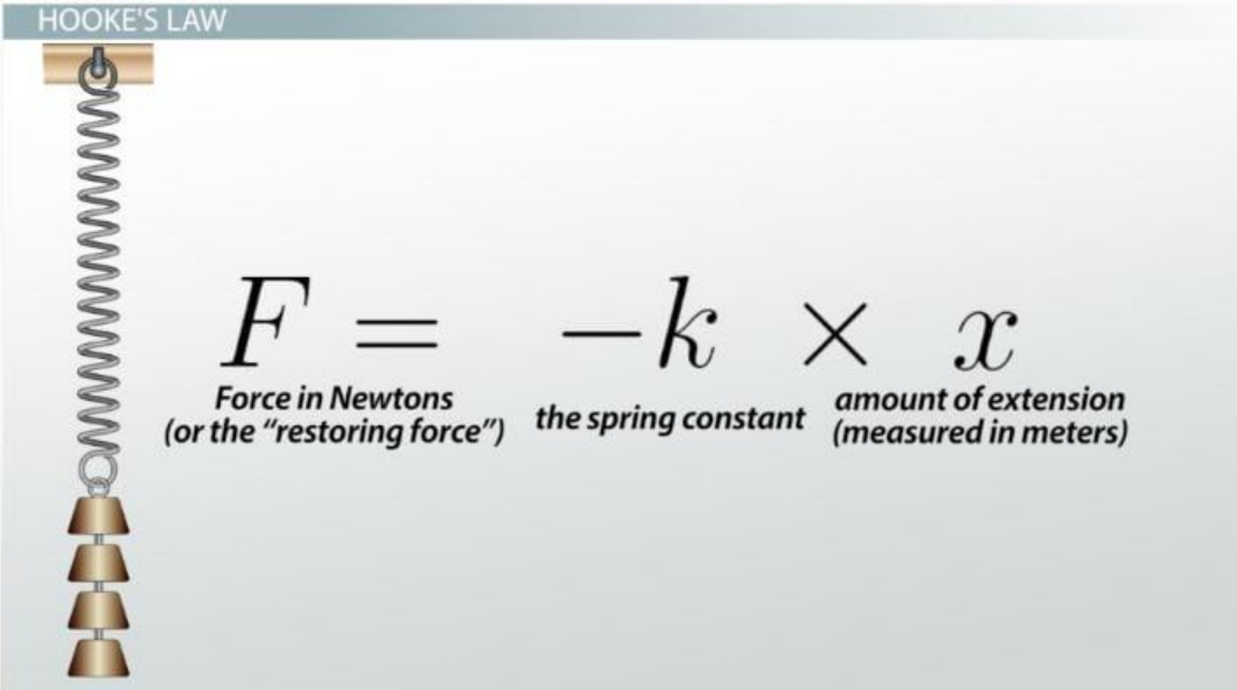


The spring constant

Here the spring constant k is in Newton meters as +𝕠d×E𝔸/+𝕆D which is the same format as the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. As a constant it means that the spring has a constant rotational potential energy in this model. When the spring is stretched, then e𝕒 as the distance comes from +𝕆D×e𝕒 potential work. Alternatively, k can be F=ma as +𝕠d×e𝕒/+𝕆D as with the capacitance. Then the factors e𝕒×e𝕒 are like the area A of a plate.

Extending a spring

When a spring is extended with a E𝕐/-𝕠d kinetic impulse then the change in its e𝕪 size in yards is proportional to the change in its e𝕧 length. The torque in the spring also changes as it is unwound, that does -𝕆D×e𝕪 kinetic work. If one end of the spring was like a clock with a hand, then unwinding would be like changing the hand as +𝕆D potential time. Because this is +𝕆D×e𝕒 potential work, the duration between the hand positions requires a torque to turn it. The spring constant can then contain the E𝕐/-𝕠d kinetic impulse and -𝕆D×e𝕪 kinetic work like in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy.



The potential difference

Here the potential energy is the square of the conventional potential difference which is +𝕠d, in this model that would be +𝕆D which is also the potential torque and probability.

In practice, it is often easier to write the stored energy in terms of the capacitor's potential difference $\Delta V_C = Q/C$. This is

$$U_C = \frac{Q^2}{2C} = \frac{1}{2}C(\Delta V_C)^2 \qquad (26.25)$$

The potential energy stored in a capacitor depends on the *square* of the potential difference across it. This result is reminiscent of the potential energy $U = \frac{1}{2}k(\Delta x)^2$ stored in a spring, and a charged capacitor really is analogous to a stretched spring. A stretched spring holds the energy until we release it, then that potential energy is transformed into kinetic energy. Likewise, a charged capacitor holds energy until we discharge it. Then the potential energy is transformed into the kinetic energy of moving charges (the current).

The permittivity constant

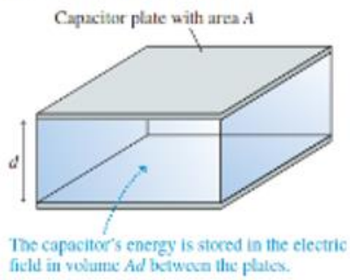
In conventional physics E is the electric field as e𝕒/+𝕠d, the e𝕒 kinetic electric charge is divided by 1/+𝕠d as the potential magnetic field. That can be written as ΔV_C=Ed or E=ΔV_C/d or +𝕠d/e𝕒. The capacitance is written here as ϵA/d, ϵ is the permittivity constant as a squared force, it gives the strength of the E𝔸/+𝕠d potential impulse. That increases also as a square with a changing area A of a plate. The distance d changes linearly because of the +𝕆D×e𝕒 potential work where e𝕒=d.

No volume of a field

In this model substituting these variables into an equation is many Pythagorean Triangles together. The energy stored as U is +𝕠d×e𝕒/+𝕆D, this comes from the +𝕆D×e𝕒 potential work. The area is a squared number of +𝕠d and e𝕒 Pythagorean Triangles and d is e𝕒, here there is no actual volume of a field. With A/d this reduces to e𝕒 so times +𝕠d×E𝔸/+𝕆D which is the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy. This is also ϵ which is a squared E𝔸 potential displacement as a constant force. E^2 is E𝔸/+𝕆D and ½ is the factor in the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy.

The Energy in the Electric Field

FIGURE 26.28 A capacitor's energy is stored in the electric field.



We can "see" the potential energy of a stretched spring in the tension of the coils. If a charged capacitor is analogous to a stretched spring, where is the stored energy? It's in the electric field!

FIGURE 26.28 shows a parallel-plate capacitor in which the plates have area A and are separated by distance d. The potential difference across the capacitor is related to the electric field inside the capacitor by $\Delta V_C = Ed$. The capacitance, which we found in Equation 26.18, is $C = \epsilon_0 A/d$. Substituting these into Equation 26.25, we find that the energy stored in the capacitor is

$$U_C = \frac{1}{2}C(\Delta V_C)^2 = \frac{\epsilon_0 A}{2d}(Ed)^2 = \frac{\epsilon_0}{2}(Ad)E^2 \qquad (26.26)$$

The quantity Ad is the volume *inside* the capacitor, the region in which the capacitor's electric field exists. (Recall that an ideal capacitor has $\vec{E} = \vec{0}$ everywhere except between the plates.) Although we talk about "the energy stored in the capacitor," Equation 26.26 suggests that, strictly speaking, **the energy is stored in the capacitor's electric field.**

Because Ad is the volume in which the energy is stored, we can define an **energy density** u_E of the electric field:

$$u_E = \frac{\text{energy stored}}{\text{volume in which it is stored}} = \frac{U_C}{Ad} = \frac{\epsilon_0}{2}E^2 \qquad (26.27)$$

Energy density

In this model Joules would be the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy and the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy on the negative plate. The volume in m^3 is the area A of a plate with a density of +𝕠d and e𝕒 Pythagorean Triangles as protons and -𝕠d and e𝕪 Pythagorean Triangles as electrons. The +𝕆D potential probability density is the same as the potential difference, the -𝕆D kinetic probability density is the same as the kinetic difference here.

The energy density has units J/m^3. We've derived Equation 26.27 for a parallel-plate capacitor, but it turns out to be the correct expression for any electric field.

From this perspective, charging a capacitor stores energy in the capacitor's electric field as the field grows in strength. Later, when the capacitor is discharged, the energy is released as the field collapses.

We first introduced the electric field as a way to visualize how a long-range force operates. But if the field can store energy, the field must be real, not merely a pictorial device. We'll explore this idea further in Chapter 31, where we'll find that the energy transported by a light wave—the very real energy of warm sunshine—is the energy of electric and magnetic fields.

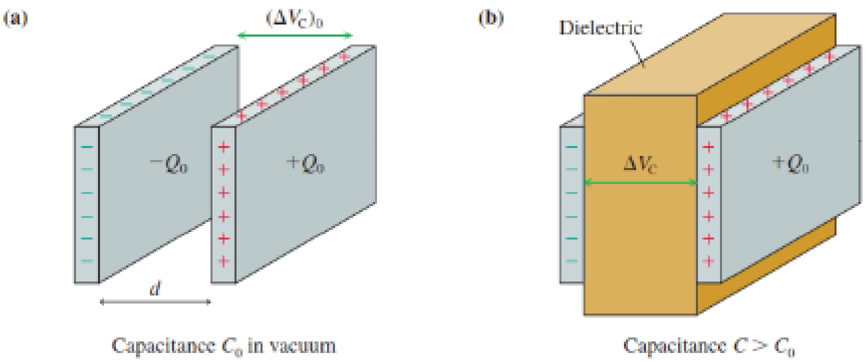
Dielectric

In this model the voltage decreases with a dielectric, this is because the atoms in the dielectric are a resistor. The atoms hold strongly onto the electrons, that means they can be polarized less to do -𝕆D×e𝕪 kinetic work in the capacitor. Here Q_0 +𝕠d×e𝕒/+𝕆D as C times +𝕠d to give +𝕠d×e𝕒/+𝕠d.

26.7 Dielectrics

FIGURE 26.29a shows a parallel-plate capacitor with the plates separated by vacuum, the perfect insulator. Suppose the capacitor is charged to voltage $(\Delta V_C)_0$, then disconnected from the battery. The charge on the plates will be $\pm Q_0$, where $Q_0 = C_0(\Delta V_C)_0$. We'll use a subscript 0 in this section to refer to a vacuum-insulated capacitor.

FIGURE 26.29 Vacuum-insulated and dielectric-filled capacitors.



The limits of the capacitor

In this model a capacitor is limited by how much +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work can be done with it. When there is too much charge a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse jumps across the plates directly. With a dielectric it is like a resistor, the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse are stopped as particles by the more stable atoms in it. The voltage decreases because the +𝕆D potential difference and -𝕆D kinetic difference cannot alignt he dielectric atoms to do work.

Now suppose, as in **FIGURE 26.29b**, an insulating material, such as oil or glass or plastic, is slipped between the capacitor plates. We'll assume for now that the insulator is of thickness d and completely fills the space. An insulator in an electric field is called a **dielectric,** for reasons that will soon become clear, so we call this a *dielectric-filled capacitor*. How does a dielectric-filled capacitor differ from the vacuum-insulated capacitor?

The charge on the capacitor plates does not change. The insulator doesn't allow charge to move through it, and the capacitor has been disconnected from the battery, so no charge can be added to or removed from either plate. That is, $Q = Q_0$. Nonetheless, measurements of the capacitor voltage with a voltmeter would find that the voltage has decreased: $\Delta V_C < (\Delta V_C)_0$. Consequently, based on the definition of capacitance, the capacitance has increased:

$$C = \frac{Q}{\Delta V_C} > \frac{Q_0}{(\Delta V_C)_0} = C_0$$

Example 26.6 found that the plate size needed to make a 1 μF capacitor is unreasonably large. It appears that we can get more capacitance *with the same plates* by filling the capacitor with an insulator.

Dipoles as capacitors

Here the polarized resistor is like a capacitor itself, the charge accumulates on the ends. The +𝕆D potential difference gives a +𝕆D potential torque to the dipoles in the dielectric, the -𝕆D kinetic difference also gives a -𝕆D kinetic torque to the dipoles. Each is like a capacitor itself with a positive plate side and a negative plate side. These add up like capacitors in series, that means more work is needed to cross the resistor.

Polarization and magnetism

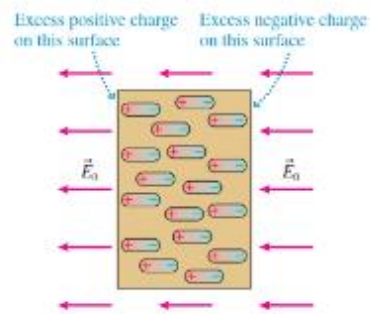
This polarization is the inverse of the magnetic spin lining up in a magnet. There the -𝕆D kinetic probability interferes destructively with other electrons around it, it interferes constructively in the direction of the north and south poles. The +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work here line up the dipoles in straight lines with a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse, in a magnet the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work cause the electrons to spin in the same direction.

We can utilize two tools you learned in Chapter 23, superposition and polarization, to understand the properties of dielectric-filled capacitors. Figure 23.27 showed how an insulating material becomes *polarized* in an external electric field. **FIGURE 26.30a** reproduces the basic ideas from that earlier figure. The electric dipoles in Figure 26.30a could be permanent dipoles, such as water molecules, or simply induced dipoles due to a slight charge separation in the atoms. However the dipoles originate, their alignment in the electric field—the *polarization* of the material—produces an excess positive charge on one surface, an excess negative charge on the other. The insulator as a whole is still neutral, but the external electric field separates positive and negative charge.

FIGURE 26.30b represents the polarized insulator as simply two sheets of charge with surface charge densities $\pm\eta_{induced}$. The size of $\eta_{induced}$ depends both on the strength of the electric field and on the properties of the insulator. These two sheets of charge create an electric field—a situation we analyzed in Chapter 23. In essence, the two sheets of induced charge act just like the two charged plates of a parallel-plate capacitor. The **induced electric field** (keep in mind that this field is due to the insulator responding to the external electric field) is

FIGURE 26.30 An insulator in an external electric field.

(a) The insulator is polarized.



Stable polarization

The surface charge on the polarized insulator does +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work on the capacitor plates, when the charge is stable there is no longer any force. They retain direction like the spin in a magnet.

Insulators

An insulator does mainly +𝕆D×e𝕒 potential work because the electrons are more bound. This reduces the +𝕆D potential difference between the plates from destructive interference. The electrons in the insulator repel the electrons doing -𝕆D×e𝕪 kinetic work, they cannot move from their atoms and reduce the -𝕆D kinetic difference.

Vector addition as well as positive and negative

In this model the E⃗ e𝕒 and e𝕪 straight Pythagorean Triangle sides are vectors, these then use vector addition. The +𝕠d potential magnetic field and -𝕠d kinetic magnetic field use positive and negative signs.

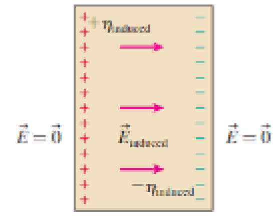
Induced electric field

In this model the induced electric field e𝕒/+𝕠d reacts against the kinetic electric charge e𝕪/-𝕠d. That adds more +𝕆D×e𝕒 potential work to the -𝕆D×e𝕪 kinetic work of the negative plate, the sum of the -𝕆D×e𝕪 kinetic work is weakened and so there is less voltage across the plates.

$$\vec{E}_{\text{induced}} = \begin{cases} \left(\dfrac{\eta_{\text{induced}}}{\epsilon_0}, \text{ from positive to negative}\right) & \text{inside the insulator} \\ \vec{0} & \text{outside the insulator} \end{cases} \quad (26.28)$$

It is because an insulator in an electric field has *two* sheets of induced *electric* charge that we call it a *dielectric*, with the prefix *di*, meaning *two*, the same as in "diatomic" and "dipole."

(b) The polarized insulator—a dielectric—can be represented as two sheets of surface charge. This surface charge creates an electric field inside the insulator.



Inserting a Dielectric into a Capacitor

FIGURE 26.31 on the next page shows what happens when you insert a dielectric into a capacitor. The capacitor plates have their own surface charge density $\eta_0 = Q_0/A$. This creates the electric field $\vec{E}_0 = (\eta_0/\epsilon_0$, from positive to negative) into which the dielectric is placed. The dielectric responds with induced surface charge density η_{induced} and the induced electric field $\vec{E}_{\text{induced}}$. Notice that $\vec{E}_{\text{induced}}$ points *opposite* to $\vec{E}_0$. By the principle of superposition, another important lesson from Chapter 23, the net electric field between the capacitor plates is the *vector* sum of these two fields:

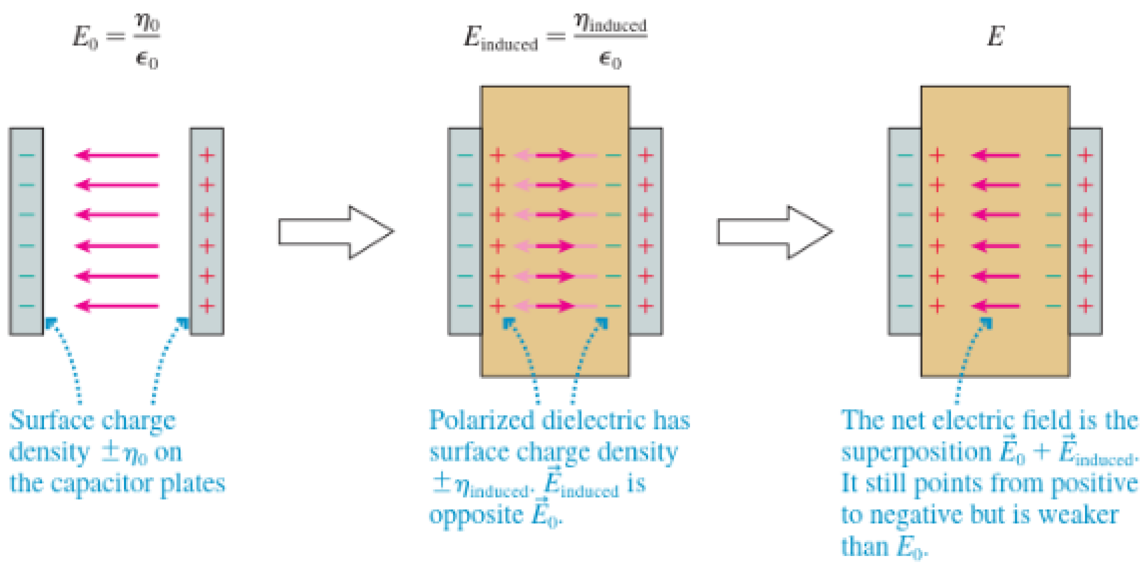
$$\vec{E} = \vec{E}_0 + \vec{E}_{\text{induced}} = (E_0 - E_{\text{induced}}, \text{ from positive to negative}) \quad (26.29)$$

The presence of the dielectric weakens the electric field, from E_0 to $E_0 - E_{\text{induced}}$, but the field still points from the positive capacitor plate to the negative capacitor plate. The field is weakened because the induced surface charge in the dielectric acts to counter the electric field of the capacitor plates.

More potential work as a repulsion

In this model the +𝕠d and e𝕒 Pythagorean Triangles as protons have reactive forces only, this repels the +𝕆D potential difference of the positive plate. That also repels the +𝕆D×e𝕒 potential work done by the positive plate as a reaction or repulsive force.

FIGURE 26.31 The consequences of filling a capacitor with a dielectric.



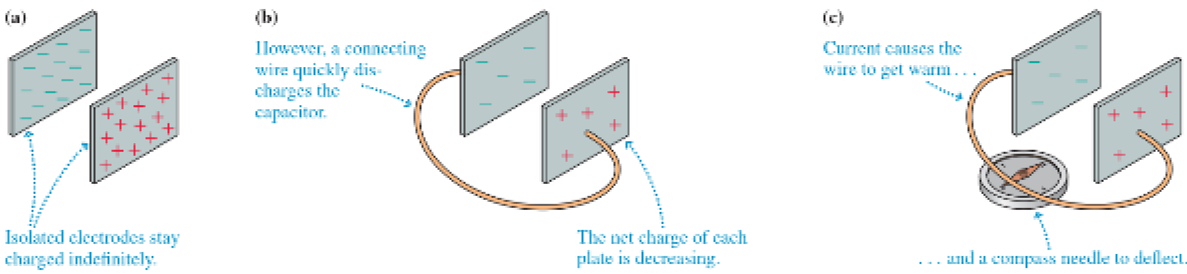
Current and Resistance

When the capacitor discharges this has work and impulse, the compass is deflected from the changing -𝕆D kinetic torque in the discharge. Because the compass rotates there is -𝕆D×e𝕪 kinetic work done on it.

27.1 The Electron Current

We've focused thus far on situations in which charges are in static equilibrium. Now it's time to explore the *controlled motion* of charges—currents. Let's begin with a simple question: How does a capacitor get discharged? **FIGURE 27.1a** shows a charged capacitor. If, as in **FIGURE 27.1b**, we connect the two capacitor plates with a metal wire, a conductor, the plates quickly become neutral; that is, the capacitor has been *discharged*. Charge has somehow moved from one plate to the other.

FIGURE 27.1 A capacitor is discharged by a metal wire.



Heating the wire

In this model the wire gets warm from +𝕆D×e𝕒 potential work resistance, that comes from the insulating properties of the wire. If it gets hot enough the -𝕆D×e𝕪 kinetic work causes e𝕪×-𝕘d photons to be emitted from the wire atoms.

In Chapter 22, we defined **current** as the motion of charges. It would seem that the capacitor is discharged by a current in the connecting wire. Let's see what else we can observe. **FIGURE 27.1c** shows that the connecting wire gets warm. If the wire is very thin in places, such as the thin filament in a lightbulb, the wire gets hot enough to glow. The current-carrying wire also deflects a compass needle, an observation we'll explore further in Chapter 29. For now, we will use "makes the wire warm" and "deflects a compass needle" as *indicators* that a current is present in a wire.

The sea of electrons

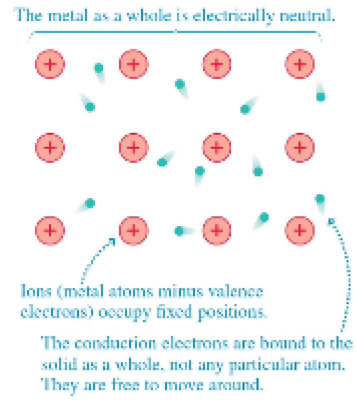
In this model the current moves with the e𝕪/-𝕠d kinetic velocity, there is a -𝕆D kinetic difference in between the electrons as they do work on each other. That causes them to repel each other with a destructive interference spreading them out. They have a constructive interference with the +𝕆D potential difference, that moves them towards the positive terminal of a battery.

Charge Carriers

The charges that move in a conductor are called the *charge carriers*. FIGURE 27.2 reminds you of the microscopic model of a metallic conductor that we introduced in Chapter 22. The outer electrons of metal atoms—the valence electrons—are only weakly bound to the nuclei. When the atoms come together to form a solid, the outer electrons become detached from their parent nuclei to form a fluid-like *sea of electrons* that can move through the solid. That is, **electrons are the charge carriers in metals.** Notice that the metal as a whole remains electrically neutral. This is not a perfect model because it overlooks some quantum effects, but it provides a reasonably good description of current in a metal.

NOTE Electrons are the charge carriers in *metals*. Other conductors, such as ionic solutions or semiconductors, have different charge carriers. We will focus on metals because of their importance to circuits, but don't think that electrons are *always* the charge carrier.

FIGURE 27.2 The sea of electrons is a model of electrons in a metal.



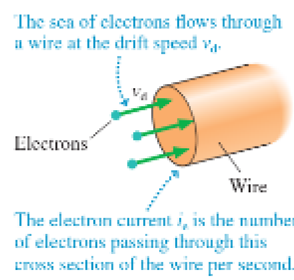
The kinetic drift velocity

In this model the kinetic drift velocity comes from the -𝕆D×e𝕪 kinetic work. The electrons also have a E𝕐/-𝕠d kinetic impulse as particles, they collide with each other in moving towards the positive terminal. The E𝕐/-𝕠d kinetic impulse is stronger because the electron is more like a particle outside the atom. The E𝕐/-𝕠d kinetic impulse is the inverse of the -𝕆D×e𝕪 kinetic work, the current then moves with a e𝕪/-𝕚d kinetic velocity as well as a -𝕠d×e𝕪 kinetic field. That makes the electrons move as a particle/wave duality.

The conduction electrons in a metal, like molecules in a gas, undergo random thermal motions, but there is no *net* motion. We can change that by pushing on the sea of electrons with an electric field, causing the entire sea of electrons to move in one direction like a gas or liquid flowing through a pipe. This net motion, which takes place at what we'll call the **drift speed** v_d, is superimposed on top of the random thermal motions of the individual electrons. The drift speed is quite small. As we'll establish later, 10^{-4} m/s is a fairly typical value for v_d.

As FIGURE 27.3 shows, the entire sea of electrons moves from left to right at the drift speed. Suppose an observer could count the electrons as they pass through this cross section of the wire. Let's define the **electron current** i_e to be the number of electrons *per second* that pass through a cross section of a wire or other conductor. The

FIGURE 27.3 The electron current.



The number of electrons

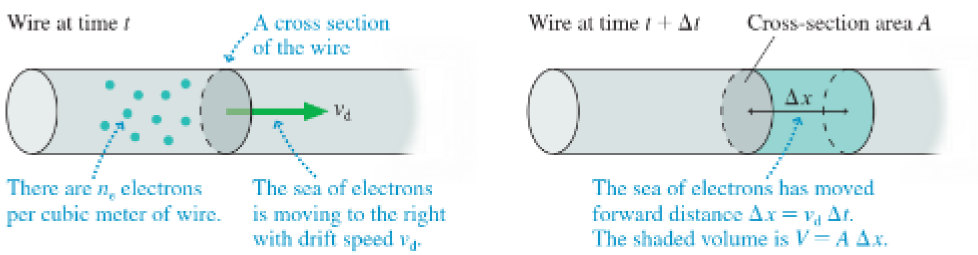
The N_e of electrons would be the number of -𝕠d and e𝕪 Pythagorean Triangles. In this model the cross section would not be used, except as the -𝕆D destructive interference between the electrons spreading them out. The electron current here is n/Δt or n/-𝕠d which is e𝕪/-𝕠d because each electrons has its own e𝕪 kinetic electric charge.

units of electron current are s^{-1}. Stated another way, the number N_e of electrons that pass through the cross section during the time interval Δt is

$$N_e = i_e \Delta t \quad (27.1)$$

Not surprisingly, the electron current depends on the electrons' drift speed. To see how, **FIGURE 27.4** shows the sea of electrons moving through a wire at the drift speed v_d. The electrons passing through a particular cross section of the wire during the interval Δt are shaded. How many of them are there?

FIGURE 27.4 The sea of electrons moves to the right with drift speed v_d.



Electron density

In this model the density would come from the -𝕆D kinetic probability density or kinetic difference. When the voltage is stronger, this can push together electrons more despite their individual -𝕆D kinetic destructive interference. When the cross-section area is larger as a square, this increases the -𝕆D kinetic probability as a square.

The electrons travel distance $\Delta x = v_d \Delta t$ to the right during the interval Δt, forming a cylinder of charge with volume $V = A\,\Delta x$. If the *number density* of conduction electrons is n_e electrons per cubic meter, then the total number of electrons in the cylinder is

$$N_e = n_e V = n_e A\,\Delta x = n_e A v_d \Delta t \quad (27.2)$$

Comparing Equations 27.1 and 27.2, you can see that the electron current in the wire is

$$i_e = n_e A v_d \quad (27.3)$$

You can increase the electron current—the number of electrons per second moving through the wire—by making them move faster, by having more of them per cubic meter, or by increasing the size of the pipe they're flowing through. That all makes sense.

In most metals, each atom contributes one valence electron to the sea of electrons. Thus the number of conduction electrons per cubic meter is the same as the number of atoms per cubic meter, a quantity that can be determined from the metal's mass density. **TABLE 27.1** gives values of the conduction-electron density n_e for several metals.

Discharging a capacitor

The electrons push on each other with destructive interference, that repulsion causes some electrons to move out of the wire. They also collide with each other as particles, the E𝕐/-𝕠d kinetic impulse is an elastic collision transmitting the impulse more quickly along the wire.

Discharging a Capacitor

FIGURE 27.5 shows a capacitor charged to ± 16 nC as it is being discharged by a 2.0-mm-diameter, 20-cm-long copper wire. *How long does it take* to discharge the capacitor? We've noted that a fairly typical drift speed of the electron current through a wire is 10^{-4} m/s. At this rate, it would take 2000 s, or about a half hour, for an electron to travel 20 cm.

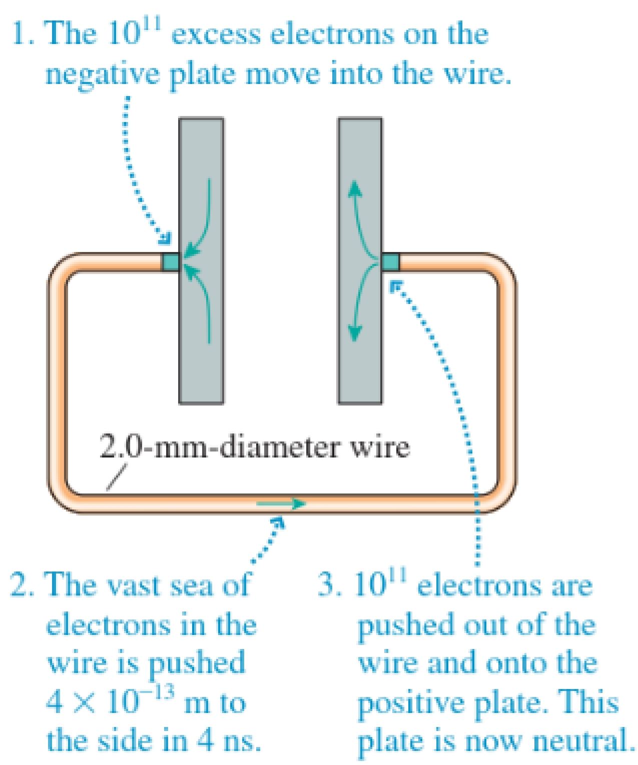
But this isn't what happens. As far as our senses are concerned, the discharge of a capacitor is instantaneous. So what's wrong with our simple calculation?

The important point we overlooked is that the wire is *already full* of electrons. As an analogy, think of water in a hose. If the hose is already full of water, adding a drop to one end immediately (or very nearly so) pushes a drop out the other end. Likewise with the wire. As soon as the excess electrons move from the negative capacitor plate into the wire, they immediately (or very nearly so) push an equal number of electrons out the other end of the wire and onto the positive plate, thus neutralizing it. We don't have to wait for electrons to move all the way through the wire from one plate to the other. Instead, we just need to slightly rearrange the charges on the plates *and* in the wire.

Equalizing the potential and kinetic differences

When the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work equalize, then positive and negative values sum to approximate neutrality.

FIGURE 27.6 The sea of electrons needs only a minuscule rearrangement.



Pushing a book

In this model pushing a book is done with -𝕆D×e𝕪 kinetic work, it changes the e𝕪 position. That is reacted against by -𝕀D×e𝕧 inertial work and so it needs to be continually pushed forward. There is also an attraction downwards with +𝕀D×e𝕙 gravitational work, the electrons in the bottom of the book tend to bind to the table's +𝕆D×e𝕒 potential work.

Pushing electrons with destructive interference

The electrons are pushed with destructive interference between the hand's electrons and the book's electrons. This causes them to repel each other, preventing the book sinking into the hand's molecules. That gives matter its strength preventing other matter from going through it. With a liquid the electrons are less tightly bound in molecules, a hand could pass through it.

Temperature and impulse

Because the electrons also move with a E𝕐/-𝕠d kinetic impulse, the e𝕪 temperature increases with a stronger E𝕐 kinetic displacement. Temperature is stronger when electrons act as particles, when they are in the atom they mainly do -𝕆D×e𝕪 kinetic work. The Fermi temperature to eject electrons is much higher, that is because the stronger -𝕆D×e𝕪 kinetic work has a weaker E𝕐/-𝕠d kinetic impulse. Collisions between atoms can raise their temperature as they vibrate chaotically.

Electron tunneling

Electrons can tunnel through a wall with -𝕆D×e𝕪 kinetic work, the tunneling distance decreases exponentially. This is because as e𝕪 increases in distance, -𝕆D as the kinetic probability decreases as a square. Comparing the two gives an exponential curve because the -𝕠d and e𝕪 Pythagorean Triangle has a constant area.

The macro world

With the macro world the distances are much larger, that makes impulse much stronger with a displacement between positions over time. With a larger e𝕧 length as a distance, the -𝕆D kinetic probability decreases as a square like with quantum tunneling. That makes matter impenetrable to this tunneling unlike with small distances. Matter is observed to be more solid and composed of particles. There is still some work done in the macro world, for example many events occur with probabilities such as in gambling. Temperatures change more easily than inside atoms, quantization is also not measured over larger distances.

Biv space-time and work

In Biv space-time the wave nature occurs over longer distances, this creates a +𝕚d gravitational geodesic in general relativity. Gravity appears to be a field and gravitons are not observed, that extends out to the CMB. When compared to the particle nature of atoms in Roy electromagnetism, this gives a observable difference between the impulse of the macro world and the curved field nature of gravity with work.

27.2 Creating a Current

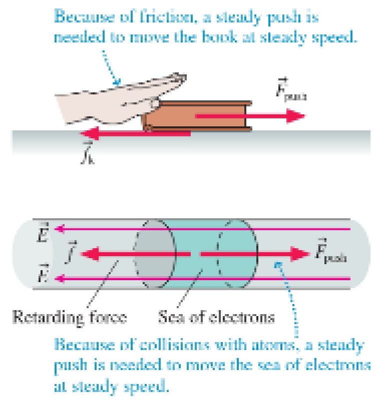
Suppose you want to slide a book across the table to your friend. You give it a quick push to start it moving, but it begins slowing down because of friction as soon as you take your hand off. The book's kinetic energy is transformed into thermal energy, leaving the book and the table slightly warmer. The only way to keep the book moving at a constant speed is to *continue pushing it*.

As FIGURE 27.7 shows, the sea of electrons is similar to the book. If you push the sea of electrons, you create a current of electrons moving through the conductor. But the electrons aren't moving in a vacuum. Collisions between the electrons and the atoms of the metal transform the electrons' kinetic energy into the thermal energy of the metal, making the metal warmer. (Recall that "makes the wire warm" is one of our indicators of a current.) Consequently, the sea of electrons will quickly slow down and stop *unless you continue pushing*. How do you push on electrons? With an electric field!

One of the important conclusions of Chapter 24 was that $\vec{E} = \vec{0}$ inside a conductor in electrostatic equilibrium. But a conductor with electrons moving through it is *not* in electrostatic equilibrium. **An electron current is a nonequilibrium motion of charges sustained by an internal electric field.**

Thus the quick answer to "What creates a current?" is "An electric field." But why is there an electric field in a current-carrying wire?

FIGURE 27.7 Sustaining the electron current with an electric field.



Compressible matter

In this model the electrons repel each other with kinetic destructive interference, they also repel each other with an inertial destructive interference from -𝕀D×e𝕧 inertial work. That makes matter less compressible, a gas tends to have its molecules repel each other with destructive interference. They also collide with each other as particles over longer distances with a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse.

Liquids and solids

A liquid has stronger +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work, the molecules are more attracted to each other with constructive interference between a nucleus and another atom's electrons. With a solid the connections between the molecules are stronger because the electrons do less -𝕆D×e𝕪 kinetic work, the increased +𝕆D×e𝕒 potential work means the atoms bind each other more with +𝕆D potential probabilities.

Melting a solid

A e𝕒 and e𝕪 temperature increase has less effect as with the Fermi temperature inside atoms. As a solid melts, the atoms become more like particles with a E𝕐/-𝕠d kinetic impulse. That allows them to break more molecular bonds with their +𝕆D×e𝕒 potential work.

Establishing the Electric Field in a Wire

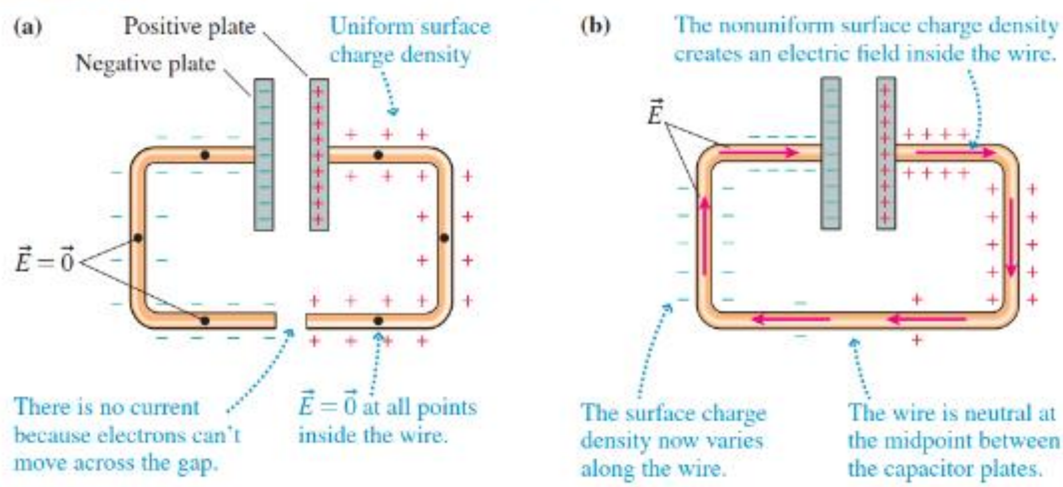
FIGURE 27.8a shows two metal wires attached to the plates of a charged capacitor. The wires are conductors, so some of the charges on the capacitor plates become spread out along the wires as a surface charge. (Remember that all excess charge on a conductor is located on the surface.)

This is an electrostatic situation, with no current and no charges in motion. Consequently—because this is always true in electrostatic equilibrium—the electric field inside the wire is zero. Symmetry requires there to be equal amounts of charge to either side of each point to make $\vec{E} = \vec{0}$ at that point; hence the surface charge density must be uniform along each wire except near the ends (where the details need not concern us). We implied this uniform density in Figure 27.8a by drawing equally spaced + and − symbols along the wire. Remember that a positively charged surface is a surface that is *missing* electrons.

Connecting wires

When the wire is connected there is the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse with a surge of straight-line motion along it. That takes +𝕠d potential time and -𝕠d kinetic time to spread out the charges again. In the capacitor the electrons are closer together with a e𝕪 distance, that comes from the -𝕆D kinetic probability which is higher on the negative plate. The electrons are more kinetically probable to be measured there. When the circuit is closed they spread out with destructive interference lowering their kinetic voltage.

FIGURE 27.8 The surface charge on the wires before and after they are connected.



A nonuniform distribution

When the circuit is closed the electrons have a nonuniform distribution, this comes from the E𝕐/-𝕠d kinetic impulse as particles. Over -𝕠d kinetic time this E𝕐 kinetic displacement decreases as an exponential decay. Then the electrons resume a normal uniform distribution with -𝕆D×e𝕪 kinetic work between them spread them out evenly.

Now we connect the ends of the wires together. What happens? The excess electrons on the negative wire suddenly have an opportunity to move onto the positive wire that is missing electrons. Within a *very* brief interval of time ($\approx 10^{-9}$ s), the sea of electrons shifts slightly and the surface charge is rearranged into a *nonuniform* distribution like that shown in **FIGURE 27.8b**. The surface charge near the positive and negative plates remains strongly positive and negative because of the large amount of charge on the capacitor plates, but the midpoint of the wire, halfway between the positive and negative plates, is now electrically neutral. The new surface charge density on the wire varies from positive at the positive capacitor plate through zero at the midpoint to negative at the negative plate.

This nonuniform distribution of surface charge has an *extremely* important consequence. **FIGURE 27.9** shows a section from a wire on which the surface charge density becomes more positive toward the left and more negative toward the right. Calculating the exact electric field is complicated, but we can understand the basic idea if we *model* this section of wire with four circular rings of charge.

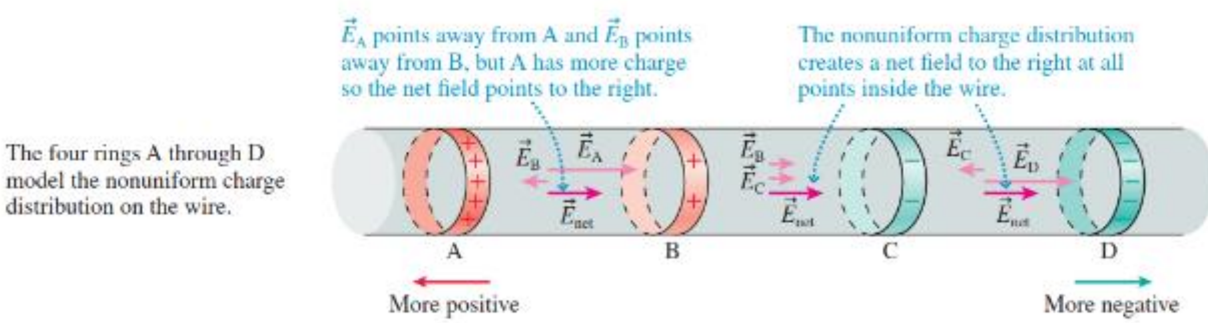
Destructive interference

In this model each electron has a -𝕆D kinetic probability, it interferes destructively with other electrons in the wire. This causes them to repel each other and spread out. The -Od kinetic difference from the negative plate means there is a higher kinetic probability the electrons are measured closer to the positive plate.

Lower repulsion

The net field here is the constructive interference between the +𝕆D potential difference and the -𝕆D kinetic difference. These are added together, there is a lower repulsion between electrons as they get closer to the positive plate. That is because the +𝕆D potential probability is added to each electron, it is like their being absorbed into atoms in the positive plate by combining with the protons there. That is why, according to this model, electrons can coexist in an atom and not have to spread out like in the wire.

FIGURE 27.9 A varying surface charge distribution creates an internal electric field inside the wire.



Vector subtraction

In this model the e𝕒 positive charge points towards the negative plate, the e𝕪 negative charge points towards the positive plate. This is because the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work is measured at e𝕒 and e𝕪 positions with vectors. There is a linear vector subtraction with these, the +𝕆D potential probability and -𝕆D kinetic probability varies as an inverse square to the vectors. The +𝕆D and -𝕆D probabilities also extend around the wires as magnetic fields.

This field is proportional to the amount of charge, here this is the number of +𝕠d and e𝕒 Pythagorean Triangle protons and -𝕠d and e𝕪 Pythagorean Triangle electrons.

In Chapter 23, we found that the on-axis field of a ring of charge

- Points away from a positive ring, toward a negative ring;
- Is proportional to the amount of charge on the ring; and
- Decreases with distance away from the ring.

The field midway between rings A and B is well approximated as $\vec{E}_{net} \approx \vec{E}_A + \vec{E}_B$. Ring A has more charge than ring B, so $\vec{E}_{net}$ points away from A.

The analysis of Figure 27.9 leads to a very important conclusion:

A *nonuniform* distribution of surface charges along a wire creates a net electric field *inside* the wire that points from the more positive end of the wire toward the more negative end of the wire. This is the internal electric field $\vec{E}$ that pushes the electron current through the wire.

Note that the surface charges are *not* the moving charges of the current. Further, the current—the moving charges—is *inside* the wire, not on the surface. In fact, as the next example shows, the electric field inside a current-carrying wire can be established with an extremely small amount of surface charge.

Random dissipation of voltage

In this model the electrons do -𝕀D×e𝕧 inertial work as a reaction to the proton's +𝕆D×e𝕒 potential work. This means they need a -𝕆D kinetic difference to keep doing work in one direction, if not then the random Gaussian nature of the probabilities will dissipate the work randomly. This gaussian distribution tends to have an average density where large concentrations and deficits of electrons at e𝕪 positions are less probable.

Random friction

Friction then comes from a randomizing process of +𝕆D and -𝕆D, motion in one direction is a straight-line which comes from a nonrandom chaotic impulse. That is deterministic so the most probable outcome is the voltage averages out to a neutral state, then the electrons move randomly in all directions.

Cooper pairs

In this model Cooper pairs of electrons have opposing spins, one electron has been flipped over. This allows them to cancel each other's -𝕆D kinetic torque, they can then move to a lower orbital. In superconductivity they form a boson pair by destructive interference from electrons in the lattice around them. This repels the Cooper pairs making it easier for them to stay together.

Superconductivity and work

In this model work is measured over a distance not time. It does not then change over time like with impulse, that is like a superconducting current not changing over time. The Cooper pairs move on a gradient like a circular racing track. There is no friction because there is no E𝕐/-𝕠d kinetic impulse and turbulence changing them over kinetic time. An outside magnetic field also does not change over time, there is a gradient from a bar magnet for example.

Repelling an external magnetic field

This is repelled as it would change the superconducting current over time. It is like two solids coming together, the -𝕆D×e𝕪 kinetic work of electrons in the solids don't change over time so they compress only a small amount. Also the fermions in the magnet are unpaired, this allows them to do -𝕆D×e𝕪 kinetic work. Their work is stronger because the fermions do not have opposing spins in a boson pair. They are repelled by the Cooper pairs like they are repelled by the boson pairs in their atoms.

The Boltzmann constant

Without a voltage the electrons move randomly with -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work. This is proportional to the Boltzmann constant k as -𝕠d×e𝕪/-𝕆D which is ma in F=ma. That is measuring work and so when electrons, or gas molecules, come closer together this constant means they spread out more on a Gaussian.

A Model of Conduction

Electrons don't just magically move through a wire as a current. They move because an electric field inside the wire—a field created by a nonuniform surface charge density on the wire—pushes on the sea of electrons to create the electron current. The field has to *keep* pushing because the electrons continuously lose energy in collisions with the positive ions that form the structure of the solid. These collisions provide a drag force, much like friction.

We will model the conduction electrons—those electrons that make up the sea of electrons—as free particles moving through the lattice of the metal. In the absence of an electric field, the electrons, like the molecules in a gas, move randomly in all directions with a distribution of speeds. If we assume that the average thermal energy of the electrons is given by the same $\frac{3}{2}k_BT$ that applies to an ideal gas, we can calculate that the average electron speed at room temperature is $\approx 10^5$ m/s. This estimate turns out, for quantum physics reasons, to be not quite right, but it correctly indicates that the conduction electrons are moving very fast.

Zero kinetic velocity

The average e𝕪/-𝕠d kinetic velocity is zero because the -𝕆D×e𝕪 kinetic work is randomizing. A net displacement would occur with a E𝕐/-𝕠d kinetic impulse where E𝕐 is the kinetic displacement. The parabolic trajectory comes from a squared force from one Pythagorean Triangle and a linear value from a second Pythagorean Triangle.

Parabolic work in Biv spacetime

For example, a projectile fired in Biv space-time falls towards a planet with a +𝕀D gravitational probability, that gives parabolic work with +𝕀D being measured by the e𝕧 length. It moves orthogonally to this with a e𝕧/-𝕚d inertial velocity. That associates the e𝕧 length with the +𝕀D gravitational probability or torque curving the trajectory. In this model e𝕧 would change proportionally to +𝕚d, also -𝕚d as the inertial mass would change proportionally to the eℍ height.

Parabolic impulse in Biv spacetime

There is also a -𝕚d inertial mass or time of the projectile, that falls with an Eℍ gravitational displacement that is observed by this time. The projectile can then move with two inverse square laws, one of work as +𝕀D×e𝕧 and one of impulse as E𝕍/+𝕚d.

Parabolas are not relativistic

This is not subject to relativistic changes, a parabolic trajectory above an event horizon would have its +𝕚d gravitational time slowed and the E𝕍 inertial displacement would be contracted as a square. The parabola would begin from a circular orbit, above the event horizon a rocket would need to have an inertial velocity close to c to maintain this. There would also be a e𝕙/+𝕚d gravitational speed downwards with the same proportional of c. To make a parabola the +𝕚d and e𝕙 Pythagorean Triangle as gravity, and the -𝕚d and e𝕧 Pythagorean Triangle as inertia, would be relativistic changed in the same way.

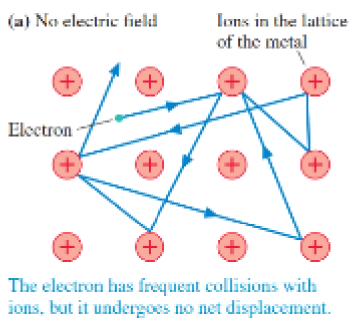
Parabolic work in Roy electromagnetism

The electrons move proportionally to this, the e𝕪 yards are proportional to the e𝕧 lengths and the +𝕆D potential probabilities are proportional to the +𝕀D gravitational probabilities. The electrons can then move parabolically, their gravitational trajectory is proportional to the potential trajectory so the two do not conflict. They do +𝕆D×e𝕒 potential work and +𝕀D×e𝕙 gravitational work.

Parabolic impulse in Roy electromagnetism

Because electrons outside the atom move mainly with a E𝕐/-𝕠d kinetic impulse and E𝕍/-𝕚d inertial impulse, they are particles. The inverse square law here would also be parabolic, the E𝔸 potential displacement is proportional to the Eℍ gravitational displacement. The -𝕠d kinetic time is proportional to the -𝕚d inertial time. That gives a parabolic impulse which is not relativistic, this is because the different Pythagorean Triangle sides change proportionally not inversely as the E𝕐/+𝕠d and E𝕍/+𝕚d impulse.

FIGURE 27.11 A microscopic view of a conduction electron moving through a metal.



However, an individual electron does not travel far before colliding with an ion and being scattered to a new direction. **FIGURE 27.11a** shows that an electron bounces back and forth between collisions, but its *average* velocity is zero, and it undergoes no *net* displacement. This is similar to molecules in a container of gas.

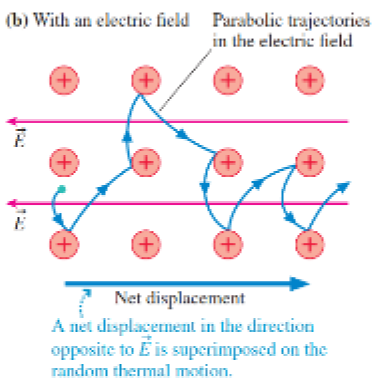
Suppose we now turn on an electric field. **FIGURE 27.11b** shows that the steady electric force causes the electrons to move along *parabolic trajectories* between collisions. Because of the curvature of the trajectories, the negatively charged electrons begin to drift slowly in the direction opposite the electric field. The motion is similar to a ball moving in a pinball machine with a slight downward tilt. An individual electron ricochets back and forth between the ions at a high rate of speed, but now there is a slow *net* motion in the "downhill" direction. Even so, this net displacement is a *very* small effect superimposed on top of the much larger thermal motion. Figure 27.11b has greatly exaggerated the rate at which the drift would occur.

Collisions as work and impulse

In this model a collision occurs as -𝕆D×e𝕪 kinetic work and the E𝕐/-𝕠d kinetic impulse. When the electrons are close to each other e𝕪 is smaller, so -𝕆D as the kinetic probability interferes more destructively between them. That is consistent with a E𝕐/-𝕠d kinetic impulse elastic collision, from a larger e𝕪 distance there is a larger E𝕐 kinetic displacement and smaller -𝕠d kinetic time.

Point sized electrons bounce off each other

That allows electrons to bounce off each other even they are point sized. The e𝕧 length is not a e𝕙 height so they have no radius to have a radius.



Suppose an electron just had a collision with an ion and has rebounded with velocity $\vec{v}_0$. The acceleration of the electron between collisions is

$$a_x = \frac{F}{m} = \frac{eE}{m} \qquad (27.4)$$

where E is the electric field strength inside the wire and m is the mass of the electron. (We'll assume that $\vec{E}$ points in the negative x-direction.) The field causes the x-component of the electron's velocity to increase linearly with time:

$$v_x = v_{0x} + a_x \Delta t = v_{0x} + \frac{eE}{m}\Delta t \qquad (27.5)$$

The electron speeds up, with increasing kinetic energy, until its next collision with an ion. The collision transfers much of the electron's kinetic energy to the ion and thus to the thermal energy of the metal. **This energy transfer is the "friction" that raises the temperature of the wire.** The electron then rebounds, in a random direction, with a new initial velocity $\vec{v}_0$, and starts the process all over.

Drift and kinetic velocities

In this model the drift velocity is the e𝕪/-𝕚d kinetic velocity of the electron. This is an average when they do -𝕆D×e𝕪 kinetic work, it is also chaotic when they are observed with a E𝕐/-𝕠d kinetic impulse. E here is -𝕚d×e𝕧/-𝕀D from F=ma, when divided by -𝕚d as the inertial mass and multiplied by -𝕚d as inertial time, this gives e𝕧/-𝕚d as the inertial velocity.

Average velocity and momentum

The average velocity comes from the -𝕆D×e𝕪 kinetic work, the -𝕚d×e𝕧/-𝕚d is the kinetic momentum containing the -𝕚d×e𝕧 inertial field and the e𝕧/-𝕚d inertial velocity. Together they give a particle/wave duality when observed or measured.

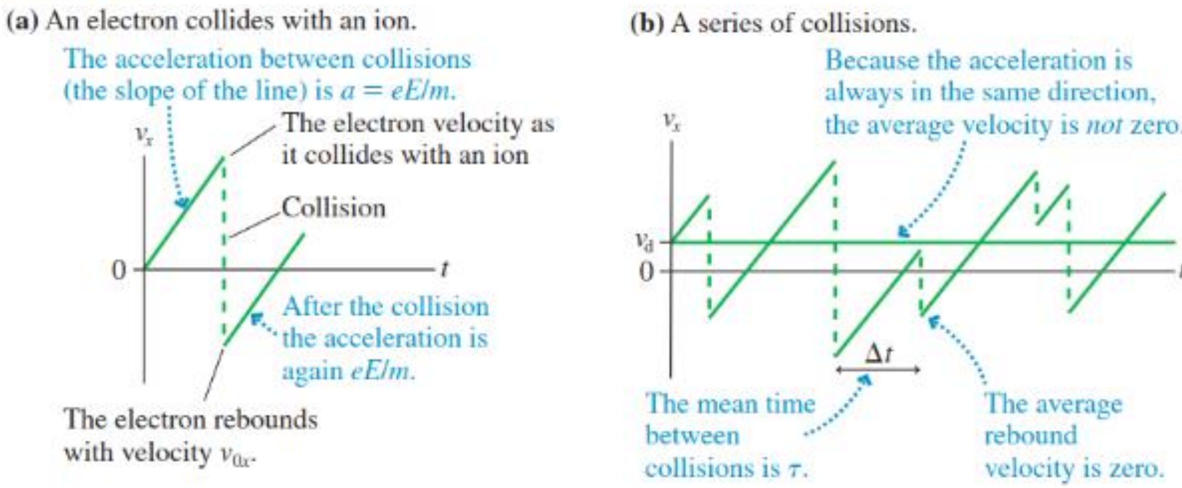
FIGURE 27.12a shows how the velocity abruptly changes due to a collision. Notice that the acceleration (the slope of the line) is the same before and after the collision. FIGURE 27.12b follows an electron through a series of collisions. You can see that each collision "resets" the velocity. The primary observation we can make from Figure 27.12b is that this repeated process of speeding up and colliding gives the electron a nonzero *average* velocity. **The magnitude of the electron's average velocity, due to the electric field, is the *drift speed* v_d of the electron.**

If we observe all the electrons in the metal at one instant of time, their average velocity is

$$v_d = \bar{v}_x = \overline{v_{0x}} + \frac{eE}{m}\overline{\Delta t} \qquad (27.6)$$

When the electron collides with an ion this is the E𝕐/-𝕠d kinetic impulse, the kinetic velocity changes chaotically and the acceleration is proportional to the E𝕧/-𝕚d inertial impulse in meters²/second. Because this is chaotic it has no average kinetic velocity, the motion is more in the direction of the +𝕆D potential difference.

FIGURE 27.12 The electron velocity as a function of time.



Mass and time

In this model (27.7) becomes -𝕚d/-𝕚d × -𝕚d×e𝕧/-𝕆D, the 1/-𝕚d inertial mass comes from the electrons. Then multiplying this by τ makes -𝕚d×e𝕧/-𝕆D into e𝕧/-𝕚d. Here the -𝕚d inertial mass and -𝕚d inertial time are inverses, so doubling the τ time is like doubling the inertial mass. The two are equivalent here, from the -𝕚d×e𝕧 inertial field doubling the -𝕚d inertial mass would double the inertial momentum. With e𝕧/-𝕚d doubling the denominator as inertial time would halve the time between collisions. Mass and time are like a wave/particle duality in this model.

Laminar flows and chaos

In (27.8) the area of the wire also changes the inertial velocity. The electrons can move like a laminar flow in a fluid, that would be -𝕆D×e𝕪 kinetic work. With a E𝕐/-𝕠d kinetic impulse the collisions can be more chaotic, resistance in the wire can create more turbulence approaching the Fiegenbaum constants δ and β. In -𝕆D×e𝕪 kinetic work they instead become more quantized with α and π.

where a bar over a quantity indicates an average value. The average value of v_{0x}, the velocity with which an electron rebounds after a collision, is zero. We know this because, in the absence of an electric field, the sea of electrons moves neither right nor left.

The quantity Δt is the time between collisions, so the average value of Δt is the **mean time between collisions,** which we designate τ. The mean time between collisions, analogous to the mean free path between collisions in the kinetic theory of gases, depends on the metal's temperature but can be considered a constant in the equations below.

Thus the average speed at which the electrons are pushed along by the electric field is

$$v_d = \frac{e\tau}{m}E \qquad (27.7)$$

We can complete our model of conduction by using Equation 27.7 for v_d in the electron-current equation $i_e = n_e A v_d$. Upon doing so, we find that an electric field strength E in a wire of cross-section area A causes an electron current

$$i_e = \frac{n_e e \tau A}{m}E \qquad (27.8)$$

Changing the voltage

When the -𝕆D kinetic difference is larger, then more -𝕆D×e𝕪 kinetic work is done on the electrons, this accelerates them according to F=ma, where F =-𝕠d×e𝕪/-𝕆D, repelling them from the negative plate. The +𝕆D potential difference is the inverse of -𝕆D, the electrons have the +𝕠d×e𝕒/+𝕆D force F drawing them towards the positive plate. Because these forces are inverses, they cancel out giving a constant kinetic current, not one that is accelerating. When the voltage is increased, the angles θ in the +𝕠d and e𝕒 Pythagorean Triangles and -𝕠d and e𝕪 Pythagorean Triangle also increases. The kinetic current increases its angle θ to conform to the new voltage.

The electron density n_e and the mean time between collisions τ are properties of the metal.

Equation 27.8 is the main result of this model of conduction. We've found that **the electron current is directly proportional to the electric field strength.** A stronger electric field pushes the electrons faster and thus increases the electron current.

Current as a duality

In this model the current comes from the -𝕠d×e𝕪/-𝕠d kinetic momentum of the electrons as Coulombs. The -𝕠d×e𝕪 kinetic field gives the electrons momentum, the e𝕪/-𝕠d kinetic velocity gives them motion.

27.3 Current and Current Density

We have developed the idea of a current as the motion of electrons through metals. But the properties of currents were known and used for a century before the discovery that electrons are the charge carriers in metals. We need to connect our ideas about the electron current to the conventional definition of current.

The rate of charge flow

In this model Q is the -𝕠d×e𝕪/-𝕠d kinetic momentum as Coulombs, when divided by t this is 1/-𝕠d in kinetic time to give -𝕠d×e𝕪/-𝕆D as F=ma as amperes. This is a steady current despite 1/-𝕆D being a square from the kinetic difference. The +𝕠d×e𝕒/+𝕠d potential momentum as Coulombs is also divided by 1/+𝕠d in potential time to give F=ma. The two forces are the inverses of each other and cancel out, that leaves a constant current with the amperes.

Because the coulomb is the unit of charge, and because currents are charges in motion, it seemed quite natural in the 19th century to define current as the *rate*, in coulombs per second, at which charge moves through a wire. If Q is the total amount of charge that has moved past a point in the wire, we define the current I in the wire to be the rate of charge flow:

$$I = \frac{dQ}{dt} \tag{27.9}$$

For a *steady current,* which will be our primary focus, the amount of charge delivered by current I during the time interval Δt is

$$Q = I\,\Delta t \tag{27.10}$$

The SI unit for current is the coulomb per second, which is called the **ampere** A:

$$1 \text{ ampere} = 1 \text{ A} = 1 \text{ coulomb per second} = 1 \text{ C/s}$$

Electron current

In this model amperes come from the -𝕠d×e𝕪/-𝕠d kinetic momentum. Because each increment of this is a separate -𝕠d and e𝕪 Pythagorean Triangle electron, the number of these per second is amperes.

The current unit is named after the French scientist André Marie Ampère, who made major contributions to the study of electricity and magnetism in the early 19th century. The *amp* is an informal abbreviation of ampere. Household currents are typically ≈ 1 A. For example, the current through a 100 watt lightbulb is 0.85 A, meaning that 0.85 C of charge flow through the bulb every second. Currents in consumer electronics, such as stereos and computers, are much less. They are typically measured in milliamps ($1 \text{ mA} = 10^{-3}$ A) or microamps ($1\ \mu\text{A} = 10^{-6}$ A).

Equation 27.10 is closely related to Equation 27.1, which said that the number of electrons delivered during a time interval Δt is $N_e = i_e\,\Delta t$. Each electron has charge of magnitude e; hence the total charge of N_e electrons is $Q = eN_e$. Consequently, the conventional current I and the electron current i_e are related by

$$I = \frac{Q}{\Delta t} = \frac{eN_e}{\Delta t} = ei_e \tag{27.11}$$

Individual electrons in the current

In this model the -𝕠d and e𝕪 Pythagorean Triangle is an electron, these can be counted up as the total kinetic current. Each -𝕠d and e𝕪 Pythagorean Triangle electron can have a different angle θ, it might move at a different e𝕪/-𝕠d kinetic velocity. With a Gaussian, there is an average kinetic velocity because of the -𝕆D×e𝕪 kinetic work done. This average is the current.

Electrons in hyperbolic geometry

In this model electrons are in hyperbolic geometry, they tend towards a hyperbolic path which is leaving the atom. Without a -𝕆D kinetic difference, the electron can move in a parabolic path which is in between the circular and elliptical orbits in the atoms, and the hyperbolic path when they flow along the wire. Protons have circular geometry, so they attract electrons with constructive interference out of the current flow. With enough voltage the circular and parabolic paths become more hyperbolic in moving between he capacitor plates.

Because electrons are the charge carriers, the rate at which charge moves is e times the rate at which the electrons move.

In one sense, the current I and the electron current i_e differ by only a scale factor. The electron current i_e, the rate at which electrons move through a wire, is more *fundamental* because it looks directly at the charge carriers. The current I, the rate at which the charge of the electrons moves through the wire, is more *practical* because we can measure charge more easily than we can count electrons.

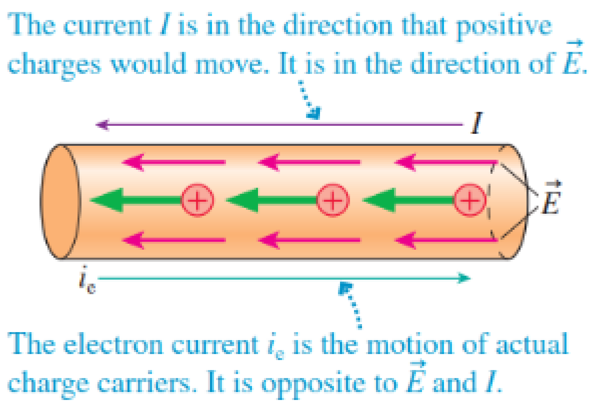
Despite the close connection between i_e and I, there's one extremely important distinction. Because currents were known and studied before it was known what the charge carriers are, **the direction of current is *defined* to be the direction in which positive charges *seem* to move.** Thus the direction of the current I is the same as that of the internal electric field $\vec{E}$. But because the charge carriers turned out to be negative, at least for a metal, **the direction of the current I in a metal is opposite the direction of motion of the electrons.**

The situation shown in FIGURE 27.13 may seem disturbing, but it makes no real difference. A capacitor is discharged regardless of whether positive charges move toward the negative plate or negative charges move toward the positive plate. The primary application of current is the analysis of circuits, and in a circuit—a macroscopic device—we simply can't tell what is moving through the wires. All of our calculations will be correct and all of our circuits will work perfectly well if we choose to think of current as the flow of positive charge. The distinction is important only at the microscopic level.

Kinetic velocity and the electron flow

In this model the kinetic velocity is in the direction of the electron flow. The +𝕆D×e𝕒 potential work from the protons is the inverse of the -𝕆D×e𝕪 kinetic work, it then gives the same answers with the current flow but in the opposite direction.

FIGURE 27.13 The current I is opposite the direction of motion of the electrons in a metal.



The current density

In this model the current density changes inversely to the area or cross section of the wire. Because this is a square it is like a force, a smaller wire with the same current velocity changes the current density J as a square. The electrons are more -𝕆D kinetically probable to be measured in a e𝕪 position also as a square.

The Current Density in a Wire

We found the electron current in a wire of cross-section area A to be $i_e = n_e A v_d$. Thus the current I is

$$I = ei_e = n_e e v_d A \qquad (27.12)$$

The quantity $n_e e v_d$ depends on the charge carriers and on the internal electric field that determines the drift speed, whereas A is simply a physical dimension of the wire. It will be useful to separate these quantities by defining the **current density** J in a wire as the current per square meter of cross section:

$$J = \text{current density} \equiv \frac{I}{A} = n_e e v_d \qquad (27.13)$$

The current density has units of A/m^2. A specific piece of metal, shaped into a wire with cross-section area A, carries current $I = JA$.

Conserving the number of electrons

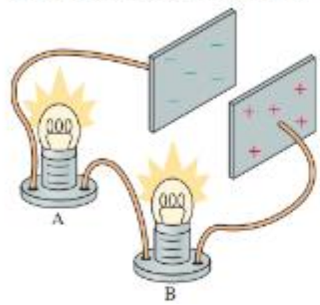
In this model the -𝕠d and e𝕪 Pythagorean Triangles are like water molecules that are not destroyed, the flow as the e𝕪/-𝕠d kinetic current is then the same through both bulbs. The rotation of the paddle wheel does -𝕆D×e𝕪 kinetic work, this reduces the -𝕆D kinetic difference in the wire like a paddle wheel can slow down a river. The destructive interference between the electrons spreads them out with an average e𝕪 spacing in and out of both bulbs.

Charge Conservation and Current

FIGURE 27.14 shows two identical lightbulbs in the wire connecting two charged capacitor plates. Both bulbs glow as the capacitor is discharged. How do you think the brightness of bulb A compares to that of bulb B? Is one brighter than the other? Or are they equally bright? Think about this before going on.

You might have predicted that B is brighter than A because the current *I*, which carries positive charges from plus to minus, reaches B first. In order to be glowing, B must use up some of the current, leaving less for A. Or perhaps you realized that the actual charge carriers are electrons, moving from minus to plus. The conventional current *I* may be mathematically equivalent, but physically it's the negative electrons rather than positive charge that actually move. Because the electron current gets to A first, you might have predicted that A is brighter than B.

FIGURE 27.14 How does the brightness of bulb A compare to that of bulb B?



Using up work

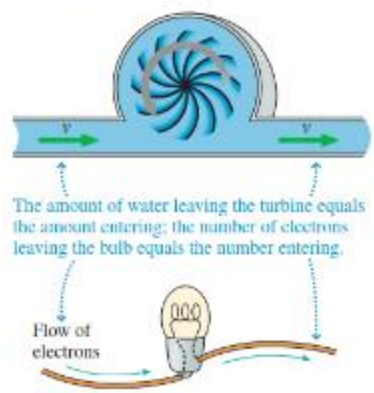
In this model the +𝕆D potential difference and -𝕆D kinetic difference are reduced, this is because the turbine need a -𝕆D kinetic torque to turn it. Some -𝕆D×e𝕪 kinetic work is used and so the voltage must drop. Pushing electrons through the lamps also uses up the -𝕆D kinetic voltage.

In fact, both bulbs are equally bright. This is an important observation, one that demands an explanation. After all, "something" gets used up to make the bulb glow, so why don't we observe a decrease in the current? Current is the amount of charge moving through the wire per second. There are only two ways to decrease *I*: either decrease the amount of charge, or decrease the charge's drift speed through the wire. Electrons, the charge carriers, are charged particles. The lightbulb can't destroy electrons without violating both the law of conservation of mass and the law of conservation of charge. Thus the amount of charge (i.e., the *number* of electrons) cannot be changed by a lightbulb.

Do charges slow down after passing through the bulb? This is a little trickier, so consider the fluid analogy shown in **FIGURE 27.15**. Suppose the water flows into one end at a rate of 2.0 kg/s. Is it possible that the water, after turning a paddle wheel, flows out the other end at a rate of only 1.5 kg/s? That is, does turning the paddle wheel cause the water current to decrease?

We can't destroy water molecules any more than we can destroy electrons, we can't increase the density of water by pushing the molecules closer together, and there's nowhere to store extra water inside the pipe. Each drop of water entering the left end pushes a drop out the right end; hence water flows out at exactly the same rate it flows in.

FIGURE 27.15 A current dissipates energy, but the flow is unchanged.



Conservation of charge

In this model the kinetic current e𝕪/-𝕠d is the same in all parts of the wire. The -𝕆D×e𝕪 kinetic work is added to by the +𝕆D×e𝕒 potential work which reduces the kinetic difference closer to the positive plate. The e𝕪/-𝕠d kinetic current is the same everywhere in the wire because otherwise it would back up until it flowed again. For example at one end of a resistor the -𝕆D kinetic difference is higher, that makes the electrons flow through it. Conservation of charge means the number of moving -𝕠d and e𝕪 Pythagorean Triangles doesn't change.

The same is true for electrons in a wire. **The rate of electrons leaving a lightbulb (or any other device) is exactly the same as the rate of electrons entering the lightbulb. The current does not change.** A lightbulb doesn't "use up" current, but it *does*—like the paddlewheel in the fluid analogy—use energy. The kinetic energy of the electrons is dissipated by their collisions with the ions in the lattice of the metal (the atomic-level friction) as the electrons move through the atoms, making the wire hotter until, in the case of the lightbulb filament, it glows. The lightbulb affects the amount of current *everywhere* in the wire, a process we'll examine later in the chapter, but the current doesn't change as it passes through the bulb.

There are many issues that we'll need to look at before we can say that we understand how currents work, and we'll take them one at a time. For now, we draw a first important conclusion: **Due to conservation of charge, the current must be the same at all points in a current-carrying wire.**

Vector addition and interference

The electrons in the current are summed together as particles with the E𝕐/-𝕠d kinetic impulse, using vector addition. An integral would be where the -𝕆D×e𝕪 kinetic work moves the electrons as waves, these cannot be added together as vectors because they are fields. Instead, addition and subtraction occur with constructive and destructive interference.

The Bernoulli effect

These electrons can be denser on the negative plate end of a narrow section of wire, it is like pushing petrol through a narrower part of a pipe in a carburetor. The e𝕧/-𝕚d inertial velocity of the petrol increases, that means less -𝕀D×e𝕧 inertial work is being done because -𝕚d is larger. The -𝕀D inertial probability of where the petrol molecules are measured decreases, that means they can move apart more to become petrol vapor.

Impulse and temperature

The E𝕍/-𝕚d inertial impulse also causes the molecules to collide more, that can separate them into vapor. The thinner wire can also get hotter, this is because of the greater E𝕐/-𝕠d kinetic impulse in the wire where e𝕪 is the kinetic temperature.

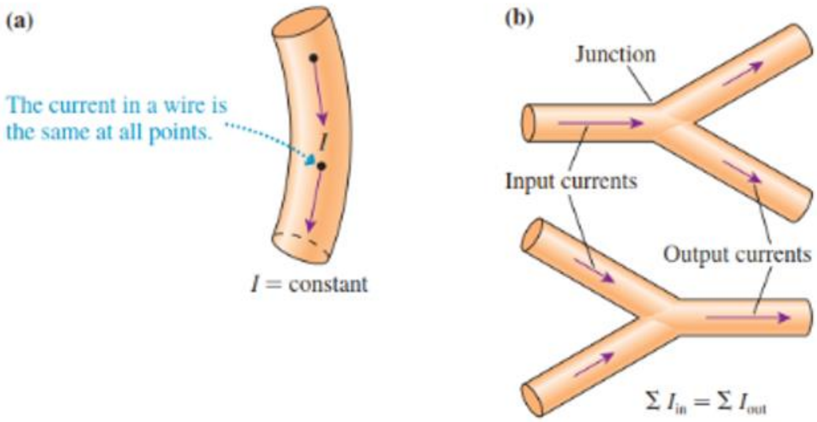
Increased work on a resistor

On the negative plate end of the resistor there is more -𝕆D×e𝕪 kinetic work, that is because e𝕪 decreases in the distance traveled and so -𝕆D increases as a square. The e𝕪/-𝕠d kinetic velocity decreases because the resistor's +𝕆D×e𝕒 potential work reacts against it. When past the resistor its +𝕆D×e𝕒 potential work is gone so the kinetic velocity resumes its former rate.

Pooling water

It is like water running down a hill with +𝕀D×e𝕙 gravitational work, when it hits more inertial resistance such as with rapids it tends to pool against the -𝕀D×e𝕧 inertial work done by it. That slows the e𝕙/+𝕚d gravitational speed of the water, but it regains this past the rapids.

FIGURE 27.16 The sum of the currents into a junction must equal the sum of the currents leaving the junction.



Summing impulse and integral areas

In this model the number of -𝕠d and e𝕪 Pythagorean Triangles as electrons does not change, so the sum of the Pythagorean Triangles in the junctions remains the same. Because each -𝕠d and e𝕪 Pythagorean Triangle has its own -𝕠d×e𝕪/-𝕠d kinetic momentum then this remains the same through the junctions or there would be an acceleration. The -𝕆D×e𝕪 kinetic work is the same, the -𝕆D kinetic probabilities of where the electrons are measured is the same whether the pipe is split into two or not.

FIGURE 27.16a summarizes the situation in a single wire. But what about **FIGURE 27.16b**, where two wires merge into one and another wire splits into two? A point where a wire branches is called a **junction.** The presence of a junction doesn't change our basic reasoning. We cannot create or destroy electrons in the wire, and neither can we store them in the junction. The rate at which electrons flow into one *or many* wires must be exactly balanced by the rate at which they flow out of others. For a *junction*, the law of conservation of charge requires that

$$\sum I_{in} = \sum I_{out} \quad (27.14)$$

where, as usual, the Σ symbol means summation.

Kirchoff's junction law

Kirchoff's junction law follows from the constant Pythagorean Triangle areas.

This basic conservation statement—that the sum of the currents into a junction equals the sum of the currents leaving—is called **Kirchhoff's junction law.** The junction law, together with *Kirchhoff's loop law* that you met in Chapter 26, will play an important role in circuit analysis in the next chapter.

Current density

In this model the current density J is proportional to the electric kinetic drift velocity as e𝕪/-𝕠d. In (27.15) the number of -𝕠d and e𝕪 Pythagorean Triangles is multiplied by τ as -𝕠d kinetic time and divided by -𝕠d as the kinetic mass. They cancel out to give the e𝕪/-𝕠d kinetic current.

Converting current to energy

Here e is squared because the kinetic velocity e𝕪/-𝕠d is converted into a square in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. This energy is not a force because E𝕐 and -𝕆D are inverses canceling each other out. It represents a store of energy that is not changing, an acceleration from the E𝕐/-𝕠d kinetic impulse or -𝕆D×e𝕪 kinetic work would change the E𝕐:-𝕆D ratio to a different ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy.

Conductivity as energy

This gives a conductivity σ which is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy the wire can carry. If the e𝕪/-𝕠d kinetic velocity is lower then the wire has more resistance. That is an inverse of conductivity because e𝕪 and -𝕠d are inverses.

27.4 Conductivity and Resistivity

The current density $J = n_e e v_d$ is directly proportional to the electron drift speed v_d. We earlier used the microscopic model of conduction to find that the drift speed is $v_d = e\tau E/m$, where τ is the mean time between collisions and m is the mass of an electron. Combining these, we find the current density is

$$J = n_e e v_d = n_e e\left(\frac{e\tau E}{m}\right) = \frac{n_e e^2 \tau}{m} E \qquad (27.15)$$

Atoms and neutrons

In this model different atoms have +𝕠d and e𝕒 Pythagorean Triangles as protons and orbiting electrons as -𝕠d and e𝕪 Pythagorean Triangles. Neutrons are where these Pythagorean Triangles combine with the 𝕠d- and 𝕞 Pythagorean Triangle as a neutrino. When an atom has only pairs of bosons in full shells, this is more resistant to losing electrons with a current flow. This conductivity then depends on the chemical composition of the material.

Conductivity and kinetic energy

Here the conductivity σ is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, that is because the more electrons can be taken from these atoms the more -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse there is. Conversely resistivity comes from the ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy, the more +𝕆D×e𝕒 potential work and E𝔸/+𝕠d potential impulse there is the weaker the -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse is.

Electric field strength

A given electric field strength would be e𝕪 as the kinetic electric charge and -𝕠d as the kinetic magnetic field. More -𝕠d and e𝕪 Pythagorean Triangle electrons gives a greater current density, this comes from the -𝕆D kinetic probability density. Fewer electrons gives a longer time τ between E𝕐/-𝕠d kinetic impulse collisions.

The quantity $n_e e^2\tau/m$ depends *only* on the conducting material. According to Equation 27.15, a given electric field strength will generate a larger current density in a material with a larger electron density n_e or longer times τ between collisions than in materials with smaller values. In other words, such a material is a *better conductor* of current.

It makes sense, then, to define the **conductivity** σ of a material as

$$\sigma = \text{conductivity} = \frac{n_e e^2 \tau}{m} \qquad (27.16)$$

Conductivity and the kinetic electric charge

Here J is the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, E is F=ma or -𝕠d×e𝕪/-𝕆D. The conductivity then is e𝕪 as the kinetic electric charge. When this increases then the E𝕐/-𝕠d kinetic impulse also increases.

Conductivity, like density, characterizes a material as a whole. All pieces of copper (at the same temperature) have the same value of σ, but the conductivity of copper is different from that of aluminum. Notice that the mean time between collisions τ can be inferred from measured values of the conductivity.

With this definition of conductivity, Equation 27.15 becomes

$$J = \sigma E \qquad (27.17)$$

The strength of the electric field

Here E is -𝕠d×e𝕪/-𝕆D with a square from -𝕆D×e𝕪 kinetic work. The current changes linearly with the square, so it changes with a squared force as well.

This is a result of fundamental importance. Equation 27.17 tells us three things:

1. Current is caused by an electric field exerting forces on the charge carriers.
2. The current density, and hence the current $I = JA$, depends linearly on the strength of the electric field. To double the current, you must double the strength of the electric field that pushes the charges along.
3. The current density also depends on the *conductivity* of the material. Different conducting materials have different conductivities because they have different values of the electron density and, especially, different values of the mean time between electron collisions with the lattice of atoms.

Temperature and resistivity

In this model the e𝕪 kinetic electric charge correlates to temperature, the e𝕪/-𝕠d kinetic velocity increases with vibrations and moving particles causing more collisions. -𝕆D×e𝕪 kinetic work is stronger at lower e𝕪 temperatures because -𝕠d as the kinetic magnetic field is the inverse of e𝕪. The resistivity ρ increases at higher temperatures with the E𝕐/-𝕠d kinetic impulse because it is the inverse of the -𝕆D kinetic difference with the voltage.

Resistivity is the inverse of conductivity

The resistivity ρ is the inverse of the conductivity σ, as e𝕪:-𝕠d. With a higher e𝕪 temperature the resistivity increases, that is the inverse of the conductivity as 1/-𝕠d. Also -𝕆D×e𝕪 kinetic work is the inverse of -𝕆D×e𝕪 kinetic work, as e𝕒 increases in an atom then e𝕪 decreases inversely. That means electrons in higher orbitals have a slower e𝕪/-𝕠d kinetic velocity.

Resistivity and potential work

The inverse of the -𝕠d kinetic magnetic field as conductivity is the +𝕠d potential magnetic field as resistivity because the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle are inverses. When +𝕠d is stronger the atoms do more +𝕆D×e𝕒 potential work, that reacts against the conductivity by binding electrons to atoms more. Also, resistivity reacts against the flow of electrons though it, the +𝕆D×e𝕒 potential work is added to the -𝕆D×e𝕪 kinetic work so +𝕆D-𝕆D is less negative. That also reduces the -𝕆D kinetic voltage.

The value of the conductivity is affected by the structure of a metal, by any impurities, and by the temperature. As the temperature increases, so do the thermal vibrations of the lattice atoms. This makes them "bigger targets" and causes collisions to be more frequent, thus lowering τ and decreasing the conductivity. Metals conduct better at low temperatures than at high temperatures.

For many practical applications of current it will be convenient to use the inverse of the conductivity, called the **resistivity:**

$$\rho = \text{resistivity} = \frac{1}{\sigma} = \frac{m}{n_e e^2 \tau} \qquad (27.18)$$

Conductivity as electrons per second

In this model J is the number of electrons times the e𝕪/-𝕠d kinetic velocity. Here this is divided by by E as -𝕠d×e𝕪/-𝕆D, that gives –𝕠d as the kinetic mass divided by 1/-𝕠d as kinetic time. The kinetic mass is held as a constant there, so the conductivity is 1/-𝕠d. Using e as the number of electrons that becomes e/-𝕠d as the number per second. If d decreases then there are a number of electrons passing in a shorter kinetic time, that is a higher conductivity σ.

The resistivity of a material tells us how reluctantly the electrons move in response to an electric field. **TABLE 27.2** gives measured values of the resistivity and conductivity for several metals and for carbon. You can see that they vary quite a bit, with copper and silver being the best two conductors.

The units of conductivity, from Equation 27.17, are those of J/E, namely A C/N m^2. These are clearly awkward. In the next section we will introduce a new unit called the *ohm*, symbolized by Ω (uppercase Greek omega). It will then turn out that resistivity has units of Ω m and conductivity has units of $\Omega^{-1}\,\text{m}^{-1}$.

Cooper pairs

In this model Cooper pairs of electrons have opposed spins like boson pairs, because of this they have a canceled -𝕠d magnetic field. They move with a E𝕐/-𝕠d kinetic impulse that has no randomizing -𝕆D kinetic probability, that means the current cannot be dissipated by random friction. Because there is no friction there is no heat.

Boson pairs repel fermions

Boson pairs in an atom also repel fermions, so they move to a higher orbital. For example with Lithium there is a boson pair of -𝕠d and e𝕪 Pythagorean Triangle electrons doing opposing -𝕆D×e𝕪 kinetic work. The extra fermion is in a higher orbital.

Superconductivity

In 1911, the Dutch physicist Heike Kamerlingh Onnes was studying the conductivity of metals at very low temperatures. Scientists had just recently discovered how to liquefy helium, and this opened a whole new field of *low-temperature physics.* As we noted above, metals become better conductors (i.e., they have higher conductivity and lower resistivity) at lower temperatures. But the effect is gradual. Onnes, however, found that mercury suddenly and dramatically loses *all* resistance to current when cooled below a temperature of 4.2 K. This complete loss of resistance at low temperatures is called **superconductivity.**

Cooper pairs as bosons

In this model a higher e𝕪 kinetic temperature has a greater E𝕐/-𝕠d kinetic impulse. This is chaotic and so breaks up the opposing -𝕆D×e𝕪 kinetic work in Cooper pairs. A higher Fermi energy can also break up boson pairs in an atom. The Cooper pairs are also held together by the repulsion of electrons doing -𝕆D×e𝕪 kinetic work in the lattice around them. They are like a boson pair outside atoms, but held together by the repulsions from unpaired fermions. The destructive interference between the Cooper pairs, and the fermions in the lattice, mean they repel an external magnetic field doing -𝕆D×e𝕪 kinetic work on them.

Later experiments established that the resistivity of a superconducting metal is not just small, it is truly zero. The electrons are moving in a frictionless environment, and charge will continue to move through a superconductor *without an electric field.* Superconductivity was not understood until the 1950s, when it was explained as being a specific quantum effect.

Superconducting wires can carry enormous currents because the wires are not heated by electrons colliding with the atoms. Very strong magnetic fields can be created with superconducting electromagnets, but applications remained limited for many decades because all known superconductors required temperatures less than 20 K. This situation changed dramatically in 1986 with the discovery of *high-temperature superconductors.* These ceramic-like materials are superconductors at temperatures as "high" as 125 K. Although −150°C may not seem like a high temperature to you, the technology for producing such temperatures is simple and inexpensive. Thus many new superconductor applications are likely to appear in coming years.

Ohm's law

Here there is a +𝕆D potential difference and a -𝕆D kinetic difference, this might come from a battery or capacitor. The electric field component E_s is -dV/ds, in this model dV is -𝕆D as the kinetic difference which is divided by ds as e𝕪 to give the -𝕆D×e𝕪 kinetic work. This would be negative with the -𝕠d and e𝕪 Pythagorean Triangle electrons, positive with the +𝕠d and e𝕒 Pythagorean Triangle protons.

E as work

With F=ma, E is -𝕠d×e𝕪/-𝕆D. Taking the -𝕠d kinetic mass as a constant, that leaves e𝕪/-𝕆D or -𝕆D /e𝕪 as the kinetic work -dV/s. When the +𝕆D potential difference is used this gives +𝕆D×e𝕒 potential work. $E_{e\mathbb{y}}$ from -𝕆D×e𝕪 kinetic work is then the inverse of $E_{e\mathbb{a}}$ from +𝕆D×e𝕒 potential work.

27.5 Resistance and Ohm's Law

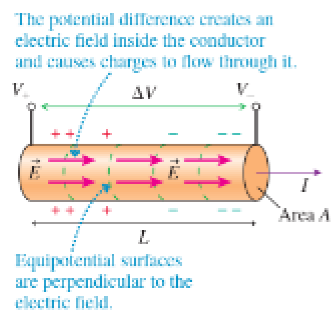
FIGURE 27.17 shows a section of wire of length L with a potential difference $\Delta V = V_+ - V_-$ between the ends. Perhaps the two ends of the wire are connected to a battery. A potential difference represents separated positive and negative charges, and, as you saw earlier, some of these charges move onto the surface of the wire. The nonuniform charge distribution creates an electric field in the wire, and that electric field is now driving current through the wire by pushing the charge carriers.

We found in Chapter 26 that the field and the potential are closely related to each other, with the field pointing "downhill," perpendicular to the equipotential surfaces. Thus it should come as no surprise that the current through the wire is related to the potential difference between the ends of the wire.

Recall that the electric field component E_s is related to the potential by $E_s = -dV/ds$. We're interested in only the electric field strength $E = |E_s|$, so the minus sign isn't relevant. The field strength is constant inside a constant-diameter conductor; thus

$$E = \frac{\Delta V}{\Delta s} = \frac{\Delta V}{L} \quad (27.19)$$

FIGURE 27.17 The current I is related to the potential difference ΔV.



Current per square meter

Here J is the e𝕪/-𝕠d current per square meter, the larger the cross section of the wire the faster the current. This works as a square the same as increasing the -𝕆D kinetic difference because both are squares. The current is multiplied by 1/ρ as the resistivity, when this is larger then e𝕪/-𝕠d slows linearly as e𝕪 contracts and -𝕠d expands inversely to it. That is like e𝕒/+𝕠d as the potential current increasing, around atoms their resistivity is higher when the attraction into them increases.

Resistivity and gravity

It is like in Biv space-time, asteroids in an asteroid belt can move past much larger asteroids with a e𝕧/-𝕚d inertial velocity. When the larger asteroids' e𝕙/+𝕚d gravitational speed increases, such as when they have more gravitational mass, then the asteroids encounter a resistivity in continuing past them. They become captured in orbits or fall into the larger asteroids. This is seen where some asteroids have many smaller asteroids in their surfaces.

Resistivity and asteroid collisions

Proportional to this, electrons have a slower e𝕪/-𝕠d kinetic velocity moving past atoms with a higher potential speed. The equivalent of resistivity, with a higher e𝕧 temperature, is where the asteroids' E𝕍/-𝕚d inertial impulse increases with a faster inertial velocity more collisions. That creates more chaos rather than a smoother laminar flow of electrons between the +𝕆D potential difference and the -𝕆D kinetic difference. This causes more asteroids to collide and fall towards the larger asteroids, some can also be captured in their sphere of influence.

Equation 27.19 is an important result: The electric field strength inside a constant-diameter conductor—the field that drives the current forward—is simply the potential difference between the ends of the conductor divided by its length.

Now we can use E to find the current I in the conductor. We found earlier that the current density is $J = \sigma E$, and the current in a wire of cross-section area A is related to the current density by $I = JA$. Thus

$$I = JA = A\sigma E = \frac{A}{\rho} E \qquad (27.20)$$

where $\rho = 1/\sigma$ is the resistivity.

Combining Equations 27.19 and 27.20, we see that the current is

$$I = \frac{A}{\rho L} \Delta V \qquad (27.21)$$

Current and voltage

In this model the e𝕪/-𝕠d kinetic current is proportional to the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work as the voltage. The current is linear because the +𝕆D potential difference and -𝕆D kinetic difference are inverse squares. It cannot accelerate the electrons because the differences are action/reaction pairs.

Resistance

The resistance R is the resistivity, ρ is 1/+𝕠d while the conductivity is 1/-𝕠d. The increase in the wire length is L, the resistance then increases linearly with the +𝕆D×e𝕒 potential work as e𝕒 is also linear. This is divided by A as the area because a larger wire gives more paths for the -𝕆D×e𝕪 kinetic work of the electrons. It is a square because the area is a square. Ohms then become +𝕆D/A where +𝕆D is the potential probability of electrons being captured rather than continuing with their conductivity.

That is, **the current is directly proportional to the potential difference between the ends of a conductor.** We can cast Equation 27.21 into a more useful form if we define the **resistance** of a conductor to be

$$R = \frac{\rho L}{A} \qquad (27.22)$$

The resistance is a property of a *specific* conductor because it depends on the conductor's length and diameter as well as on the resistivity of the material from which it is made.

The SI unit of resistance is the **ohm,** defined as

$$1 \text{ ohm} = 1\ \Omega \equiv 1\ \text{V/A}$$

Resistance and distance

The resistance is the inverse of the conductivity, that would be -𝕆D/A when measured as -𝕆D×e𝕪 kinetic work. The conductivity can also be regarded as the E𝕐/-𝕠d kinetic impulse, electrons are particles travel with a e𝕪/-𝕠d kinetic current. Then the resistance would be 1/+𝕠d when the E𝔸/+𝕠d potential impulse is observed, in both cases they are inverses of each other.

The ohm is the basic unit of resistance, although kilohms ($1\ \text{k}\Omega = 10^3\ \Omega$) and megohms ($1\ \text{M}\Omega = 10^6\ \Omega$) are widely used. You can now see from Equation 27.22 why the resistivity ρ has units of $\Omega\,\text{m}$ while the units of conductivity σ are $\Omega^{-1}\text{m}^{-1}$.

The resistance of a wire or conductor increases as the length increases. This seems reasonable because it should be harder to push electrons through a longer wire than a shorter one. Decreasing the cross-section area also increases the resistance. This again seems reasonable because the same electric field can push more electrons through a fat wire than a skinny one.

Ohm's law

The e𝕪/-𝕠d kinetic current as I is ΔV/R where 1/R is 1/+𝕠d as the resistivity ρ, the kinetic velocity reduces with the length L of the wire as e𝕒 so a longer wire has more resistance. As e𝕒 increases with more atoms then e𝕪 decreases inversely to that and -𝕠d increases, that makes e𝕪/-𝕠d slower. The kinetic velocity increases as a square A with a thicker wire. When ΔV increases as -𝕆D from the kinetic difference, that increases the kinetic current.

The definition of resistance allows us to write the current through a conductor as

$$I = \frac{\Delta V}{R} \qquad \text{(Ohm's law)} \qquad (27.23)$$

In other words, establishing a potential difference ΔV between the ends of a conductor of resistance R creates an electric field (via the nonuniform distribution of charges on the surface) that, in turn, causes a current $I = \Delta V/R$ through the conductor. The smaller the resistance, the larger the current. This simple relationship between potential difference and current is known as **Ohm's law.**

Batteries and current

In this model the wire gets warm with the E𝕐/-𝕠d kinetic impulse of the current. It deflects a compass needle with a -𝕆D kinetic torque because of the -𝕆D kinetic difference. The charge flows because -𝕠d and e𝕪 Pythagorean Triangle electrons move through the wire.

Batteries and Current

Our study of current has focused on the discharge of a capacitor because we can understand where all the charges are and how they move. By contrast, we can't easily see what's happening to the charges inside a battery. Nonetheless, current in most "real" circuits is driven by a battery rather than by a capacitor. Just like the wire discharging a capacitor, a wire connecting two battery terminals gets warm, deflects a compass needle, and makes a lightbulb glow brightly. These indicators tell us that charges flow through the wire from one terminal to the other.

Roy electromagnetism and Biv spacetime

In this model Roy electromagnetism is proportional to Biv space-time. This means that the charging of a battery with the potential and kinetics is like gravity and inertia. All electromagnetic phenomena can then be described by an equivalent process in Biv space-time. One difference is the kinetic forces from the electron are active, the potential forces from the proton are reactive. Gravity is an active force, inertial is only reactive.

Negative charges go uphill

In this diagram the positive charge is moved uphill, with this model the negative charge as -𝕠d and e𝕪 Pythagorean Triangles would be moved uphill. This is like moving water uphill to a greater e𝕙 height against gravity, then storing it in a tank as the battery. That is proportional to moving the electrons uphill against the positive charges.

Water and electrons going downhill

When the water falls downhill this is from the +𝕀D×e𝕙 gravitational work and Eℍ/+𝕚d gravitational impulse. That is proportional to electrons falling downhill towards the positive terminal from the +𝕆D×e𝕒 potential work and E𝔸/+𝕠d potential impulse. The charge escalator is then like a real escalator moving water up to the tank, then when it is released through a pipe it has a e𝕧/-𝕚d inertial current and a e𝕙/+𝕚d gravitational speed.

Viscosity and resistivity

This water has inertia which reacts against or resists the active gravity moving it downhill. When this inertia is greater it has more viscosity, that is like ρ as the resistivity. The +𝕆D×e𝕒 potential work of the nuclei is stronger and holds onto passing electrons in a current more. The pipe might have baffles in it for example, this increases the resistivity as ohms. These baffles also tend to hold the water more around them so it changes less over time. When the water has less viscosity, it flows faster like conductivity.

Orbitals and α

In this model viscosity and resistivity are also related to turbulence. With a low viscosity water can flow more easily, that is like a high conductivity. Here α comes from $e^{-𝕠d}$ where d=1 in the ground state, then higher orbitals increment -𝕠d as quantized orbitals with -𝕆D×e𝕪 kinetic work. α also gives a probability of particle decay, such as in the collision of two electrons. Here α is proportional to δ as the first Fiegenbaum number, that gives cascades and bifurcations in chaos.

Electron bifurcations

An electron can then have a bifurcation to stay in a higher orbital or cascade down to a lower one. That probability is also determined by α according to the exponent $e^{-𝕠d}$. That is because the -𝕆D×e𝕪 kinetic work has -𝕆D as the kinetic torque the electron has in maintaining and orbit, also the kinetic probability of it being measured there. -𝕆D is the kinetic difference, so a higher orbital can be more easily stripped of electrons by the -𝕆D kinetic difference or voltage in a wire.

Tines and quantization

Here β as the second Fiegenbaum number is ≈ 1/(√2π), it approaches regular quantized spacings as the tines in chaos. When this is squared it is related to ½π as the constant in the probability equation to give 1. That allows for probabilities to be given as fractions of 1, in this model the fractions would be the slope of the +𝕠d and e𝕒 Pythagorean Triangles. From those the E𝔸/+𝕠d potential impulse can be observed, δ and β then are the relationship between the -𝕠d and e𝕪 Pythagorean Triangle electron and +𝕠d and e𝕒 Pythagorean Triangle proton.

Renormalization

In this model ½π here also reduces exponential increases, in conventional physics that requires renormalization. That is because exponentials come from $e^{e𝕪}$ where there can be an exponential increase in impulse. When an electron for example is observed, that increases the E𝕐/-𝕠d kinetic impulse exponentially. That can cause additional particles to be observed around it.

Exponentials and inverse exponentials

The inverse of the exponential curve here is the normal curve. The exponent here is $e^{-𝕠d}$ coming from α, that gives quantized orbitals based on circles and ellipses. With $e^{E𝕐}$ the exponent is a whole number not a square root, that allows for the exponential to blow up with observations. When the exponent is negative, here this applies to the square of any spin Pythagorean Triangle side such as $e^{-𝕆D}$, that gives a normal curve where D is a series of integers.

Inverse exponential and normal curves

Because of this the exponential and normal curves are inverses, the -𝕠d and e𝕪 Pythagorean Triangle has its Pythagorean Triangle sides inverses of each other as well. They equal each other because of the constant Pythagorean Triangle areas.

Observations blowing up

Observation than can cause a blowing up of exponentials, measurement can have a quantization of probabilities. Blowing up is in itself an exponential process. With these inverses there is always a renormalization value coming from the spin Pythagorean Triangle side. It also means a quantization can always be overcome by impulse and observation, electrons can always leave the atom.

Macro exponentials, micro normal curves

The particle/wave duality is also exponential particles being observed, and normalized waves being measured. That gives a macro world where exponentials are more common, a micro world where inverse exponentials or normal curves are more common.

The probability density function

In the probability density function below, dividing by ½π removes probability as a multiplication such as +𝕠d×e𝕒, then they would be integers with a ratio between them rather than being fractions. Dividing by 1/2π is like converting the circumference as an orbital to a radius, these ratios can blow up as an exponential without the renormalization from 1/(2π). Because ½π is a square, that is the +𝕆D potential torque or probability. The intervals between these radii as e𝕒 are like the quantized distances between the times as β.

The Standard Normal (Z): "Universal Currency"

The formula for the standardized normal probability density function is

$$p(Z) = \frac{1}{(1)\sqrt{2\pi}} \cdot e^{-\frac{1}{2}(\frac{Z-0}{1})^2} = \frac{1}{\sqrt{2\pi}} \cdot e^{-\frac{1}{2}(Z)^2}$$

Laminar flow and viscosity

With a lower viscosity the laminar flow of a fluid is disrupted into chaos and turbulence. That is because δ and β deviate more from α and π. With resistivity the nuclei resist change over time, so electrons tend to be held around the resistor's atoms with work rather than flowing with impulse.

A charge escalator and a tank

In Biv space-time the charge escalator is like pumping water up to a tank. The circuit is like letting the water flow down through a pipe, then the tank can be recharged like a battery or capacitor with the -𝕆D×e𝕪 kinetic work and -𝕀D×e𝕧 inertial work of the pump. A rotary pump uses -𝕆D kinetic torque, when the pump moves back and forth this is like a E𝕐/-𝕠d kinetic impulse. A viscous fluid is like a wire with a higher resistivity.

The one major difference between a capacitor and a battery is the duration of the current. The current discharging a capacitor is transient, ceasing as soon as the excess charge on the capacitor plates is removed. In contrast, the current supplied by a battery is *sustained*.

We can use the charge escalator model of a battery to understand why. **FIGURE 27.19** shows the charge escalator creating a potential difference ΔV_{bat} by lifting positive charge from the negative terminal to the positive terminal. Once at the positive terminal, positive charges can move *through the wire* as current I. In essence, the charges are "falling downhill" through the wire, losing the energy they gained on the escalator. This energy transfer to the wire warms the wire.

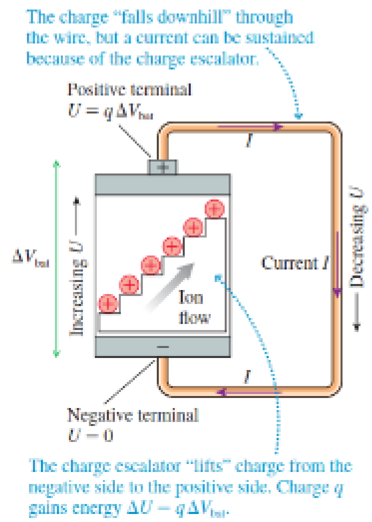
Eventually the charges find themselves back at the negative terminal of the battery, where they can ride the escalator back up and repeat the journey. A battery, unlike a charged capacitor, has an internal source of energy (the chemical reactions) that keeps the charge escalator running. It is the charge escalator that *sustains* the current in the wire by providing a continually renewed supply of charge at the battery terminals.

An important consequence of the charge escalator model, one you learned in the previous chapter, is that **a battery is a source of potential difference.** It is true that charges flow through a wire connecting the battery terminals, but current is a *consequence* of the battery's potential difference. The battery's emf is the *cause;* current, heat, light, sound, and so on are all *effects* that happen when the battery is used in certain ways.

Distinguishing cause and effect will be vitally important for understanding how a battery functions in a circuit. The reasoning is as follows:

1. A battery is a source of potential difference ΔV_{bat}. An ideal battery has $\Delta V_{bat} = \mathcal{E}$.
2. The battery creates a potential difference $\Delta V_{wire} = \Delta V_{bat}$ between the ends of a wire.
3. The potential difference ΔV_{wire} causes an electric field $E = \Delta V_{wire}/L$ in the wire.
4. The electric field establishes a current $I = JA = \sigma AE$ in the wire.
5. The magnitude of the current is determined *jointly* by the battery and the wire's resistance R to be $I = \Delta V_{wire}/R$.

FIGURE 27.19 A battery's charge escalator causes a sustained current in a wire.



A gravitational and inertial difference

In this model the current of the water pumped up to the tank creates a +𝕀D gravitational difference and a -𝕀D inertial difference. The current can be regarded as causing the gravitational and inertial difference, however that comes from +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work.

Cause and effect versus here and there

The word "causing" here is associated with the E𝕳/+𝕚d gravitational impulse and E𝕍/-𝕚d inertial impulse, cause and effect is deterministic when observed over a +𝕚d gravitational and -𝕚d inertial time. When this increase in the difference is measured that is not cause and effect, it is not deterministic but is probabilistic. There is no before and after with respect to time, instead it uses here and there with respect to positions.

Ohmic materials

When the +𝕆D potential and -𝕆D kinetic difference as measured as squared forces, the ohmic material gives a straight-line graph. That is because the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work are inverses of each other, if the +𝕆D×e𝕒 potential work increases then the -𝕆D×e𝕪 kinetic work decreases inversely. Because of this the current is linear rather than always accelerating.

Non-ohmic materials

A non-ohmic material such as a diode can also have a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. For example, as it heats up with the current its resistivity can change. An increase in the -

𝕆D kinetic voltage can heat the diode, this is like a viscous fluid becoming turbulent with an increased water pressure.

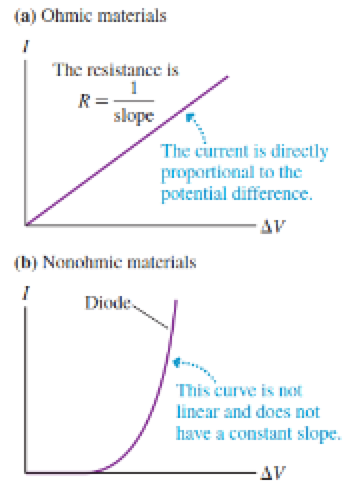
Resistors and Ohmic Materials

Circuit textbooks often write Ohm's law as $V = IR$ rather than $I = \Delta V/R$. This can be misleading until you have sufficient experience with circuit analysis. First, Ohm's law relates the current to the potential *difference* between the ends of the conductor. Engineers and circuit designers *mean* "potential difference" when they use the symbol V, but the symbol is easily misinterpreted as simply "the potential." Second, $V = IR$ or even $\Delta V = IR$ suggests that a current I causes a potential difference ΔV. As you have seen, current is a *consequence* of a potential difference; hence $I = \Delta V/R$ is a better description of cause and effect.

Despite its name, Ohm's law is *not* a law of nature. It is limited to those materials whose resistance R remains constant—or very nearly so—during use. The materials to which Ohm's law applies are called *ohmic*. FIGURE 27.20a shows that the current through an ohmic material is directly proportional to the potential difference. Doubling the potential difference doubles the current. Metal and other conductors are ohmic devices.

Because the resistance of metals is small, a circuit made exclusively of metal wires would have enormous currents and would quickly deplete the battery. It is useful to limit the current in a circuit with ohmic devices, called **resistors,** whose resistance is significantly larger than the metal wires. Resistors are made with poorly conducting materials, such as carbon, or by depositing very thin metal films on an insulating substrate.

FIGURE 27.20 Current-versus-potential-difference graphs for ohmic and nonohmic materials.



The electromotive force

In this model the electromotive force $\mathcal{E}$ is -𝕆D as the kinetic difference, when ΔV is interpreted as an instant or fluxion it would be the -𝕠𝕕 kinetic magnetic field. A kinetic current 𝕖𝕪/-𝕠𝕕 has 1/-𝕠𝕕 as 1/ΔV, this is linear because of the inverse +𝕆D×𝕖𝕒 potential work and -𝕆D×𝕖𝕪 kinetic work. The emf $\mathcal{E}$ is the electromotive force, that would be -𝕆D from -𝕆D×𝕖𝕪 kinetic work even though the current is the balance between two inverse forces.

Gravity and drag

In Biv space-time it would be like a falling projectile, at a 𝕖𝕙/+𝕚𝕕 gravitational speed the -𝕀D×𝕖𝕧 inertial work done by the air would slow it to a terminal velocity against the +𝕀D×𝕖𝕙 gravitational work. If the -𝕀D×𝕖𝕧 inertial work increased, such as with colder thicker air, then then terminal velocity would be slower but it would still be linear.

Turbulence and the terminal velocity

Resistivity and viscosity work in the same way as drag, with a reactive +𝕆D×𝕖𝕒 potential work from the protons in resistors and fluids. The resistor's atoms tend to hold onto other atoms, for example air would slow the change of a leaf's fall over time.

Some materials and devices are *nonohmic*, meaning that the current through the device is *not* directly proportional to the potential difference. For example, FIGURE 27.20b shows the I-versus-ΔV graph of a commonly used semiconductor device called a *diode*. Diodes do not have a well-defined resistance. Batteries, where $\Delta V = \mathcal{E}$ is determined by chemical reactions, and capacitors, where the relationship between I and ΔV differs from that of a resistor, are important nonohmic devices.

We can identify three important classes of ohmic circuit materials:

Wires

In this model a wire with a high conductivity σ is like a fluid with low viscosity. The flow of electrons is more laminar, the -𝕆D kinetic difference relates to $1/(2\pi)$ as β^2 so the current moves with a kinetic probability. The laminar flow is maintained by the strong +𝕆D potential and -𝕆D kinetic difference as the wire's voltage.

Resistors

These do more +𝕆D×e𝕒 potential work, the -𝕆D kinetic difference can be higher on one side of the resistor like a -𝕆D kinetic gradient of work. As the e𝕪 kinetic temperature rises there is an emission of e𝕪×-𝕘d photons where electrons jump to different orbitals with this kinetic gradient. This is like the left side of the blackbody curve where photons are emitted from -𝕆D×e𝕪 kinetic work. Other photons are emitted with a rising e𝕪 temperature from the E𝕐/-𝕠d kinetic impulse, they are on the right side of the blackbody curve.

Insulators

In this model an insulator does mainly +𝕆D×e𝕒 potential work, the electrons are more bound in the atoms as boson pairs. They can do little -𝕆D×e𝕪 kinetic work, so the e𝕪/-𝕠d kinetic current flows poorly through them.

1. *Wires* are metals with very small resistivities ρ and thus very small resistances ($R \ll 1\ \Omega$). An **ideal wire** has $R = 0\ \Omega$; hence the potential difference between the ends of an ideal wire is $\Delta V = 0$ V *even if there is a current in it*. We will usually adopt the *ideal-wire model* of assuming that any connecting wires in a circuit are ideal.
2. *Resistors* are poor conductors with resistances usually in the range 10^1 to $10^6\ \Omega$. They are used to control the current in a circuit. Most resistors in a circuit have a specified value of R, such as 500 Ω. The filament in a lightbulb (a tungsten wire with a high resistance due to an extremely small cross-section area A) functions as a resistor as long as it is glowing, but the filament is slightly nonohmic because the value of its resistance when hot is larger than its room-temperature value.
3. *Insulators* are materials such as glass, plastic, or air. An **ideal insulator** has $R = \infty\ \Omega$; hence there is no current in an insulator even if there is a potential difference across it ($I = \Delta V/R = 0$ A). This is why insulators can be used to hold apart two conductors at different potentials. All practical insulators have $R \gg 10^9\ \Omega$ and can be treated, for our purposes, as ideal.

Constructive interference in a resistor

The -𝕆D kinetic difference drops along the resistor, it would also drop along a wire with a higher resistivity. This is because each atom's -𝕠d and e𝕪 Pythagorean Triangle protons do +𝕆D×e𝕒 potential work adding to the -𝕆D×e𝕪 kinetic work. There is a constructive interference where the electrons are more attracted to the resistor atoms, that slows their forward progress along the resistor.

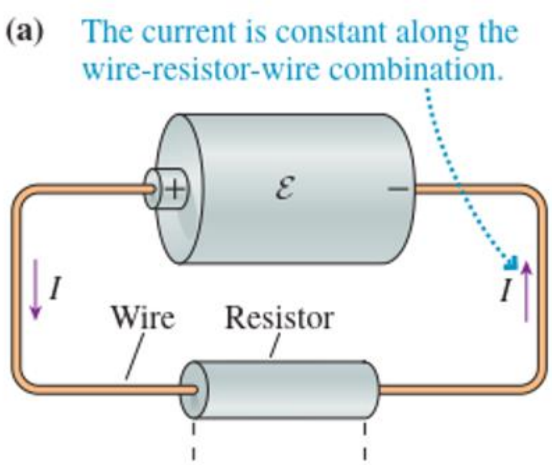
FIGURE 27.21a shows a resistor connected to a battery with current-carrying wires. There are no junctions; hence the current I through the resistor is the same as the current in each wire. Because the wire's resistance is *much* less than that of the resistor, $R_{wire} \ll R_{resist}$, the potential difference $\Delta V_{wire} = IR_{wire}$ between the ends of each wire is *much* less than the potential difference $\Delta V_{resist} = IR_{resist}$ across the resistor.

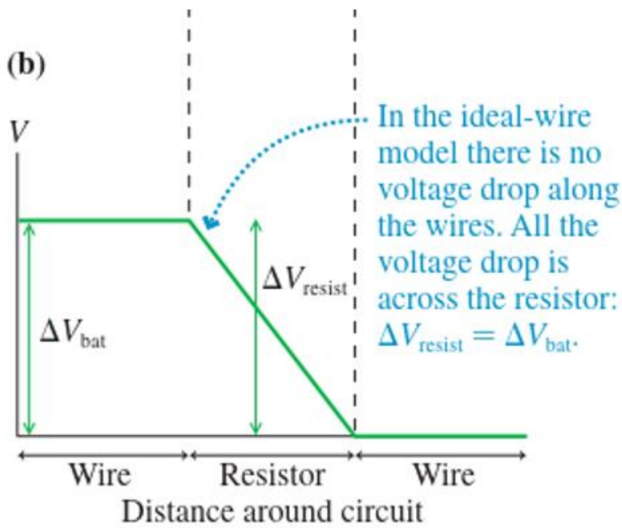
If we assume ideal wires with $R_{wire} = 0\ \Omega$, then $\Delta V_{wire} = 0$ V and *all* the voltage drop occurs across the resistor. In this **ideal-wire model,** shown in **FIGURE 27.21b**, the wires are equipotentials, and the segments of the voltage graph corresponding to the wires are horizontal. As we begin circuit analysis in the next chapter, we will assume that all wires are ideal unless stated otherwise. Thus our analysis will be focused on the resistors.

The kinetic voltage drops linearly

In this model the resistor does more +𝕆D×e𝕒 potential work against the -𝕆D×e𝕪 kinetic work of the current. This adds +𝕆D as the potential probability to the -𝕆D kinetic probability, that reduces the voltage for the circuit as the distance e𝕒 or length L of the resistor increases. It is linear because the opposing squared forces are inverses, -𝕆D decreases its kinetic voltage as it progresses along the wire encountering more +𝕆D×e𝕒 potential work from more protons.

FIGURE 27.21 The potential along a wire-resistor-wire combination.





Fundamentals of Circuits

Circuit diagrams

In this model capacitors and resistor differ in their ratios of +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, there can also be a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. When a resistor gets hot it can emit e𝕪/-𝕘d photons with a continuous spectrum from collisions between atoms and electrons. There can also be an emission of e𝕪×-𝕘d photons from the -𝕆D×e𝕪 kinetic work being done, that would give a discrete spectrum. Together they can give a blackbody spectrum.

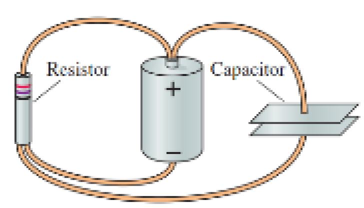
28.1 Circuit Elements and Diagrams

The last several chapters have focused on the physics of electric forces, fields, and potentials. Now we'll put those ideas to use by looking at one of the most important applications of electricity: the controlled motion of charges in *electric circuits*. This chapter is not about circuit design—you will see that in more advanced courses—but about understanding the fundamental ideas that underlie all circuits.

FIGURE 28.1 shows an electric circuit in which a resistor and a capacitor are connected by wires to a battery. To understand the functioning of this circuit, we do not need to know whether the wires are bent or straight, or whether the battery is to the right or to the left of the resistor. The literal picture of Figure 28.1 provides many irrelevant details. It is customary when describing or analyzing circuits to use a more abstract picture called a **circuit diagram.** A circuit diagram is a *logical* picture of what is connected to what.

A circuit diagram also replaces pictures of the circuit elements with symbols. FIGURE 28.2 shows the basic symbols that we will need. The longer line at one end of the battery symbol represents the positive terminal of the battery. Notice that a lightbulb, like a wire or a resistor, has two "ends," and current passes *through* the bulb. It is often useful to think of a lightbulb as a resistor that gives off light when a current is present. A lightbulb filament is not a perfectly ohmic material, but the resistance of a *glowing* lightbulb remains reasonably constant if you don't change ΔV by much.

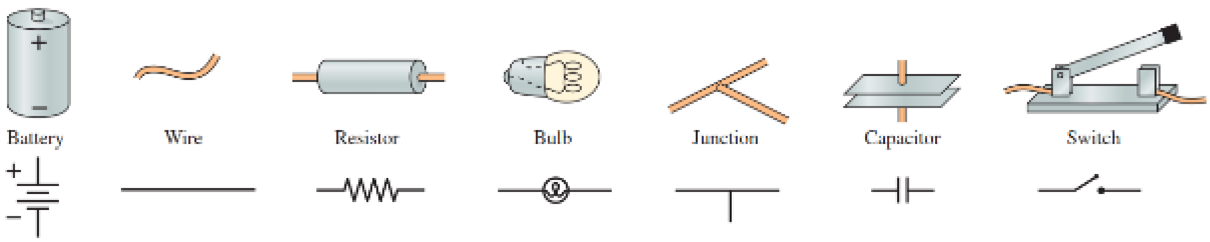
FIGURE 28.1 An electric circuit.



Components of Roy electromagnetism

In this model a circuit is composed of differing ratios of +𝕠d and e𝕒 Pythagorean Triangle proton attributes and -𝕠d and e𝕪 Pythagorean Triangle electron attributes. All of these are proportional to Biv space-time, so each of these is analogous to attributes of gravity and inertia.

FIGURE 28.2 A library of basic symbols used for electric circuit drawings.

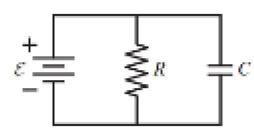


Emf, capacitors and resistors

Here the $\mathcal{E}$ is in between the +𝕆D potential difference and -𝕆D kinetic difference. The capacitor stores -𝕆D×e𝕪 kinetic work, the resistor reacts against this by doing +𝕆D×e𝕒 potential work. When a switch is closed there can be a surge of current as the E𝕐/-𝕠d kinetic impulse.

FIGURE 28.3 is a circuit diagram of the circuit shown in Figure 28.1. Notice how the circuit elements are labeled. The battery's emf $\mathcal{E}$ is shown beside the battery, and + and − symbols, even though somewhat redundant, are shown beside the terminals. We would use numerical values for $\mathcal{E}$, R, and C if we knew them. The wires, which in practice may bend and curve, are shown as straight-line connections between the circuit elements.

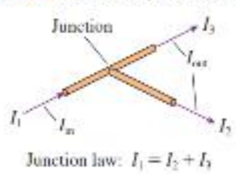
FIGURE 28.3 A circuit diagram for the circuit of Figure 28.1.



Charge and current are conserved

In this model charge is conserved because the Pythagorean Triangles are conserved in number.

FIGURE 28.4 Kirchhoff's junction law.



28.2 Kirchhoff's Laws and the Basic Circuit

We are now ready to begin analyzing circuits. To analyze a circuit means to find:

1. The potential difference across each circuit component.
2. The current in each circuit component.

Because charge is conserved, the total current into the junction of **FIGURE 28.4** must equal the total current leaving the junction. That is,

$$\sum I_{in} = \sum I_{out} \qquad (28.1)$$

Kirchoff's loop law

A closed path that has no overall change in the e𝕒 and e𝕪 positions does no +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. That means the sum of the +𝕆D-𝕆D voltages is zero, this is approximate because each Pythagorean Triangle does it own work. Observing and measuring other Pythagorean Triangles always has some uncertainty unless they are entangled.

This statement, which you met in Chapter 27, is **Kirchhoff's junction law.**

Because energy is conserved, a charge that moves around a closed path has $\Delta U = 0$. We apply this idea to the circuit of FIGURE 28.5 by adding all of the potential differences *around* the loop formed by the circuit. Doing so gives

$$\Delta V_{\text{loop}} = \sum (\Delta V)_i = 0 \tag{28.2}$$

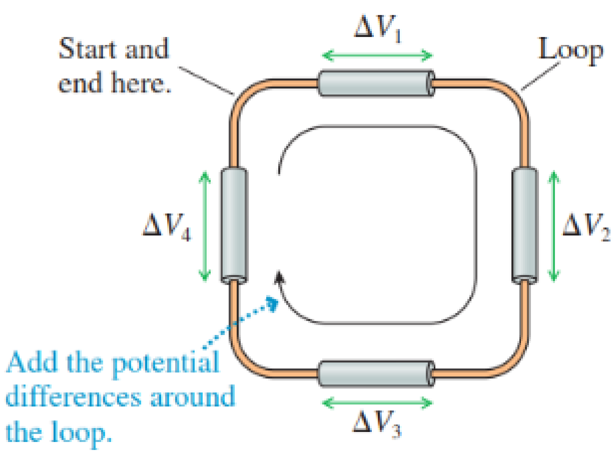
where $(\Delta V)_i$ is the potential difference of the ith component in the loop. This statement, introduced in Chapter 26, is **Kirchhoff's loop law.**

Kirchhoff's loop law can be true only if at least one of the $(\Delta V)_i$ is negative. To apply the loop law, we need to explicitly identify which potential differences are positive and which are negative.

Adding potential differences around a loop

In the diagram the kinetic and potential differences would cancel out, there is approximately no probability that a difference in work would be measured.

FIGURE 28.5 Kirchhoff's loop law.



Loop law: $\Delta V_1 + \Delta V_2 + \Delta V_3 + \Delta V_4 = 0$

The current is the same everywhere

In this model the +𝕠d and e𝕒 Pythagorean Triangles as protons, and the -𝕠d and e𝕪 Pythagorean Triangles as electrons are conserved. So the current is the same everywhere, if not then there would be a +𝕆D potential probability and a -𝕆D kinetic probability it would equalize.

The Basic Circuit

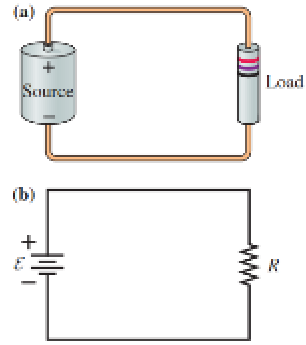
The most basic electric circuit is a single resistor connected to the two terminals of a battery. **FIGURE 28.6a** shows a literal picture of the circuit elements and the connecting wires; **FIGURE 28.6b** is the circuit diagram. Notice that this is a **complete circuit,** forming a continuous path between the battery terminals.

The resistor might be a known resistor, such as "a 10 Ω resistor," or it might be some other resistive device, such as a lightbulb. Regardless of what the resistor is, it is called the **load.** The battery is called the **source.**

FIGURE 28.7 shows the use of Kirchhoff's loop law to analyze this circuit. Two things are worth noting:

1. This circuit has no junctions, so the current I is the same in all four sides of the circuit. Kirchhoff's junction law is not needed.
2. We're assuming the ideal-wire model, in which there are *no* potential differences along the connecting wires.

FIGURE 28.6 The basic circuit of a resistor connected to a battery.



Charging a battery

In this model a discharged battery would have equal numbers of +𝕠d and e𝕒 Pythagorean Triangles and -𝕠d and e𝕪 Pythagorean Triangles. The charging process moves electrons to the negative terminal, the change in distance gives the -𝕆D×e𝕪 kinetic work done. This change in potential would be from the +𝕆D×e𝕒 potential work as $\mathcal{E}$.

The potential decreases with the current

In this model the potential decreases in the direction of the current, this is because the electrons move towards the positive terminal doing -𝕆D×e𝕪 kinetic work. As they are measured in different e𝕪 positions, closer to the +𝕆D potential difference this is increasingly added to the -𝕆D kinetic difference.

Inside the atom is like a current

In this model it is like inside an atom, an electron in a higher orbital does more -𝕆D×e𝕪 kinetic work because its -𝕆D kinetic torque is stronger. Closer to the protons in the lower orbitals, the -𝕆D×e𝕪 kinetic work is lower as the -𝕆D kinetic torque is increasingly added to by the +𝕆D potential torque.

Kirchhoff's loop law, with two circuit elements, is

$$\Delta V_{loop} = \sum_i (\Delta V)_i = \Delta V_{bat} + \Delta V_{res} = 0 \qquad (28.3)$$

Let's look at each of the two voltages in Equation 28.3:

1. The potential *increases* as we travel through the battery on our clockwise journey around the loop. We enter the negative terminal and, farther downstream, exit the positive terminal after having gained potential $\mathcal{E}$. Thus

$$\Delta V_{bat} = +\mathcal{E}$$

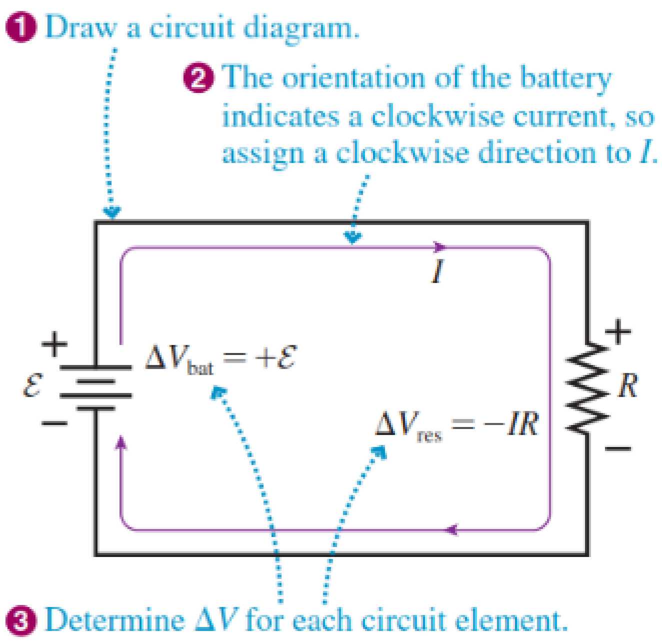
2. The potential of a conductor *decreases* in the direction of the current, which we've indicated with the + and − signs in Figure 28.7. Thus

$$\Delta V_{res} = V_{downstream} - V_{upstream} = -IR$$

Kinetic current direction

In this model the kinetic current would move counterclockwise.

FIGURE 28.7 Analysis of the basic circuit using Kirchhoff's loop law.



ℰ and current

In this model the emf ℰ is the difference between the +𝕆D potential difference and the -𝕆D kinetic difference, +𝕆D-𝕆D=0. When this is observed with the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse then this is unsquared as +𝕠d potential time and -𝕠d kinetic time.

The potential current is the inverse of the kinetic current

The potential resistivity comes from the +𝕠d and e𝕒 Pythagorean Triangles as +𝕆D×e𝕒 potential work. Here the kinetic current is e𝕪/-𝕠d which equals +𝕠d/e𝕒 where e𝕒 is 1/e𝕪 as the inverse of the kinetic conductivity. Then +𝕠d is the inverse of the 1/-𝕠d kinetic ℰ, +𝕠d/e𝕒 is the inverse of e𝕪/-𝕠d.

With this information, the loop equation becomes

$$\mathcal{E} - IR = 0 \tag{28.4}$$

We can solve the loop equation to find that the current in the circuit is

$$I = \frac{\mathcal{E}}{R} \tag{28.5}$$

Defining the electromotive force

Here ΔV_R would be +𝕠d as the potential magnetic field. This is squared with the -𝕆D potential difference, when opposed by the -𝕆D kinetic difference it is still a force but only has linear changes. The electromotive force here refers to a duality depending on whether it is measured as work or observed as impulse. It also depends on whether it is referred to in isolation or as part of the circuit.

We can then use the current to find that the magnitude of the resistor's potential difference is

$$\Delta V_R = IR = \mathcal{E} \qquad (28.6)$$

This result should come as no surprise. The potential energy that the charges gain in the battery is subsequently lost as they "fall" through the resistor.

NOTE The current that the battery delivers depends jointly on the emf of the battery and the resistance of the load.

Energy is not a force

In this model energy is not a force, the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy for example has two forces E𝕐 and -𝕆D which are the inverses of each other. That cancels them out so this is stable. That makes energy a constant value unless a force changes it, the -𝕠d×e𝕪/-𝕠d as the kinetic momentum or Coulombs is equivalent because that is also constant with no forces.

Energy not needed

The energy changes as the angle θ in each -𝕠d and e𝕪 Pythagorean Triangle changes with -𝕆D×e𝕪 kinetic work or the E𝕐/-𝕠d kinetic impulse. For example with kinetic energy, this decreases as E𝕐 decreases and -𝕆D inversely increases. That is the same as the change in the angle θ, energy is not needed in this model instead of momentum. Also E𝕐/-𝕆D, as the division of two inverse forces, implies an observation and a measurement at the same time and position. This is not allowed here except as an approximation.

Thermal energy

The thermal energy changes here would come from the -𝕆D×e𝕪 kinetic work and the E𝕐/-𝕠d kinetic impulse. Blackbody radiation combines the two, changes in work can emit quantized e𝕪×-𝕘d photon. Changes in impulse occur with collisions as e𝕪/-𝕘d photons with a continuous spectrum.

Potential energy and the potential momentum

In this model U is +𝕠d×e𝕒/+𝕆D from F=ma, that equals q as +𝕠d×e𝕒/+𝕠d as the potential momentum times ΔV_{bat} as 1/+𝕠d.

Power

In this model power would be joules/second, that is the number of -𝕠d and e𝕪 Pythagorean Triangles as electrons with their ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy each second. These electrons would have a -𝕠d×e𝕪/-𝕠d kinetic momentum in Coulombs, the squares E𝕐 and -𝕆D are not needed because there is no force. The factor per second as 1/-𝕠d in kinetic time would not be included in the formula, it is not an observation or measurement of individual -𝕠d and e𝕪 Pythagorean Triangles.

A charge gains potential energy $\Delta U = q\,\Delta V_{\text{bat}}$ as it moves up the charge escalator in the battery. For an ideal battery, with $\Delta V_{\text{bat}} = \mathcal{E}$, the battery supplies energy $\Delta U = q\mathcal{E}$ as it lifts charge q from the negative to the positive terminal.

It is useful to know the *rate* at which the battery supplies energy to the charges. Recall from Chapter 9 that the rate at which energy is transferred is *power,* measured in joules per second or *watts.* If energy $\Delta U = q\mathcal{E}$ is transferred to charge q, then the *rate* at which energy is transferred from the battery to the moving charges is

$$P_{\text{bat}} = \text{rate of energy transfer} = \frac{dU}{dt} = \frac{dq}{dt}\mathcal{E} \qquad (28.7)$$

Kinetic power

Here the kinetic power would be e𝕪/-𝕠d as the kinetic current times 1/-𝕠d as kinetic time. That would be the inverse of U as the potential energy, e𝕪/-𝕆D which would be -𝕆D×e𝕪 kinetic work, also from F=ma. Making the electrons move through the wire requires -𝕆D×e𝕪 kinetic work which would be the kinetic power here. If the electrons are moving with kinetic q as -𝕠d×e𝕪/-𝕠d, then counting them per second need not be a direct measurement of work. With the overall current I then this would not be a force, but the -𝕆D×e𝕪 kinetic work being done in each electron gives the power.

But dq/dt, the rate at which charge moves through the battery, is the current I. Hence the power supplied by a battery, or the rate at which the battery (or any other source of emf) transfers energy to the charges passing through it, is

$$P_{\text{bat}} = I\mathcal{E} \qquad \text{(power delivered by an emf)} \qquad (28.8)$$

$I\mathcal{E}$ has units of J/s, or W. For example, a 120 V battery that generates 2 A of current is delivering 240 W of power to the circuit.

Energy dissipation in resistors

In this model energy loss is the losses from the -𝕆D×e𝕪 kinetic work and E𝕐/-𝕠d kinetic impulse, the reactive +𝕆D×e𝕒 potential work and E𝔸/+𝕠d potential impulse increasingly do this as the resistor strength increases. The +𝕆D×e𝕒 potential work has a randomizing effect because work is based on a normal curve and potential probability here. Inversely to this the E𝔸/+𝕠d potential impulse causes chaotic collisions which increase the e𝕪 kinetic temperature. That is because instead of a laminar flow of electrons, the -𝕆D kinetic voltage is changed into E𝕐 as a kinetic displacement.

Energy Dissipation in Resistors

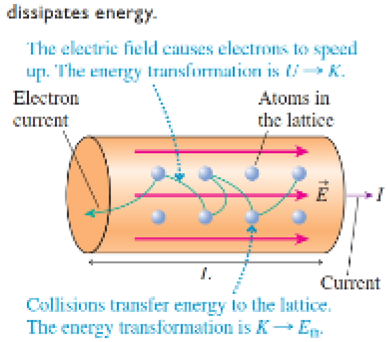
P_{bat} is the energy transferred per second from the battery's store of chemicals to the moving charges that make up the current. But what happens to this energy? Where does it end up? **FIGURE 28.12**, a section of a current-carrying resistor, reminds you of our microscopic model of conduction. The electrons accelerate in the electric field, transforming potential energy into kinetic, then collide with atoms in the lattice. The collisions transfer the electron's kinetic energy to the *thermal* energy of the lattice. The potential energy was acquired in the battery, so the entire energy-transfer process looks like

$$E_{\text{chem}} \rightarrow U \rightarrow K \rightarrow E_{\text{th}}$$

The net result is that **the battery's chemical energy is transferred to the thermal energy of the resistors,** raising their temperature.

Consider a charge q that moves all the way through a resistor with a potential difference ΔV_R between its two ends. The charge *loses potential energy* $\Delta U = -q\,\Delta V_R$,

FIGURE 28.12 A current-carrying resistor dissipates energy.



Increase in thermal energy

In (28.9) ΔE_{th} is the change from the kinetic q as -𝕠d×e𝕪/-𝕠d times 1/-𝕠d as V_R. This would be a reduction in -𝕆D×e𝕪 kinetic work from +𝕆D×e𝕒 potential work in the resistor. The inverse of 1/-𝕠d is e𝕪, then -𝕠d×E𝕐/-𝕠d contains the E𝕐/-𝕠d kinetic impulse which also dissipates energy. The two forces E𝕐 and -𝕆D are contained in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, this decreases because part of it is being dissipated from both -𝕆D×e𝕪 kinetic work and the E𝕐/-𝕠d kinetic impulse.

and, after a vast number of collisions, all that energy is transformed into thermal energy. Thus the resistor's *increase in thermal energy* due to this one charge is

$$\Delta E_{th} = q\,\Delta V_R \qquad (28.9)$$

The *rate* at which energy is transferred from the current to the resistor is then

$$P_R = \frac{dE_{th}}{dt} = \frac{dq}{dt}\Delta V_R = I\,\Delta V_R \qquad (28.10)$$

Power as counting electrons

The rate of this energy dissipation is the potential power P_R, that is e𝕒/+𝕠d times 1/+𝕠d as +𝕆D×e𝕒 potential work and e𝕒 as its inverse to give the E𝔸/+𝕠d potential impulse. The power is counting the number of -𝕠d and e𝕪 Pythagorean Triangle electrons going through the wire per second. When that corresponds to individual electrons here, this becomes the +𝕆D×e𝕒 potential work and the E𝔸/+𝕠d potential impulse. In both cases that increases as power because there are more electrons flowing per second.

Power—so many joules per second—is the rate at which energy is *dissipated* by the resistor as charge flows through it. The resistor, in turn, transfers this energy to the air and to the circuit board on which it is mounted, causing the circuit and all its surroundings to heat up.

From our analysis of the basic circuit, in which a single resistor is connected to a battery, we learned that $\Delta V_R = \mathcal{E}$. That is, the potential difference across the resistor is exactly the emf supplied by the battery. But then Equations 28.8 and 28.10, for P_{bat} and P_R, are numerically equal, and we find that

$$P_R = P_{bat} \qquad (28.11)$$

The answer to the question "What happens to the energy supplied by the battery?" is "The battery's chemical energy is transformed into the thermal energy of the resistor." The *rate* at which the battery supplies energy is exactly equal to the *rate* at which the resistor dissipates energy. This is, of course, exactly what we would have expected from energy conservation.

Power dissipated by a resistor

In (28.12) the potential power dissipated by the resistor is I^2R or E𝕐/-𝕆D × 1/e𝕪 as the -𝕆D×e𝕪 kinetic work reduced. The inverse of this is the +𝕆D×e𝕒 potential work. When atoms get hot this is from the -𝕆D×e𝕪 kinetic work emitting e𝕪×-𝕘d photons, when they get hot by vibrations and colliding this is caused by the E𝕐/-𝕠d kinetic impulse emitting e𝕪/-𝕘d photons.

A resistor obeys Ohm's law, $\Delta V_R = IR$. (Remember that Ohm's law gives only the *magnitude* of ΔV_R.) This gives us two alternative ways of writing the power dissipated by a resistor. We can either substitute IR for ΔV_R or substitute $\Delta V_R/R$ for I. Thus

$$P_R = I\Delta V_R = I^2R = \frac{(\Delta V_R)^2}{R} \qquad \text{(power dissipated by a resistor)} \qquad (28.12)$$

If the same current I passes through several resistors in series, then $P_R = I^2R$ tells us that most of the power will be dissipated by the largest resistance. This is why a lightbulb filament glows but the connecting wires do not. Essentially *all* of the power supplied by the battery is dissipated by the high-resistance lightbulb filament and essentially no power is dissipated by the low-resistance wires. The filament gets very hot, but the wires do not.

Joules as counting electrons

In this model joules are the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, that is the number of -𝕠d and e𝕪 Pythagorean Triangles through the wire. This can be regarded as kinetic power when divided by 1/-𝕠d kinetic time, it means more electrons pass through the wire per second. Multiplying the kinetic power by time restores it to joules, it is also the -𝕠d×e𝕪/-𝕠d kinetic momentum in Coulombs because each is a single -𝕠d and e𝕪 Pythagorean Triangle.

Kilowatt Hours

The energy dissipated (i.e., transformed into thermal energy) by a resistor during time Δt is $E_{th} = P_R\,\Delta t$. The product of watts and seconds is joules, the SI unit of energy. However, your local electric company prefers to use a different unit, the *kilowatt hour*, to measure the energy you use each month.

A load that consumes P_R kW of electricity for Δt hours has used $P_R\,\Delta t$ **kilowatt hours** of energy, abbreviated kWh. For example, a 4000 W electric water heater uses 40 kWh of energy in 10 hours. A 1500 W hair dryer uses 0.25 kWh of energy in 10 minutes. Despite the rather unusual name, a kilowatt hour is a unit of energy. A homework problem will let you find the conversion factor from kilowatt hours to joules.

Your monthly electric bill specifies the number of kilowatt hours you used last month. This is the amount of energy that the electric company delivered to you, via an electric current, and that you transformed into light and thermal energy inside your home. The cost of electricity varies throughout the country, but the average cost of electricity in the United States is approximately 10¢ per kWh ($0.10/kWh). Thus it costs about $4.00 to run your water heater for 10 hours, about 2.5¢ to dry your hair.

Capacitors and resistors as inverses

In this model the +𝕆D×e𝕒 potential work of the resistors in series is added together. The -𝕆D×e𝕪 kinetic work of capacitors in series is also added together, that makes them the inverse of each other.

28.4 Series Resistors

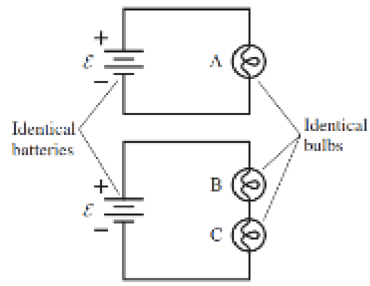
Consider the three lightbulbs in FIGURE 28.13. The batteries are identical and the bulbs are identical. You learned in the previous section that B and C are equally bright, because the current is the same through both, but how does the brightness of B compare to that of A? Think about this before going on.

FIGURE 28.14a shows two resistors placed end to end between points a and b. Resistors that are aligned end to end, *with no junctions between them*, are called **series resistors** or, sometimes, resistors "in series." Because there are no junctions, the current I must be the same through each of these resistors. That is, the current out of the last resistor in a series is equal to the current into the first resistor.

The potential differences across the two resistors are $\Delta V_1 = IR_1$ and $\Delta V_2 = IR_2$. The total potential difference ΔV_{ab} between points a and b is the sum of the individual potential differences:

$$\Delta V_{ab} = \Delta V_1 + \Delta V_2 = IR_1 + IR_2 = I(R_1 + R_2) \qquad (28.13)$$

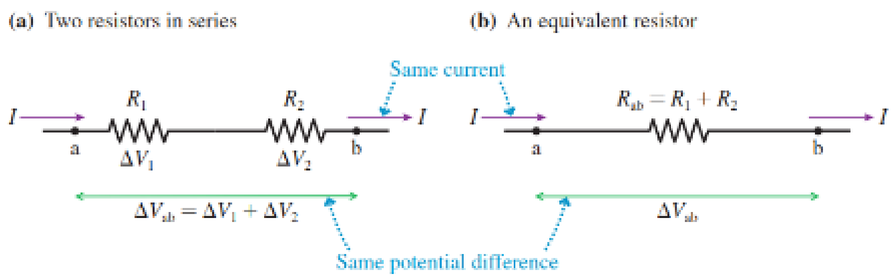
FIGURE 28.13 How does the brightness of bulb B compare to that of A?



An equivalent resistor

Here the +𝕆D×e𝕒 potential work adds together with +𝕆D destructive interference, the single resistor can then replace them.

FIGURE 28.14 Replacing two series resistors with an equivalent resistor.



Vector addition with resistance

Here the resistance is e𝕒, that is measuring the +𝕆D×e𝕒 potential work over an e𝕒 distance. That is not the same as an E𝔸 displacement where a force moves from a starting to a final e𝕒 position. It is the same as adding the +𝕆D potential probabilities of the resistor, as this increases with more resistors the potential probability adds more to the -𝕆D kinetic probability. That makes it less likely the -𝕆D kinetic difference will get through the resistors. That is written here as R_{ab} is +𝕠d×e𝕒/+𝕠d = e𝕒. The e𝕒 potential electric charge uses vector addition to sum to a larger resistance.

Suppose, as in **FIGURE 28.14b**, we replaced the two resistors with a single resistor having current I and potential difference $\Delta V_{ab} = \Delta V_1 + \Delta V_2$. We can then use Ohm's law to find that the resistance R_{ab} between points a and b is

$$R_{ab} = \frac{\Delta V_{ab}}{I} = \frac{I(R_1 + R_2)}{I} = R_1 + R_2 \qquad (28.14)$$

Because the battery has to establish the same potential difference across the load and provide the same current in both cases, the two resistors R_1 and R_2 act exactly the same as a *single* resistor of value $R_1 + R_2$. We can say that the single resistor R_{ab} is *equivalent* to the two resistors in series.

There was nothing special about having only two resistors. If we have N resistors in series, their **equivalent resistance** is

$$R_{eq} = R_1 + R_2 + \cdots + R_N \qquad \text{(series resistors)} \qquad (28.15)$$

Adding the potential current

In this model there is the same e𝕒/+𝕠d potential current through the resistors.

The current and the power output of the battery will be unchanged if the N series resistors are replaced by the single resistor R_{eq}. The key idea in this analysis is that **resistors in series all have the same current.**

NOTE Compare this idea to what you learned in Chapter 26 about capacitors in series. The end-to-end connections are the same, but the equivalent capacitance is *not* the sum of the individual capacitances.

The kinetic difference between two lamps

In this model -𝕆D×e𝕪 kinetic work is used to get through the first lamp, with its reactive +𝕆D×e𝕒 potential work. That leaves a lower -𝕆D×e𝕪 kinetic work voltage for the second lamp so it is dimmer. The first bulb has +𝕠d/e𝕒 as the potential current, two of them have 2𝕒/+𝕠d. This is inverted but that does not change the value. Because the resistance doubles the potential current it halves the e𝕪/-𝕠d kinetic current so the second bulb is dimmer.

Now we can answer the lightbulb question posed at the beginning of this section. Suppose the resistance of each lightbulb is R. The battery drives current $I_A = \mathcal{E}/R$ through bulb A. Bulbs B and C are in series, with an equivalent resistance $R_{eq} = 2R$, but the battery has the same emf $\mathcal{E}$. Thus the current through bulbs B and C is $I_{B+C} = \mathcal{E}/R_{eq} = \mathcal{E}/2R = \frac{1}{2}I_A$. Bulb B has only half the current of bulb A, so B is dimmer.

A fixed voltage in a battery

The battery has a fixed amount of voltage, so it does a fixed amount of +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. When the current goes through the first lamp the -𝕆D×e𝕪 kinetic work goes down, that means -𝕆D has decreased and so the F=ma force on the current reduces. That makes the kinetic current slow down.

Many people predict that A and B should be equally bright. It's the same battery, so shouldn't it provide the same current to both circuits? No! A battery is a source of emf, *not* a source of current. In other words, the battery's emf is the same no matter how the battery is used. When you buy a 1.5 V battery you're buying a device that provides a specified amount of potential difference, not a specified amount of current.The battery does provide the current to the circuit, but the *amount* of current depends on the resistance of the load. Your 1.5 V battery causes 1 A to pass through a 1.5 Ω load but only 0.1 A to pass through a 15 Ω load. As an analogy, think about a water faucet. The pressure in the water main underneath the street is a fixed and unvarying quantity set by the water company, but the amount of water coming out of a faucet depends on how far you open it. A faucet opened slightly has a "high resistance," so only a little water flows. A wide-open faucet has a "low resistance," and the water flow is large.

In summary, **a battery provides a fixed and unvarying emf (potential difference). It does *not* provide a fixed and unvarying current. The amount of current depends jointly on the battery's emf *and* the resistance of the circuit attached to the battery.**

Ammeters

In this model the ammeter moves with the e𝕪/-𝕠d kinetic current, with the -𝕠d×e𝕪/-𝕠d kinetic momentum as Coulombs it counts the number of -𝕠d and e𝕪 Pythagorean Triangle electrons moving through it per second. It observes the straight-line motion of electrons through it as the E𝕐/-𝕠d kinetic impulse.

Ammeters

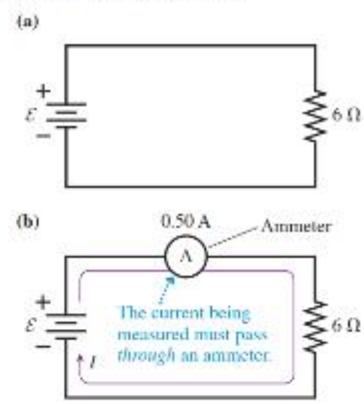
A device that measures the current in a circuit element is called an **ammeter.** Because charge flows *through* circuit elements, an ammeter must be placed *in series* with the circuit element whose current is to be measured.

FIGURE 28.16a shows a simple one-resistor circuit with an unknown emf $\mathcal{E}$. We can measure the current in the circuit by inserting the ammeter as shown in FIGURE 28.16b. Notice that we have to *break the connection* between the battery and the resistor in order to insert the ammeter. Now the current in the resistor has to first pass through the ammeter.

Because the ammeter is now in series with the resistor, the total resistance seen by the battery is $R_{eq} = 6\ \Omega + R_{ammeter}$. In order that the ammeter measure the current without changing the current, the ammeter's resistance must, in this case, be $\ll 6\ \Omega$. Indeed, an ideal ammeter has $R_{ammeter} = 0\ \Omega$ and thus has no effect on the current. Real ammeters come very close to this ideal.

The ammeter in Figure 28.16b reads 0.50 A, meaning that the current through the 6 Ω resistor is $I = 0.50$ A. Thus the resistor's potential difference is $\Delta V_R = IR = 3.0$ V. If the ammeter is ideal, with no resistance and thus no potential difference across it, then, from Kirchhoff's loop law, the battery's emf is $\mathcal{E} = \Delta V_R = 3.0$ V.

FIGURE 28.16 An ammeter measures the current in a circuit element.



Internal resistance

In this model there is +𝕆D×e𝕒 potential work done in charging the battery, that reacts against the -𝕆D×e𝕪 kinetic work in the charge escalator. Because +𝕆D and -𝕆D are probabilities, they are random and are measured on a normal curve. There is an internal resistance in charging and discharging the battery, the random directions of the work done reduce the overall potential and kinetic difference.

28.5 Real Batteries

Real batteries, like ideal batteries, use chemical reactions to separate charge, create a potential difference, and provide energy to the circuit. However, real batteries also provide a slight resistance to the charges on the charge escalator. They have what is called an **internal resistance,** which is symbolized by r. FIGURE 28.17 on the next page shows both an ideal and a real battery.

From our vantage point outside a battery, we cannot see $\mathcal{E}$ and r separately. To the user, the battery provides a potential difference ΔV_{bat} called the **terminal voltage.** $\Delta V_{bat} = \mathcal{E}$ for an ideal battery, but the presence of the internal resistance affects ΔV_{bat}. Suppose the current in the battery is I. As charges travel from the negative to the

A short circuit

In this model the potential current is $\mathcal{E}$/r or +𝕠d/e𝕒, the larger the e𝕒 resistance the more e𝕒/+𝕠d is. That makes e𝕪/-𝕠d decrease inversely as the kinetic current. The current is limited by the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work the battery does even with a short circuit.

A Short Circuit

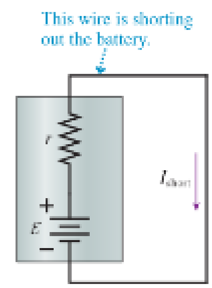
In FIGURE 28.19 we've replaced the resistor with an ideal wire having $R_{wire} = 0\ \Omega$. When a connection of very low or zero resistance is made between two points in a circuit that are normally separated by a higher resistance, we have what is called a **short circuit.** The wire in Figure 28.17 is *shorting out* the battery.

If the battery were ideal, shorting it with an ideal wire $(R = 0\ \Omega)$ would cause the current to be $I = \mathcal{E}/0 = \infty$. The current, of course, cannot really become infinite. Instead, the battery's internal resistance r becomes the only resistance in the circuit. If we use $R = 0\ \Omega$ in Equation 28.17, we find that the *short-circuit current* is

$$I_{short} = \frac{\mathcal{E}}{r} \qquad (28.20)$$

A 3 V battery with 1 Ω internal resistance generates a short circuit current of 3 A. This is the *maximum possible current* that this battery can produce. Adding any external resistance R will decrease the current to a value less than 3 A.

FIGURE 28.19 The short-circuit current of a battery.



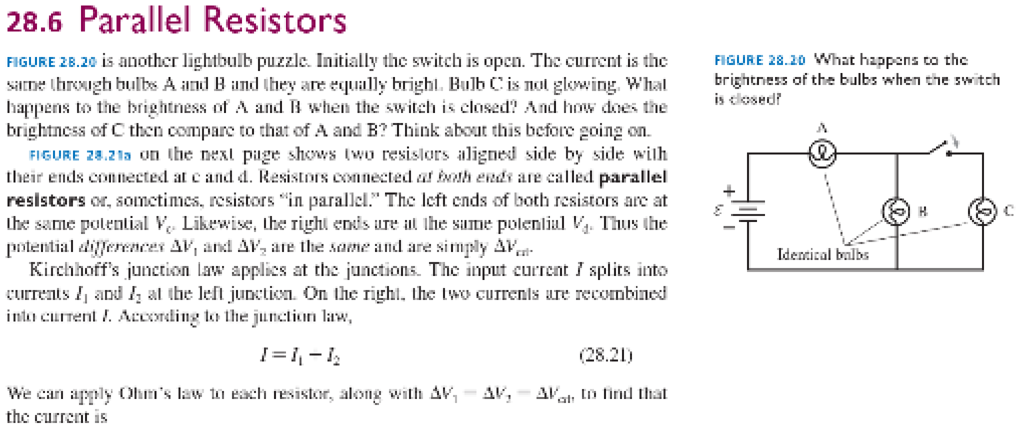
Randomizing and internal resistance

When the internal resistance is higher, then there is more randomizing done by the +𝕆D×e𝕒 potential work in it.

Most of the time a battery is used under conditions in which $r \ll R$ and the internal resistance is negligible. The ideal battery model is fully justified in that case. Thus we will assume that batteries are ideal *unless stated otherwise*. But keep in mind that batteries (and other sources of emf) do have an internal resistance, and this internal resistance limits the current of the battery.

Parallel resistors

In this model each resistor does the same +𝕆D×e𝕒 potential work, the -𝕆D×e𝕪 kinetic work done through each is the same after the +𝕆D×e𝕒 potential work is added to it.



28.6 Parallel Resistors

FIGURE 28.20 is another lightbulb puzzle. Initially the switch is open. The current is the same through bulbs A and B and they are equally bright. Bulb C is not glowing. What happens to the brightness of A and B when the switch is closed? And how does the brightness of C then compare to that of A and B? Think about this before going on.

FIGURE 28.21a on the next page shows two resistors aligned side by side with their ends connected at c and d. Resistors connected *at both ends* are called **parallel resistors** or, sometimes, resistors "in parallel." The left ends of both resistors are at the same potential V_c. Likewise, the right ends are at the same potential V_d. Thus the potential *differences* ΔV_1 and ΔV_2 are the *same* and are simply ΔV_{cd}.

Kirchhoff's junction law applies at the junctions. The input current I splits into currents I_1 and I_2 at the left junction. On the right, the two currents are recombined into current I. According to the junction law,

$$I = I_1 + I_2 \qquad (28.21)$$

We can apply Ohm's law to each resistor, along with $\Delta V_1 = \Delta V_2 = \Delta V_{cd}$, to find that the current is

FIGURE 28.20 What happens to the brightness of the bulbs when the switch is closed?

Parallel resistors and capacitors

Here the parallel resistors are inverses to the capacitors in parallel, this is because the resistors do +𝕆D×e𝕒 potential work and the capacitors do -𝕆D×e𝕪 kinetic work. In (28.22) the equation is +𝕠d/e𝕒, because e𝕒 is in the denominator this is added together as fractions. The inverse of this is with capacitors, so they are added together as e𝕪/-𝕠d where e𝕪 is added in the numerator.

Inverted vector addition

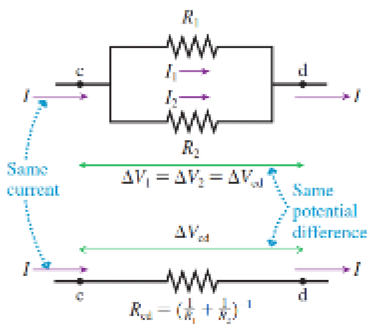
In measuring the +𝕆D×e𝕒 potential work of resistors this gives +𝕆D/e𝕒 while the inverse with capacitors is e𝕪/+𝕆D. With resistors the parallel addition is a vector addition as fractions, inverses of the vector addition of capacitors in parallel.

Numerator and denominator

With resistors in series there is a straight-line motion through them as the E𝔸/+𝕠d potential impulse. The potential displacement has a reactive force against the E𝕐/-𝕠d kinetic impulse of the current. Because the E𝔸/+𝕠d potential impulse is the inverse of the +𝕆D×e𝕒 potential work, the vector addition of the force vectors E𝔸 is also inverted. That allows for the E𝔸 potential displacement to be added in the numerator. Conversely the -𝕠d/E𝕐 kinetic impulse is the inverse, so the kinetic displacement force uses vector addition in the denominator.

FIGURE 28.21 Replacing two parallel resistors with an equivalent resistor.

(a) Two resistors in parallel



(b) An equivalent resistor

$$I = \frac{\Delta V_1}{R_1} + \frac{\Delta V_2}{R_2} = \frac{\Delta V_{cd}}{R_1} + \frac{\Delta V_{cd}}{R_2} = \Delta V_{cd}\left(\frac{1}{R_1} + \frac{1}{R_2}\right) \qquad (28.22)$$

Suppose, as in **FIGURE 28.21b**, we replaced the two resistors with a single resistor having current I and potential difference ΔV_{cd}. This resistor is equivalent to the original two because the battery has to establish the same potential difference and provide the same current in either case. A second application of Ohm's law shows that the resistance between points c and d is

$$R_{cd} = \frac{\Delta V_{cd}}{I} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} \qquad (28.23)$$

The single resistor R_{cd} draws the same current as resistors R_1 and R_2, so, as far as the battery is concerned, resistor R_{cd} is *equivalent* to the two resistors in parallel.

There is nothing special about having chosen two resistors to be in parallel. If we have N resistors in parallel, the *equivalent resistance* is

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}\right)^{-1} \quad \text{(parallel resistors)} \qquad (28.24)$$

Series and parallel as inverses

In this model capacitors and resistors in series have a E𝕐/-𝕕d kinetic impulse and E𝔸/+𝕕d potential impulse. In parallel there is no straight-line motion through them, instead the negative charges have a -𝕆D kinetic probability of which capacitor or resistor they go through. This makes series and parallel inverses of each other.

Two identical resistors*

In series	$R_{eq} = 2R$
In parallel	$R_{eq} = \frac{R}{2}$

*$R_1 = R_2 = R$

The behavior of the circuit will be unchanged if the N parallel resistors are replaced by the single resistor R_{eq}. The key idea of this analysis is that **resistors in parallel all have the same potential difference.**

NOTE Don't forget to take the inverse—the -1 exponent in Equation 28.24—after adding the inverses of all the resistances.

More paths through resistors

In this model when there are more paths through resistors, then e𝕒 increases linearly and +𝕆D as the potential probability decreases as a square. That also changes linearly because it is the inverse of the -𝕆D kinetic probability.

The result of Example 28.7 seems surprising. The equivalent of a parallel combination of 15 Ω, 4 Ω, and 8 Ω was found to be 2.26 Ω. How can the equivalent of a group of resistors be *less* than any single resistance in the group? Shouldn't more resistors imply more resistance? The answer is yes for resistors in series but not for resistors in parallel. Even though a resistor is an obstacle to the flow of charge, parallel resistors provide more pathways for charge to get through. Consequently, the equivalent of several resistors in parallel is always *less* than any single resistor in the group.

Complex combinations of resistors can often be reduced to a single equivalent resistance through a step-by-step application of the series and parallel rules. The final example in this section illustrates this idea.

Summary of series and parallel resistors

	I	ΔV
Series	Same	Add
Parallel	Add	Same

Probability and parallel resistors

In this model the resistors in parallel have an equal +𝕆D potential probability of which -𝕆D×e𝕪 kinetic work is reduced in going through them. When they are in series there is no probability, the -𝕕d and e𝕪 Pythagorean Triangle electrons must take a deterministic path through both resistors. That makes it the inverse of +𝕆D×e𝕒 potential work and the E𝔸/+𝕕d potential impulse.

The double slit experiment with resistors

In this model the outcome is related to the double slit experiment. When a slit is not observed for its e𝕐/-𝕘d light impulse, then the e𝕪×-𝕘d photons can go through both with a constructive and destructive interference. That is like resistors in parallel, it it not possible to observe which one the electrons go through so there can only be a +𝕆D potential probability of where the electrons can be measured.

Observing which resistor has the current first

When the resistors are in series, then it is known that the electrons go through the first resistor, then the second one. That observation removes the potential probability, there can only be a E𝔸/+𝕠d potential impulse through them as the inverse of the +𝕆D×e𝕒 potential work.

The double slit experiment with capacitors

The inverse of this is the capacitors. When they are in series it is not known which ones the electrons become stored in. So there is a -𝕆D kinetic probability, they can also interfere with each other if they are too close together. That also happens with high voltage powerlines.

Observing which capacitor has the current first

When the capacitors are in series it is known which one the electrons go into first. There is no -𝕆D kinetic probability, so the observation is deterministic with a E𝕐/-𝕠d kinetic impulse. These are inverses, also inverses of the +𝕆D×e𝕒 potential work and E𝔸/+𝕠d potential impulse.

To return to the lightbulb question that began this section, FIGURE 28.26 has redrawn the circuit with each bulb shown as a resistance R. Initially, before the switch is closed, bulbs A and B are in series with equivalent resistance $2R$. The current from the battery is

$$I_{\text{before}} = \frac{\mathcal{E}}{2R} = \frac{1}{2}\frac{\mathcal{E}}{R}$$

This is the current in both bulbs.

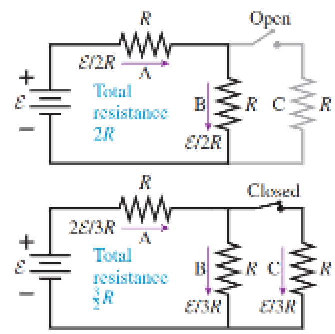
Closing the switch places bulbs B and C in parallel. The equivalent resistance of two identical resistors in parallel is $R_{eq} = \frac{1}{2}R$. This equivalent resistance of B and C is in series with bulb A; hence the total resistance of the circuit is $\frac{3}{2}R$ and the current leaving the battery is

$$I_{\text{after}} = \frac{\mathcal{E}}{3R/2} = \frac{2}{3}\frac{\mathcal{E}}{R} > I_{\text{before}}$$

Closing the switch *decreases* the circuit resistance and thus *increases* the current leaving the battery.

All the charge flows through A, so A *increases* in brightness when the switch is closed. The current I_{after} then splits at the junction. Bulbs B and C have equal resistance, so the current splits equally. The current in B is $\frac{1}{3}(\mathcal{E}/R)$, which is *less* than I_{before}. Thus B *decreases* in brightness when the switch is closed. Bulb C has the same brightness as bulb B.

FIGURE 28.26 The lightbulbs of Figure 28.20 with the switch open and closed.



Probability in the macro world

In this model an observation can come from many Pythagorean Triangles, they sum up to impulse being observed over time. The -𝕚d and e𝕧 Pythagorean Triangles for example as inertia are associated with electrons in a ball. That allows the whole ball to be observed with an E𝕍/-𝕚d inertial impulse, even when some of the electrons are doing -𝕆D×e𝕪 kinetic work. Its protons are observed as part of this with a E𝔸/+𝕠d potential impulse and Eℍ/+𝕚d gravitational impulse.

A before and after observation

When there is a deterministic cause and effect relationship, that happens with a before and after observation of time, then there is impulse. If the ball hits a window then it breaks the glass deterministically in a cause and effect way, there are chaotic changes in its structure. Like Wigner's friend someone might observe the ball, then observe the window breaking. Another person observes the first person reacting through a camera trained on the window and them.

Because implies time

The word "because" implies impulse as a cause then an effect. People who observe this chain of events, like Wigner's friend, also observe a series of deterministic linked events over -ⅈd inertial time.

Impulse is more common in the macro world

Impulse is more common in the macro world because -ⅅ×e𝕧 inertial work is weaker over longer distances but does not disappear. The term "more common" implies measurement of work itself is less probable.

Modeling probability as impulse

Probabilities can sometimes be modeled as a series of deterministic causes and effects. For example, throwing a dice can be argued to be observable in principle, a slow motion camera breaks it up into smaller increments of e.g. -ⅈd inertial time. As the time intervals shorten then the ball appears to stop in between the images, velocity seems to itself stop as it approaches measurability with work. This is Zeno's paradox which the arrow not moving at given instants of time.

Observing a dice with a higher frame rate

In this model that approaches the uncertainty principle, when a dice appears to stop in shorter timeframes so its e𝕧 length of motion in the video is reducing. That means the -ⅅ×e𝕧 inertial work is increasing, the motion of the ball becomes uncertain with a -ⅅ inertial probability. The real inertial velocity as e𝕧/-ⅈd can only be estimated and so there is no longer a deterministic observation. The times the camera takes an image become closer to a now and so there is only a probabilistic change in position as work.

Maxwell's daemon

Maxwell's daemon was also like this idea, that in principle someone could follow what every atom did if they could observe quickly enough. Then they could predict deterministically into the future what configurations they would be in. This is cause and effect in a past and future, so it is impulse and chaos.

Work always exists

In this model work can always exist with many Pythagorean Triangles, that is because each spin Pythagorean Triangle side can be squared. To assert only impulse exists with Maxwell's daemon implies that all probability reduces to determinism. That also implies an integral area is equal to a sum of parts in integration, also that an infinite series of mathematical terms can sum to one term.

Chaos is not randomness

Here this also asserts chaos is equal to randomness, however it has been shown mathematically to be separate from probability. In this model β gives the limit of tine widths in chaos, it is also close to

1/(√2π). They do not equal each other, and so ½π as the radius of a circle does not become β as equal straight-line intervals.

Not everything is observed

Because there are always parts of an environment that are not observing a process, that is they are not dependent on instants of time being deterministic in chains of causality, then there can be work.

Collisions and interference

A collision in this model between electrons also does -𝕆D×e𝕪 kinetic work between them. In smaller e𝕪 distances they have a destructive interference on each other, they emit e𝕪×-𝕘d photons in between them as part of the repulsion. When dice are thrown the collisions with the table also have this constructive and destructive interference over small distances. That makes the outcome innate probabilistic to some degree.

Past and future versus now

The alternative to causality with a past and future is the present or now, this is where work operates in this model. This now changes with measurements of different positions, the world can then be describable with some accuracy by ignoring time and only measuring the changes in positions with forces.

F=ma and probability

Here that is what F=ma does as -𝕚d×e𝕧/-𝕆D because the square is a probability. An object according to Newton moves deterministically until this force is exerted on it, here this is probabilistic and so the deterministic motion ends.

Wigner's friend

With Wigner's friend the wave function exists in the box, that is because there is no observation of a time other than now or the present. There are only positions in the box and only measurements without regard to instants in time.

Opening the box collapses the wave function

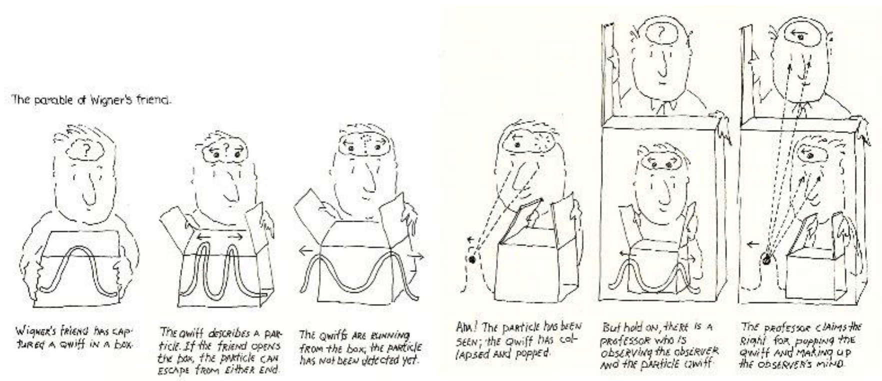
"When it is opened" implies a future event deterministically tied to the box, like opening it. This cannot be reduced to probability and work because times are being observed, that would collapse the wave function.

Looking for objects impulsively

Then there is an observation of looking for objects in it which can only happen with impulse. His friend observes Wigner doing this at a time after Wigner felt the impulse to open the box. An impulsive action then arises from impulse here.

Observing Wigner

The cause and effect in these events means his friend observes Wigner's expression changing after his observation. He might turn and say something, make a signal etc. Wigner is then communicating his opening of the box at an instant of time not in that present before opening the box.



The voltmeter measures work in parallel

In this model the voltmeter measured the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work of the circuit. It is in parallel because there is a measurable probability of whether electrons would go through it or the circuit. There is also an attraction or repulsion of parallel wires with a voltage in them, that happens with constructive or destructive interference here.

The ammeter observes impulse

Conversely the ammeter observes the current in series with the circuit. That is deterministic, there is no probability of whether the electrons go through the ammeter or not. It observes the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse of the circuit, for example a paddle wheel can act like an ammeter in water. It turns because of the E𝕍/-𝕚d inertial impulse of water striking it.

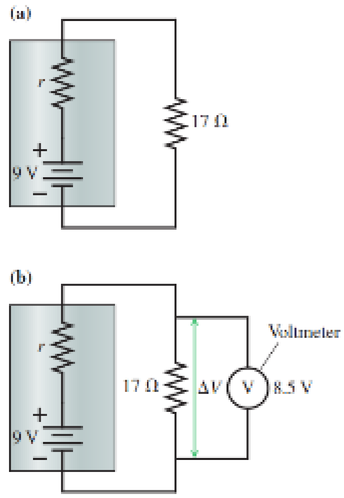
Converting impulse into work

That is converted to rotary motion as the -𝕀D inertial torque, this could be used to generate electricity with a -𝕆D kinetic voltage. A motor on the circuit would act like an ammeter, it would convert the E𝕐/-𝕠d kinetic impulse of the electrons inta -𝕆D kinetic torque.

Voltmeters

A device that measures the potential difference across a circuit element is called a **voltmeter.** Because potential difference is measured *across* a circuit element, from

FIGURE 28.27 A voltmeter measures the potential difference across an element.



one side to the other, a voltmeter is placed in *parallel* with the circuit element whose potential difference is to be measured.

FIGURE 28.27a shows a simple circuit in which a 17 Ω resistor is connected across a 9 V battery with an unknown internal resistance. By connecting a voltmeter across the resistor, as shown in FIGURE 28.27b, we can measure the potential difference across the resistor. Unlike an ammeter, using a voltmeter does *not* require us to break the connections.

Because the voltmeter is now in parallel with the resistor, the total resistance seen by the battery is $R_{eq} = (1/17\ \Omega + 1/R_{voltmeter})^{-1}$. In order that the voltmeter measure the voltage without changing the voltage, the voltmeter's resistance must, in this case, be $\gg 17\ \Omega$. Indeed, an *ideal voltmeter* has $R_{voltmeter} = \infty\ \Omega$, and thus has no effect on the voltage. Real voltmeters come very close to this ideal, and we will always assume them to be so.

The voltmeter in Figure 28.27b reads 8.5 V. This is less than $\mathcal{E}$ because of the battery's internal resistance. Equation 28.18 found an expression for the resistor's potential difference ΔV_R. That equation is easily solved for the internal resistance r:

$$r = \frac{\mathcal{E} - \Delta V_R}{\Delta V_R} R = \frac{0.5\ \text{V}}{8.5\ \text{V}} 17\ \Omega = 1.0\ \Omega$$

Here a voltmeter reading was the one piece of experimental data we needed in order to determine the battery's internal resistance.

The ground is neutral

In this model +𝕠d and e𝕒 Pythagorean Triangles do +𝕆D×e𝕒 potential work and have a E𝔸/+𝕠d potential impulse, -𝕠d and e𝕪 Pythagorean Triangle do -𝕆D×e𝕪 kinetic work and have a E𝕐/-𝕠d kinetic impulse. In the ground, these approximately balance with about the same number of protons and electrons. If not then the ground would be charged, that would tend to spread out with destructive interference repelling the charges from each other.

Constructive and destructive interference with the ground wire

The +𝕆D×e𝕒 potential work could attract electrons up the ground wire with constructive interference. The -𝕆D×e𝕪 kinetic work could repel electrons down the ground wire with destructive interference, there is some probability both of these happen. Summing them together means the overall probability of the voltage is no electrons go down the ground wire.

28.8 Getting Grounded

People who work with electronics are often heard to say that something is "grounded." It always sounds quite serious, perhaps somewhat mysterious. What is it?

The circuit analysis procedures we have discussed so far deal only with potential *differences*. Although we are free to choose the zero point of potential anywhere that is convenient, our analysis of circuits has not revealed any need to establish a zero point. Potential differences are all we have needed.

Difficulties can begin to arise, however, if you want to connect two *different* circuits together. Perhaps you would like to connect your DVD to your television or your computer monitor to the computer itself. Incompatibilities can arise unless all the circuits to be connected have a *common* reference point for the potential.

No common reference point

In this model the voltage reference point is not changed, except as an approximation. That is because a zero voltage implies Pythagorean Triangles with their spin sides also being zero. Then they could not have a constant Pythagorean Triangle area. Instead each +𝕠d and e𝕒 Pythagorean

Triangle has a reference point of a minimum +𝕠d Pythagorean Triangle side size, as does the -𝕠d and e𝕪 Pythagorean Triangle.

> You learned previously that the earth itself is a conductor. Suppose we have two circuits. If we connect *one* point of each circuit to the earth by an ideal wire, and we also agree to call the potential of the earth $V_{earth} = 0$ V, then both circuits have a common reference point. But notice something very important: *one* wire connects

> the circuit to the earth, but there is not a second wire returning to the circuit. That is, the wire connecting the circuit to the earth is not part of a complete circuit, so there is *no current* in this wire! Because the wire is an equipotential, it gives one point in the circuit the same potential as the earth, but it does *not* in any way change how the circuit functions. A circuit connected to the earth in this way is said to be **grounded,** and the wire is called the *ground wire*.

Pythagorean Triangles attracting each other

When the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work are inverses of each other in a circuit, then the ground does not change that. This is like atoms in a part of the ground, their +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work does not dissipate into other parts of the ground because they can only attract unlike Pythagorean Triangles and repel like ones. For example if some negative ions are ionized relative to positive ions, then they are only attracted to the positive ions not neutral atoms in the ground.

> **FIGURE 28.32a** shows a fairly simple circuit with a 10 V battery and two resistors in series. The symbol beneath the circuit is the *ground symbol*. It indicates that a wire has been connected between the negative battery terminal and the earth, but the presence of the ground wire does not affect the circuit's behavior. The total resistance is $8\ \Omega + 12\ \Omega = 20\ \Omega$, so the current in the loop is $I = (10\text{ V})/(20\ \Omega) = 0.50$ A. The potential differences across the two resistors are found, using Ohm's law, to be $\Delta V_8 = 4$ V and $\Delta V_{12} = 6$ V. These are the same values that we would find if the ground wire were *not* present. So what has grounding the circuit accomplished?

The minimum kinetic probability in the ground state

In reference to the neutral ground, there is a +𝕆D potential difference and a -𝕆D kinetic difference. The -𝕆D value in relation to neutral is its value from the -𝕠d and e𝕪 Pythagorean Triangles, so in this model it always has a reference point of a minimum -𝕆D kinetic probability. That is in the ground state of an atom.

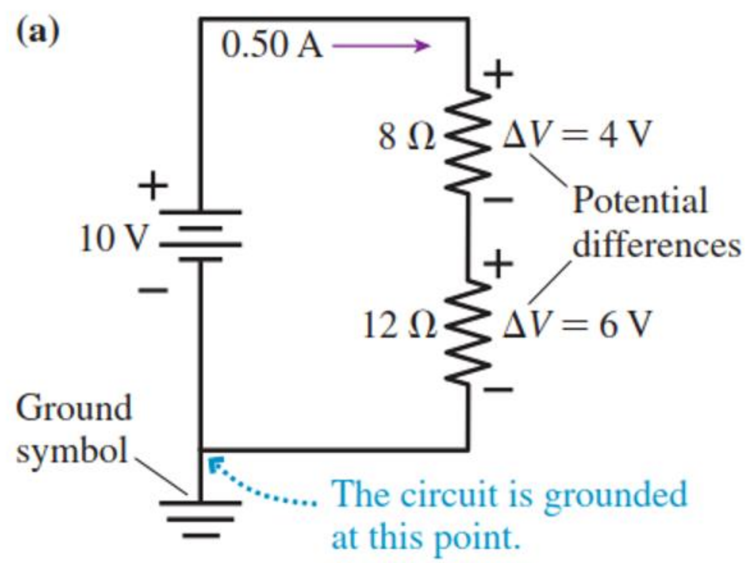
FIGURE 28.32b shows the actual potential at several points in the circuit. By definition, $V_{earth} = 0$ V. The negative battery terminal and the bottom of the 12 Ω resistor are connected by ideal wires to the earth, so *the* potential at these two points must also be zero. The positive terminal of the battery is 10 V more positive than the negative terminal, so $V_{neg} = 0$ V implies $V_{pos} = +10$ V. Similarly, the fact that the potential *decreases* by 6 V as charge flows through the 12 Ω resistor now implies that *the* potential at the junction of the resistors must be +6 V. The potential difference across the 8 Ω resistor is 4 V, so the top has to be at +10 V. This agrees with the potential at the positive battery terminal, as it must because these two points are connected by an ideal wire.

All that grounding the circuit does is allow us to have *specific values* for the potential at each point in the circuit. Now we can say "The voltage at the resistor junction is 6 V," whereas before all we could say was "There is a 6 V potential difference across the 12 Ω resistor."

Grounded at one point

Here the ground has a balanced +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, there is a balanced potential and kinetic probability that electrons would flow in or out of the ground.

FIGURE 28.32 A circuit that is grounded at one point.



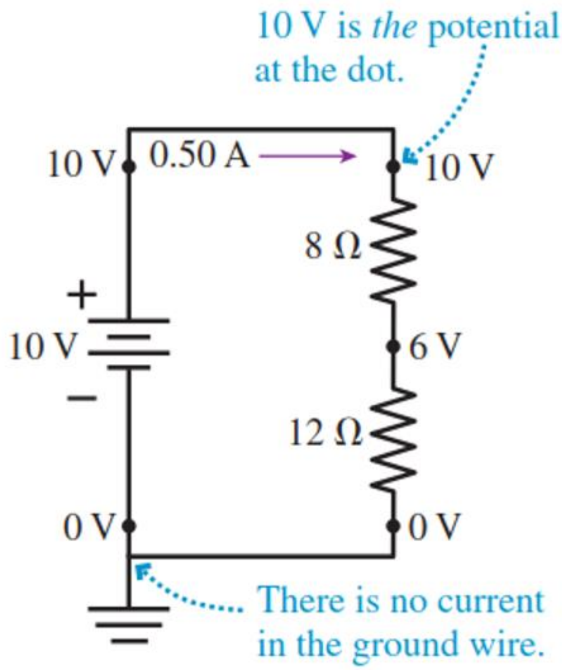
Kinetic difference as torque

Here 10V is the -𝕆D kinetic difference, in this model it comes from the -𝕆D kinetic torque of electrons in their orbitals. A higher orbital has more kinetic torque, its e𝕪/-𝕠d kinetic velocity is slower so -𝕠d is larger as is -𝕆D. When the electron leaves the atom its e𝕪/-𝕠d kinetic current comes from its E𝕐/-𝕠d kinetic impulse. It is also attracted by the +𝕆D potential difference so there is a constructive interference pulling the electron towards the positive plate or terminal.

More potential work from the positive charges

That is similar to the positive nucleus with its +𝕆D potential difference and +𝕆D×e𝕒 potential work. Because there are many more positive charges in the positive plate or terminal, that does more +𝕆D×e𝕒 potential work with more constructive interference attracting the electron.

(b)



Grounding a case

A neutral case could receive -𝕆D×e𝕪 kinetic work, then this can be directed into the ground for safety.

There is one important lesson from this: **Being grounded does not affect the circuit's behavior under normal conditions.** You cannot use "because it is grounded" to *explain* anything about a circuit's behavior.

We added "under normal conditions" because there is one exception. Most circuits are enclosed in a case of some sort that is held away from the circuit with insulators. Sometimes a circuit breaks or malfunctions in such a way that the case comes into electrical contact with the circuit. If the circuit uses high voltage, or even ordinary 120 V household voltage, anyone touching the case could be injured or killed by electrocution. To prevent this, many appliances or electrical instruments have the case itself grounded. Grounding ensures that the potential of the case will always remain at 0 V and be safe. If a malfunction occurs that connects the case to the circuit, a large current will pass through the ground wire to the earth and cause a fuse to blow. This is the *only* time the ground wire would ever have a current, and it is *not* a normal operation of the circuit.

Time and impulse

When the switch closes there is a change over time, this is the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. They keep time because impulse is being observed on a clock gauge. Work here would be measured over a distance not time, for example different positions on the circuit would have a different +𝕆D potential difference.

An approximate oscillation

In this model a capacitor and resistor are inverses, the capacitor mainly does -𝕆D×e𝕪 kinetic work and the resistor +𝕆D×e𝕒 potential work. When a circuit begins or approximately oscillates, the change is observed over time with impulse. There is a -𝕆D kinetic difference in the capacitor, reacted against with a +𝕆D potential difference in the resistor.

Increasing chaotic current reversal

These are also a -𝕆D kinetic time and a +𝕠d potential time, that gives how long the current takes to move and reverse through the circuit. That is not a perfect oscillation in this model, impulse is chaotic. If the current reversal increased in time, then it would become increasingly chaotic.

The inverse of work is impulse

In (28.25) the inverse of the work done is impulse, ΔV_{cap} can then be -𝕠d kinetic time and +𝕠d potential time. Q is the kinetic and potential momentum, when divided by C it gives +𝕠d and -𝕠d as time. These are not durations of time, that happens in work. Instead this is where impulse is observed at an instant of time.

28.9 *RC* Circuits

A resistor circuit has a steady current. By adding a capacitor and a switch, we can make a circuit in which the current varies with time as the capacitor charges and discharges. Circuits with resistors and capacitors are called ***RC* circuits.** *RC* circuits are at the heart of timekeeping circuits in applications ranging from the intermittent windshield wipers on your car to computers and other digital electronics.

FIGURE 28.34a shows a charged capacitor, a switch, and a resistor. The capacitor has charge Q_0 and potential difference $\Delta V_0 = Q_0/C$. There is no current, so the potential difference across the resistor is zero. Then, at $t = 0$, the switch closes and the capacitor begins to discharge through the resistor.

How long does the capacitor take to discharge? How does the current through the resistor vary as a function of time? To answer these questions, **FIGURE 28.34b** shows the circuit at some point in time after the switch was closed.

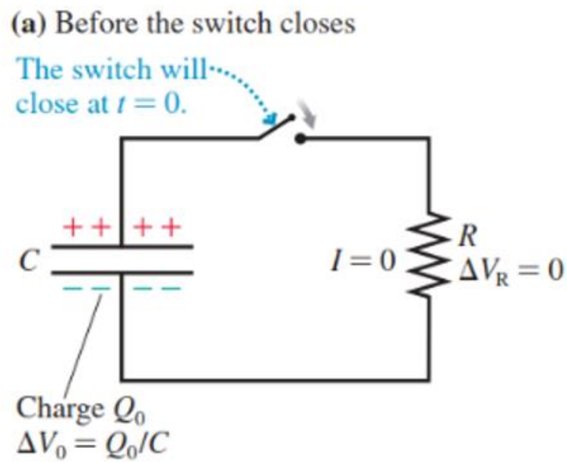
Kirchhoff's loop law is valid for any circuit, not just circuits with batteries. The loop law applied to the circuit of Figure 28.34b, going around the loop cw, is

$$\Delta V_{cap} + \Delta V_{res} = \frac{Q}{C} - IR = 0 \qquad (28.25)$$

Closing the switch

In the diagram the switch closes, this causes a E𝕐/-𝕠d kinetic impulse from the negative plate towards the E𝔸/+𝕠d potential impulse of the positive plate. This is a straight-line force not a field in the capacitor, there is also some -𝕆D×e𝕪 kinetic work being done. Reacting against this is the resistor with a straight-line E𝔸/+𝕠d potential impulse against the E𝕐/-𝕠d kinetic impulse.

FIGURE 28.34 Discharging a capacitor.



The current decreases exponentially

When the switch is closed and there is no change after a long -𝕠d kinetic time, then E𝕐 as the kinetic displacement decreases inversely as a square. With the constant -𝕠d and e𝕪 Pythagorean Triangle area the two vary as an exponential curve. That is because as the square decreases, and the linear Pythagorean Triangle side increases, the two trace out the exponential curve.

Exponential decay in higher electron orbitals

That is also seen in exponential decay with -𝕆D×e𝕪 kinetic work, the -𝕆D kinetic probability means there is a random decay of an electron in a higher orbital with its -𝕆D kinetic torque. Then it would move to a lower orbital and emit a e𝕪×-𝕘d photon.

Exponential radioactive decay

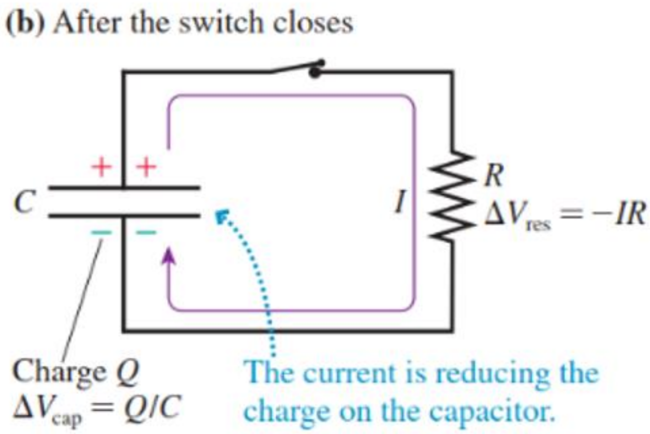
With radioactive decay this happens with the E𝕐/-𝕠d kinetic impulse, as the -𝕠d kinetic time increases linearly the -𝕆D kinetic displacement weakens as a force. The radioactive atoms emit observed particles less often in this exponential decay curve.

Exponential and normal curves

In this model the two are inverses, the -𝕆D kinetic probability of the electron has an inverse exponential or normal curve distribution.

The electron is more likely to be closer to the nucleus

The +𝕆D×e𝕒 potential work done by the nucleus means that a higher e𝕒 altitude of the electron, in a higher orbital, is less +𝕆D potentially probable. The electron is then more likely to be found in the lowest energy state closer to the nucleus. That gives an exponential curve of when the electron is likely to decay to a lower orbital.



Charge with respect to time

In (28.26) q is the -𝕠d×e𝕪/-𝕠d kinetic momentum in Coulombs. Differentiating with respect to -𝕠d kinetic time here would give -𝕠d×e𝕪/-𝕆D in Newtons from F=ma, that would be -𝕆D×e𝕪 kinetic work so there would be no time reversals. Instead q/t would be E𝕐/-𝕠d as the E𝕐/-𝕠d kinetic impulse, the force is changing with the E𝕐 kinetic displacement with respect to -𝕠d kinetic time not with respect to the kinetic momentum.

Q and I in this equation are the *instantaneous* values of the capacitor charge and the resistor current.

The current I is the rate at which charge flows through the resistor: $I = dq/dt$. But the charge flowing through the resistor is charge that was *removed* from the capacitor. That is, an infinitesimal charge dq flows through the resistor when the capacitor charge *decreases* by dQ. Thus $dq = -dQ$, and the resistor current is related to the instantaneous capacitor charge by

$$I = -\frac{dQ}{dt} \tag{28.26}$$

Impulse and RC

That makes dQ/dt the E𝕐/-𝕠d kinetic impulse, it would be negative here. The change in charge is observable as electrons here with respect to -𝕠d kinetic time, the change with RC requires using Coulombs and capacitance not as a derivative. Q/RC would be positive as the +𝕠d/E𝔸 potential impulse. Here Q is +𝕠d×e𝕒/+𝕠d and divided by the potential capacitance +𝕠d×e𝕒/+𝕆D gives +𝕠d. Here 1/R is 1/e𝕒 so it becomes +𝕠d/e𝕒. When observed as the +𝕠d/E𝔸 potential impulse that is the inverse to the E𝕐/-𝕠d kinetic impulse to equal zero. The inverse of 1/E𝔸 is E𝕐 and the inverse of +𝕠d is 1/-𝕠d, the inverse of +𝕠d/E𝔸 is then E𝕐/+𝕠d.

Inverting dimensions does not change them

In this model the inversion is not usually used, but it makes no difference to the actual dimensions. E𝔸/+𝕠d is meters²/second and +𝕠d/E𝔸 is seconds per meters² which is the same acceleration or force.

Now I is positive when Q is decreasing, as we would expect. The reasoning that has led to Equation 28.26 is rather subtle but very important. You'll see the same reasoning later in other contexts.

If we substitute Equation 28.26 into Equation 28.25 and then divide by R, the loop law for the RC circuit becomes

$$\frac{dQ}{dt} + \frac{Q}{RC} = 0 \qquad (28.27)$$

RC as a constant

In this model RC is +𝕠d/e𝕒, this is a constant for a circuit with a fixed capacitor and resistor. It gives the E𝔸/+𝕠d potential impulse of the potential charge, the inverse of that is e𝕪/-𝕠d as the kinetic charge with a E𝕐/-𝕠d kinetic impulse. Together they give a way to observe +𝕠d potential and -𝕠d kinetic time changing. This is not a +𝕠d/e𝕒 current here, it refers to time in the E𝔸/+𝕠d potential impulse.

Equation 28.27 is a first-order differential equation for the capacitor charge Q, but one that we can solve by direct integration. First, we rearrange Equation 28.27 to get all the charge terms on one side of the equation:

$$\frac{dQ}{Q} = -\frac{1}{RC}\,dt$$

The product RC is a constant for any particular circuit.

The potential time constant

Taking RC as +𝕠d that gives a E𝔸/+𝕠d potential impulse that would surge between the positive and negative capacitor plates with a displacement. Here R is 1/e𝕒 and C is +𝕠d, so when these remain constants the τ potential time constant is also +𝕠d. The E𝕐/-𝕠d kinetic impulse is the inverse of this, so the -𝕠d and e𝕪 Pythagorean Triangle electrons accelerate with E𝕐/-𝕠d proportional in meters^2/second as E𝕍/-𝕚d.

The capacitor charge was Q_0 at $t = 0$ when the switch was closed. We want to integrate from these starting conditions to charge Q at a later time t. That is,

$$\int_{Q_0}^{Q} \frac{dQ}{Q} = -\frac{1}{RC}\int_0^t dt \qquad (28.28)$$

Both are well-known integrals, giving

$$\ln Q\Big|_{Q_0}^{Q} = \ln Q - \ln Q_0 = \ln\left(\frac{Q}{Q_0}\right) = -\frac{t}{RC}$$

We can solve for the capacitor charge Q by taking the exponential of both sides, then multiplying by Q_0. Doing so gives

$$Q = Q_0 e^{-t/RC} \quad (28.29)$$

Notice that $Q = Q_0$ at $t = 0$, as expected.

The argument of an exponential function must be dimensionless, so the quantity RC must have dimensions of time. It is useful to define the **time constant** τ to be

$$\tau = RC \quad (28.30)$$

The capacitor voltage decays exponentially

The capacitor voltage as the -𝕆D kinetic difference decays exponentially with the E𝕐/-𝕠d kinetic impulse. In this model the E𝕐/-𝕠d kinetic impulse is the inverse of the -𝕆D×e𝕪 kinetic work, so the -𝕆D kinetic voltage is the inverse of the E𝕐 kinetic displacement. That is the particle/wave duality, the -Od kinetic difference is where the -𝕆D×e𝕪 kinetic work is measured in a stable circuit. This is when the switch has been closed for a long time and the charges have reached an equilibrium.

Observing the surge of displacement

At the initial -𝕠d kinetic time the closing of the switch allows for an observation of this surge of current. It weakens exponentially while the circuit inversely and exponentially gains in +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work. That is because the -𝕆D kinetic probability is an inverse exponential in this model.

Impulse decays to work

As the impulse exponential decays, then the inverse exponential increases as the circuit moves to a more probable charge distribution, measured over positions not time. This higher probability is where the +𝕆D potential voltage and -𝕆D kinetic voltage are discharged, the most probable outcome is +𝕆D-𝕆D≈0.

Exponential voltage

In this model the time t cannot become infinite, that would mean the +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle as infinite spin Pythagorean Triangle sides. Then they could not also have a constant Pythagorean Triangle area. The voltage graph has the same shape because voltage is the inverse of displacement. However voltage is measured by work, the time constant is observed with impulse.

We can then write Equation 28.29 as

$$Q = Q_0 e^{-t/\tau} \quad \text{(capacitor discharging)} \tag{28.31}$$

The capacitor voltage, directly proportional to the charge, also decays exponentially as

$$\Delta V_C = \Delta V_0 e^{-t/\tau} \tag{28.32}$$

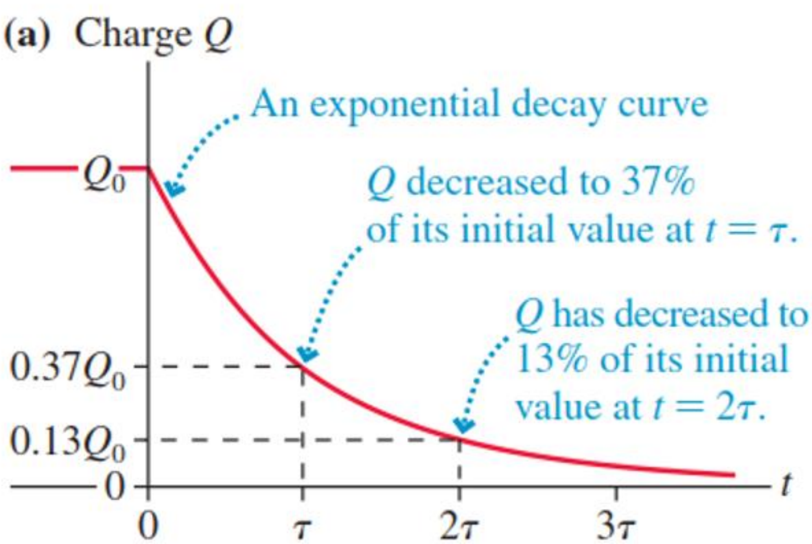
The meaning of Equation 28.31 is easier to understand if we portray it graphically. **FIGURE 28.35a** shows the capacitor charge as a function of time. The charge decays exponentially, starting from Q_0 at $t = 0$ and asymptotically approaching zero as $t \rightarrow \infty$. The time constant τ is the time at which the charge has decreased to e^{-1} (about 37%) of its initial value. At time $t = 2\tau$, the charge has decreased to e^{-2} (about 13%) of its initial value. A voltage graph would have the same shape.

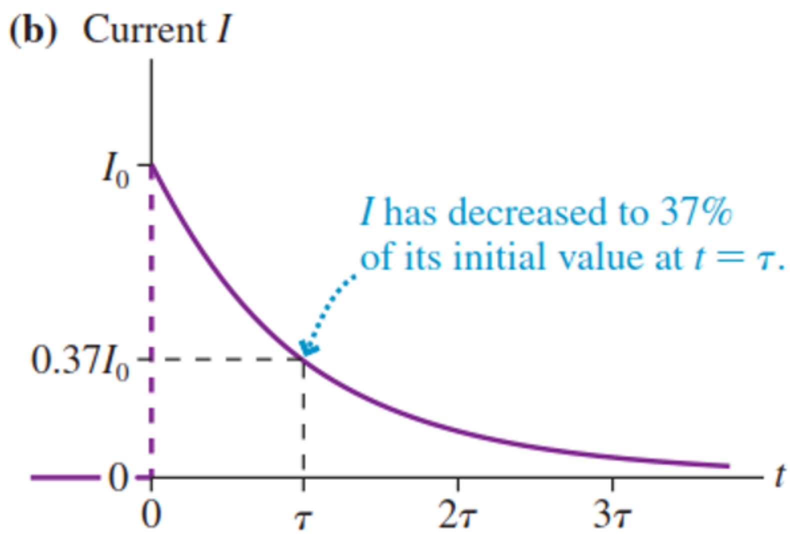
NOTE The *shape* of the graph of Q is always the same, regardless of the specific value of the time constant τ.

Decay curves

Here the time constant changes linearly as the -𝕠d kinetic time. The E𝕐 kinetic displacement drops as a square, this force allows it to be observed. The two form an exponential curve.

FIGURE 28.35 The decay curves of the capacitor charge and the resistor current.





A derivative with respect to potential time

In (28.33) the exponential is $e^{-𝕠d}$, this is divided by the time constant τ for example as increments of one second. The 1/RC value here is +𝕠d/e𝕒 which is the potential current. When written as dQ/dt that takes e𝕒 as the potential electric charge with respect to +𝕠d in potential time. It is not taking the other +𝕠d factors in the potential momentum, they can be regarded as constants. In this model they refer to a combination of an integral and derivative in the potential momentum.

The time constant as instants

This is shown below as being equal to e𝕒/+𝕠d which is the same as +𝕠d/e𝕒. The time constant can be regarded as instants of time separated by an equal value, the potential clock gauge would have these as where the clock hand had equal angles between them. They are not the temporal duration between the instants, that implies a torque to move the hand from one to the next in this model.

The current changes exponentially

When written as $\Delta V_R/R$ this is +𝕠d/e𝕒, multiplied by an exponential means this changes exponentially. That is done in this model for example by +𝕠d increasing linearly and E𝔸 decreasing as a square. The +𝕠d/e𝕒 potential current then changes exponentially as the E𝔸/+𝕠d potential impulse.

We find the resistor current by using Equation 28.26:

$$I = -\frac{dQ}{dt} = \frac{Q_0}{\tau}e^{-t/\tau} = \frac{Q_0}{RC}e^{-t/\tau} = \frac{\Delta V_0}{R}e^{-t/\tau} = I_0 e^{-t/\tau} \qquad (28.33)$$

where $I_0 = \Delta V_0/R$ is the initial current, immediately after the switch closes. **FIGURE 28.35b** is a graph of the resistor current versus t. You can see that the current undergoes the same exponential decay, with the same time constant, as the capacitor charge.

> **NOTE** There's no specific time at which the capacitor has been discharged, because Q approaches zero asymptotically, but the charge and current have dropped to less than 1% of their initial values at $t = 5\tau$. Thus 5τ is a reasonable answer to the question "How long does it take to discharge a capacitor?"

Charging the capacitor

In this model charging the capacitor is with a E𝕐/-ⓞd kinetic impulse, that is also an exponential. The -ⓞd kinetic time is linear with impulse.

Charging a Capacitor

FIGURE 28.38a shows a circuit that charges a capacitor. After the switch is closed, the battery's charge escalator moves charge from the bottom electrode of the capacitor to the top electrode. The resistor, by limiting the current, slows the process but doesn't stop it. The capacitor charges until $\Delta V_C = \mathcal{E}$; then the charging current ceases. The full charge of the capacitor is $Q_0 = C(\Delta V_C)_{max} = C\mathcal{E}$.

The analysis is much like that of discharging a capacitor. As a homework problem, you can show that the capacitor charge and the circuit current at time t are

$$Q = Q_0(1 - e^{-t/\tau}) \qquad \text{(capacitor charging)} \qquad (28.34)$$
$$I = I_0 e^{-t/\tau}$$

where $I_0 = \mathcal{E}/R$ and, again, $\tau = RC$. The capacitor charge's "upside-down decay" to Q_0 is shown graphically in **FIGURE 28.38b**.

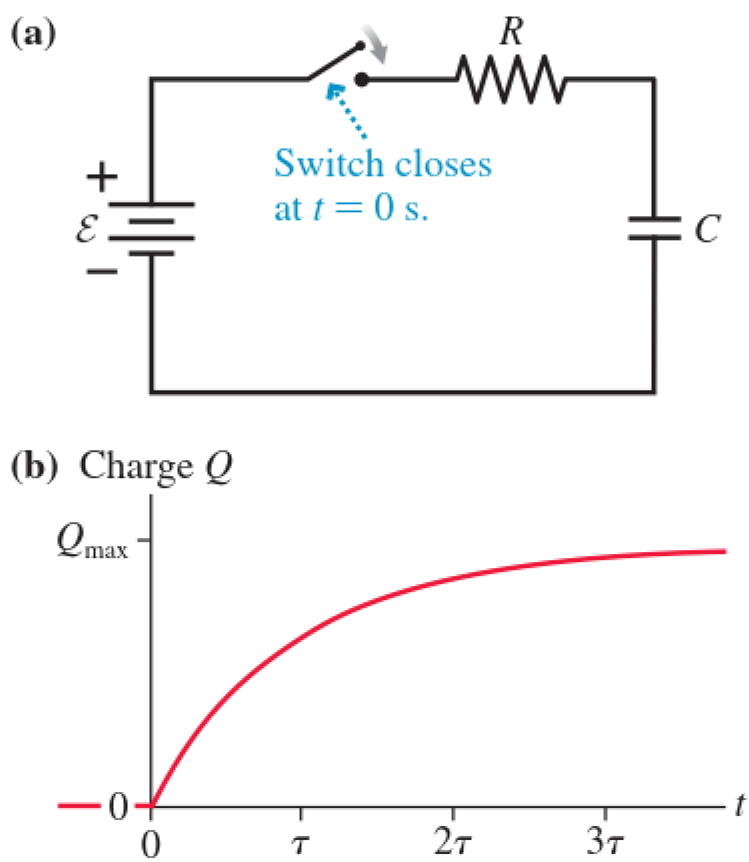
A logarithmic curve and subtracting force vectors

The curve below can be regarded as a logarithmic curve, the inverse of the exponential curve. That allows for different charge displacements to be subtracted instead of divided. In equation (28.8) above the charge division is converted into a subtraction of their logarithms. They would then appear on this logarithmic curve. This happens in this model because the changing E𝕐 values use vector addition and subtraction as force vectors.

Squared force vectors

On the logarithmic curve the E𝕐 values can be regarded as force vectors that are changing in value, the time changes linearly. The division of dQ/Q with different Q values becomes vector addition and subtraction because the forces are always squares.

FIGURE 28.38 Charging a capacitor.



The Magnetic Field

Side of the magnet

In this model magnets are created by the -𝕆D×ey kinetic work of spinning electrons. When they are aligned in the same direction there is a minimum of magnetism from the side of the magnet. That is because the -𝕆D kinetic torque is orthogonal from the side, so there is less torque there.

Constructive and destructive magnetic interference

Along the direction of ey there is constructive interference so the magnet can attract or repel other magnets. When there is attraction between a north and south pole there is constructive interference, this makes it more likely the magnets come together. With like poles there is destructive interference, that makes it more likely they move apart.

Cutting magnets in half

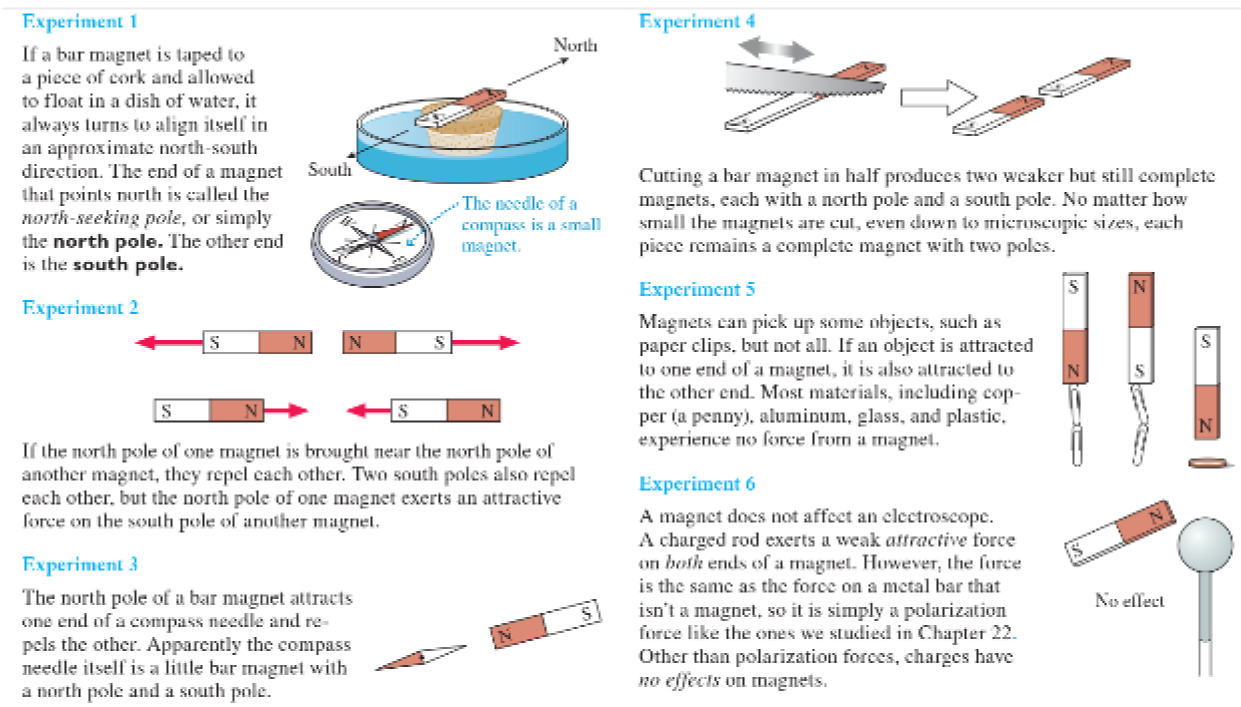
If the magnet is cut in half, the two parts are attracted with this constructive interference. Some of the electrons have their spins aligned in the two halves, they then attract each other with constructive interference. This is the same as the magnet attracting another's unlike pole.

A compass and kinetic torque

In this model a compass turns with a -𝕆D kinetic torque, the kinetic probability means it is more likely to be measured pointing in a different direction.

An electroscope and impulse

An electroscope has a E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse, this has a small effect on the -𝕆D×𝕖𝕪 kinetic work of the magnet. The electric charge tends to polarize the dipoles with -𝕆D×𝕖𝕪 kinetic work, turning them with a -𝕆D kinetic torque. The magnet has constructive interference with many electrons, they are also fixed in orientation with domains in it. A coil of wire does -𝕆D×𝕖𝕪 kinetic work and can change the magnet, an electroscope has mainly a straight-line E𝕐/-𝕠d kinetic impulse with no coils to create a kinetic torque.



Compasses in a circle

A current in a wire does +𝕆D×𝕖𝕒 potential work and -𝕆D×𝕖𝕪 kinetic work, this comes from a torque. That causes the magnets with their own -𝕆D kinetic torque to arrange themselves in a circle. The -𝕆D kinetic difference is this circular field of kinetic probability, it weakens outwards from the wire according to the inverse square rule.

A magnetic field is not a force

In this model the -𝕠d kinetic magnetic field around the wire is not a force, it comes from the -𝕠d×𝕖𝕪 integral field. It does not then have a direction in which this spin is going, when the -𝕠d kinetic time is observed with a E𝕐/-𝕠d kinetic impulse it is on a kinetic clock gauge going clockwise. If the clock was observed from behind it would be counterclockwise.

Kinetic time spins towards the future

Here -𝕠d refers to kinetic time which is moving forward towards the future, the way the kinetic clock gauge has its hand spinning. The spin can only be observed by that impulse can be observed to change in kinetic time as it moves towards the future.

Potential time spins towards the past

The E𝔸/+𝕠d potential impulse, from the positive plate or battery terminal, also has a +𝕠d potential magnetic field from the +𝕠d×e𝕪 integral as the +𝕠d and e𝕒 Pythagorean Triangle area. This has the opposite direction to the kinetic clock, it moves backwards in time so it would be counterclockwise in comparison to the kinetic clock.

Adding potential and kinetic time

On a potential time clock the hand moves counterclockwise, when the two time changes are added together that can give the E𝔸/+𝕠d potential impulse added to the E𝕐/-𝕠d kinetic impulse. The E𝔸 potential impulse and E𝕐 kinetic impulse are vector added, the +𝕠d potential time and -𝕠d kinetic time are added according to their signs.

Spin direction relative to each other

The spin direction are in relation to each other, that is like the plus and minus signs in arithmetic. In this model spin refers to clockwise as negative values and counterclockwise as positive values, as future and past, they can be added as an example with standard arithmetic.

Adding like spins gives repulsion

A plus value such as +𝕠3 has an additional relation to another say +𝕠5 to give +𝕠8, here √3,√5, and √8 are all square roots. If these were all +𝕆D values with D or d^2 squared as 3,5, and 8 then that would be destructive interference and repulsion. In this model then destructive interference is like addition, the same would happen if all these were -𝕠d.

Adding unlike spins gives repulsion

With +𝕠8 -𝕠3 this is +𝕠5 as constructive interference, the two come closer together as the difference between them was √11. With the destructive interference the difference between them was √2 yet the addition of them gave √8 as +𝕠8. Here the difference would be like the +𝕆D potential difference as +𝕆8 (which is an integer 8 not √8) minus the kinetic difference -𝕆3 (as 3 not √3). The constructive interference makes the answer smaller than their original difference. In this model that would cause an attraction between the two differences as +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work.

Squaring square roots

With +𝕆3 +𝕆5 = +𝕆8 these are all squared square roots, so they are integers. The original difference between 3 and 5 was 2, now it adds to 8 as a repulsion. The probabilities add in the same way, with the like positive charges there is a +𝕆D potential probability that will be larger. With the positive and negative charges, there is a destructive interference as the +𝕆D potential probability minus a -𝕆D kinetic probability that will be smaller so they are closer together.

Clock gauges as spin exponents

In this model +𝕠d and -𝕠d are spin, they can be regarded as exponents of e such as $e^{+𝕠d-𝕠d}$. Here +𝕠d would be counterclockwise backwards in time and -𝕠d would be clockwise forwards in time, they can be added the same way as with the arithmetic example.

Quantized orbitals

When +𝕆D or -𝕆D has D as an integer this completes a circle like a quantized orbital, if a -𝕆D value is measured as the ground state then double this would be the next orbital with n=2 in conventional physics. When D is an integer such as 2 this is quantized because there is not a division sign like 2/3 for example.

Work from multiplication, impulse from division

So in this model quantization comes from only Multiplication signs in integrals. Division only uses division signs and is always impulse.

The magnetic field reduces linearly

The wire then has a 𝕠d kinetic magnetic field that extends around the wire, this decreases linearly as the e𝕪 distance increases linearly. Its -𝕠d kinetic spin represents a forward motion in time on a kinetic clock gauge. When -𝕆D is the kinetic torque from this it turns the compasses as a measurement, that is because the wire and compasses are doing -𝕆D×e𝕪 kinetic work on each other. The compasses then have a greater -𝕆D kinetic probability of changing their orientation.

Spin is not like spinning a top

This spin would then not be represented as clockwise or counterclockwise like spinning a top, but as clockwise being forward in -𝕠d kinetic time. Adding this with another -𝕠d kinetic time means the kinetic clock gauge moves further forward in time. That is a stronger -𝕆D kinetic torque as the force needed to move the kinetic clock gauge hand twice, accelerating it and decelerating it.

Understanding spin

To better understand spin in this model, only clock gauges are used to observe or measure it. That only happens as time changes. A clock hand can move to represent this in calculations, but only time actually makes this spin. It is emphasized here because magnetism is about spin here, coming from time. That a magnet can move another over a distance does not means distance is spin.

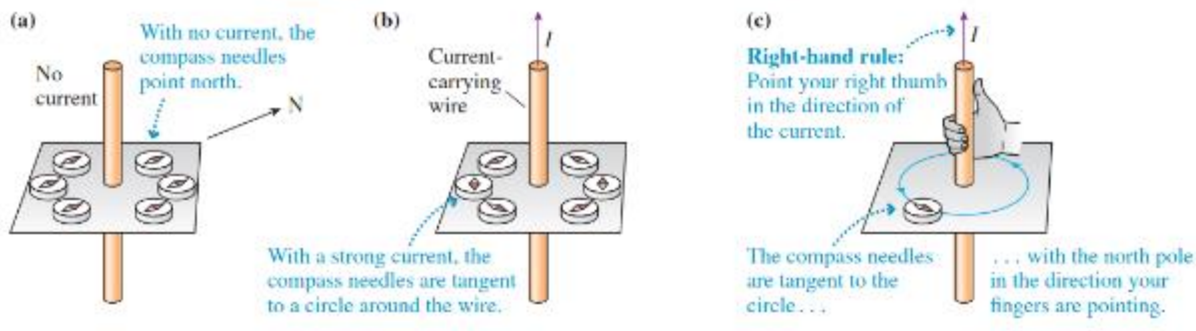
Understanding distance

It is like distances with the straight Pythagorean Triangle sides, they are only changes in positions. A single position is a point, in between two points moving from one to another is a displacement. Diagrams can be made of points and displacements, but only actual events can show points and displacements in reality.

Modeling spin as distance, and distance as time is misleading

Modeling spin as a change in distance is not allowed in this model except as an example. It is like modeling distances as changes in time, it can be misleading. This can happen because the -𝕠d and e𝕪 Pythagorean Triangle for example has both spin as -𝕠d kinetic time, and e𝕪 as a kinetic distance. They are together in one Pythagorean Triangle, but they have different properties.

FIGURE 29.2 Response of compass needles to a current in a straight wire.



Vectors in and out of the page

In this model the e𝕪 kinetic electric charge is a vector, that can point in and out of the page. When these point in one direction the -𝕠d kinetic magnetic field increases with constructive interference. That means the magnet can move objects with a E𝕐/-𝕠d kinetic impulse as time move forwards, like attracting an unlike pole to it.

A kinetic timeline

The inverse of this is the main force of -𝕆D×e𝕪 kinetic work, then there is a -𝕆D kinetic duration of time. For example a kinetic clock gauge has two instants of time, a starting and final value. On a kinetic timeline these can be connected with E𝕐 kinetic displacement vectors with cause and effect.

A temporal duration as now

The force to move from one instant to another is called a duration here, this is measured as a Now in between a past and future instant. The past is the initial instant of -𝕠d kinetic time, the future is the final instant of kinetic time. In between the past and future is a force of temporal duration called Now.

Constructive interference and e𝕪 vector addition

When the -𝕠d kinetic spins are aligned the e𝕪 vectors point in the same direction. There is vector addition between them, the more there are the stronger the -𝕆D×e𝕪 kinetic work of the magnet is being measured in e𝕪 positions.

Constructive and destructive magnetic interference

Because the -𝕠d and e𝕪 Pythagorean Triangles are the same, this also increases the -𝕆D kinetic torque of each electron with constructive interference on each other. When they encounter an unlike magnetic pole, they attract it with this constructive interference. When it is a like pole, such as north-north and south-south, then there is destructive interference. The spins are opposing in direction, like a clockwise kinetic clock gauge and a counterclockwise kinetic clock gauge.

Opposing spins cancel

These are both forwards in -𝕠d kinetic time, the opposing spins tend to cancel each other out. That reduces the -𝕆D kinetic probability in between the like poles, it is then less kinetically probable for the electrons to be measured there. That is a repulsion between the magnetic poles.

Opposing clock gauges

A potential clock gauge would move counterclockwise backwards in time, a kinetic clock gauge moves forwards in time. Each as the spin of a clock hand, can have two directions by being measured from opposing sides. It can also be flipped over to a different energy state, then a second flip restores the original state. With opposing spins the like poles of a magnet destructively interfere, it is like a top that only spins clockwise.

Reorienting versus flipping a top

When two clockwise spinning tops comes together the opposing -𝕆D kinetic torque pushes them apart. It is less kinetically probable for them to stay together. If one is viewed upside down, then coming together they don’t get pushed apart, this is where unlike poles attract with constructive interference.

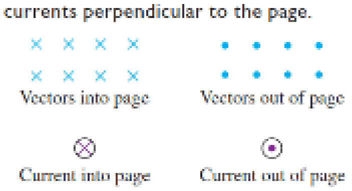
Quantized torque

Flipping a top requires work, if it is reoriented with work and impulse less than a quantized amount of torque the same state is retained. Then the like poles can be brought together and repelled. The same happens with electrons in this model, they can be turned to a new orientation or flipped into a different state with quantization.

Turning a magnet with impulse and work

A magnet can be turned around by hand, that is a combination of -𝕀D×e𝕧 inertial work and an E𝕍/-𝕚d inertial impulse. When that happens there is a difference force from it being turned, such as from attraction to repulsion. The turning of the magnet is itself spin, a clockwise turn will change it in the same way as a counterclockwise turn.

FIGURE 29.3 The notation for vectors and currents perpendicular to the page.



Magnetism is more demanding than electricity in requiring a three-dimensional perspective of the sort shown in Figure 29.2. But since two-dimensional figures are easier to draw, we will make as much use of them as we can. Consequently, we will often need to indicate field vectors or currents that are perpendicular to the page. **FIGURE 29.3** shows the notation we will use. **FIGURE 29.4** demonstrates this notation by showing the compasses around a current that is directed into the page. To use the right-hand rule, point your right thumb in the direction of the current (into the page). Your fingers will curl cw, and that is the direction in which the north poles of the compass needles point.

A magnetic field at instants of time

In this model a magnetic field is not at points in space, but at instants in time. An +𝕠d and e𝕒 Pythagorean Triangle and -𝕠d and e𝕪 Pythagorean Triangle have potential and kinetic instants respectively. These are part of Pythagorean Triangles with straight sides that have positions or points.

Kinetic magnetic monopoles

In this model there is a single magnetic monopole on each Pythagorean Triangle. The -𝕠d and e𝕪 Pythagorean Triangle electron has a kinetic monopole, this can appear for example as clockwise with e𝕪 pointing up and counterclockwise with e𝕪 pointing down. Here constructive and destructive interference works to give an attraction and repulsion without an actual north and south pole.

Potential magnetic monopoles

The +𝕠d and e𝕒 Pythagorean Triangle has a potential monopole as +𝕠d, this would appear as counterclockwise going backwards in time on a potential clock gauge. It can also appear as clockwise from the other side while still going backwards in time, it can have constructive and destructive interference as attraction and repulsion. Inside a nucleus the protons can arrange themselves with opposing spins and constructive interference.

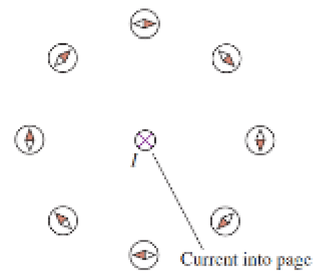
We need a similar idea to understand the long-range force exerted by a current on a compass needle.

Let us define the **magnetic field** $\vec{B}$ as having the following properties:

1. A magnetic field is created at *all* points in space surrounding a current-carrying wire.
2. The magnetic field at each point is a vector. It has both a magnitude, which we call the *magnetic field strength B*, and a direction.
3. The magnetic field exerts forces on magnetic poles. The force on a north pole is parallel to $\vec{B}$; the force on a south pole is opposite $\vec{B}$.

FIGURE 29.5 shows a compass needle in a magnetic field. The field vectors are shown at several points, but keep in mind that the field is present at *all* points in space. A magnetic force is exerted on each of the two poles of the compass, parallel to $\vec{B}$ for the north pole and opposite $\vec{B}$ for the south pole. This pair of opposite forces exerts a torque on the needle, rotating the needle until it is parallel to the magnetic field at that point.

FIGURE 29.4 The orientation of the compasses is given by the right-hand rule.



Magnetic lines

In this model the -𝕆D kinetic torque of the magnet's electrons make the compass more likely to reorient itself. A field line can be regarded as the e𝕪 straight Pythagorean Triangle side, these are turned into loops with the -𝕆D kinetic torque. B⃗ here would be e𝕪 as the kinetic vector, it gives a series of kinetic positions where the -𝕆D×e𝕪 kinetic work is measured. The compass is turned with the -𝕆D kinetic torque which is measured as B⃗ kinetic positions.

Notice that the north pole of the compass needle, when it reaches the equilibrium position, is in the direction of the magnetic field. Thus a compass needle can be used as a probe of the magnetic field, just as a charge was a probe of the electric field. **Magnetic forces cause a compass needle to become aligned parallel to a magnetic field, with the north pole of the compass showing the direction of the magnetic field at that point.**

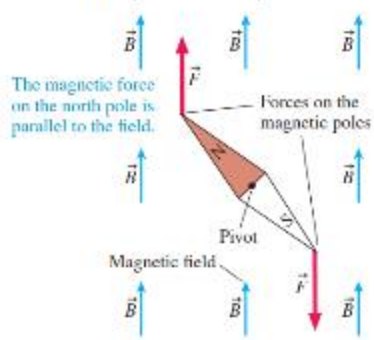
Look back at the compass alignments around the current-carrying wire in Figure 29.4. Because compass needles align with the magnetic field, the magnetic field at each point must be tangent to a circle around the wire. FIGURE 29.6a shows the magnetic field by drawing field vectors. Notice that the field is weaker (shorter vectors) at greater distances from the wire.

Another way to picture the field is with the use of **magnetic field lines.** These are imaginary lines drawn through a region of space so that

- A tangent to a field line is in the direction of the magnetic field, and
- The field lines are closer together where the magnetic field strength is larger.

FIGURE 29.6b shows the magnetic field lines around a current-carrying wire. Notice that magnetic field lines form loops, with no beginning or ending point. This is in contrast to electric field lines, which stop and start on charges.

FIGURE 29.5 The magnetic field exerts forces on the poles of a compass.



Orbiting the wire

In the diagram the vectors would be e𝕪, they would measure the -𝕆D×e𝕪 kinetic work done as a series of positions. An -𝕠d and e𝕪 Pythagorean Triangle can be regarded as orbiting the wire, the e𝕧 length is proportional to e𝕪 and the -𝕚d inertial time is like the period of rotation. Because there is no work being done there is no inertial velocity with a rotation, it could also occur as clockwise or counterclockwise.

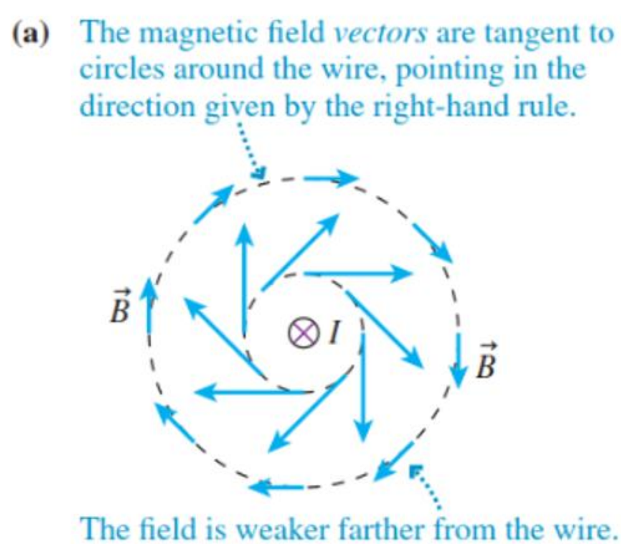
Kinetic clock hands

In the diagram the vectors pointing outwards can be regarded as kinetic clock hands. These would spin clockwise by convention in time but not in space as shown below, the kinetic clock gauge could be viewed from the other side as counterclockwise. A direction of magnetic spin comes from the e𝕪 kinetic electric charge as vectors flowing down the wire, that has a e𝕪/-𝕠d kinetic current where -𝕠d is kinetic time.

Spin direction and destructive interference

The spin direction does destructive interference with a second wire parallel to it, where the current flows in the same direction. The spin directions are opposed where they come close together, that is whether they are portrayed as clockwise like below or counterclockwise. This cancels some of the -𝕆D kinetic probability between the wires, it makes it less likely they will be measured close to each other. That creates a repulsion between the two wires.

FIGURE 29.6 The magnetic field around a current-carrying wire.



A circular magnetic field

In this model the circles come from spin, a kinetic clock gauge would have its hand move in a circle. The direction of spin makes no difference for a clock, instants of time would appear with the same proportions. The duration between these instants is also the same.

A ruler has no preferred direction

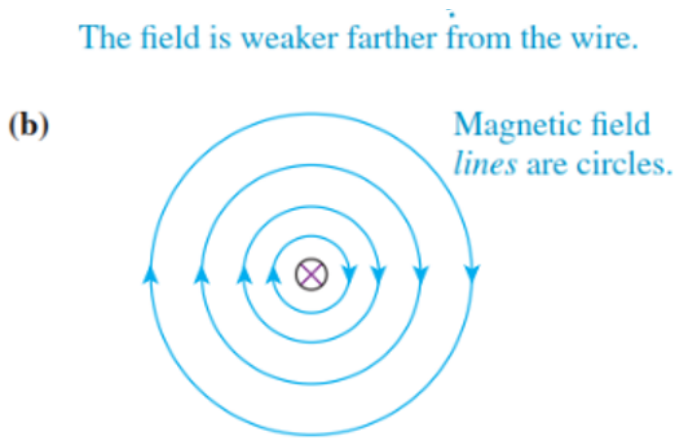
A ruler can point in any direction as well, it might have positions on it from left to right or right to left. Their proportions are the same, also the displacements between positions on it. A ruler can also be regarded as a vector, the positions giving a magnitude and the displacements between positions as force vectors. They can be vector added in the same direction, then the E𝕍/-𝕚d inertial impulse for example would increase as constructive displacement. When the rulers point in opposing directions there is vector subtraction or destructive displacement.

A ruler and a clock from straight and spin Pythagorean Triangle sides

A ruler is always straight lines because of the straight Pythagorean Triangle sides, a clock gauge is always circles because it comes from the spin Pythagorean Triangle sides.

Spin in Biv space-time

In Biv space-time the +𝕠d gravitational field is also spin, going backwards in +𝕚d gravitational time. It also has no preferred spin direction, that would be defining spin in terms of distances such as the e𝕙 height. A planet can spin in either direction, a featureless ball can spin clockwise or counterclockwise with its +𝕆D gravitational torque. A moon would tend to spin in the same direction as the planet's spin, that is destructive interference and so they repel each other forming a resonation with other planets and moons.



A moving charge

In this model μ is the permeability constant as a square, that is the inverse of the permittivity constant ϵ. The charge q is -𝕠d×e𝕪/-𝕠d times v as e𝕪/-𝕠d which gives the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. This varies with the inverse square law as r^2, the inverse of this is 1/-𝕆D as the kinetic probability around a negatively charged iota. With a positive charge this would be 1/+𝕆D.

Sinθ with work and impulse

The sinθ angle means the forces change according to the angle to r. When this angle is zero the charge moves parallel with r, then there is no -𝕆D×e𝕪 kinetic work only a E𝕐/-𝕠d kinetic impulse. When the angle θ approaches 90° then this is mainly -𝕆D×e𝕪 kinetic work. When there is only impulse the particle moves in a straight-line, as there is also more impulse the -𝕆D kinetic torque turns the charge.

29.3 The Source of the Magnetic Field: Moving Charges

Figure 29.6 is a qualitative picture of the wire's magnetic field. Our first task is to turn that picture into a quantitative description. Because current in a wire generates a magnetic field, and a current is a collection of moving charges, our starting point is the idea that **moving charges are the source of the magnetic field.** FIGURE 29.7 shows a charged particle q moving with velocity $\vec{v}$. The magnetic field of this moving charge is found to be

$$\vec{B}_{\text{point charge}} = \left(\frac{\mu_0}{4\pi} \frac{qv\sin\theta}{r^2}, \text{ direction given by the right-hand rule} \right) \qquad (29.1)$$

The Biot Savart law

This is analogous to Coulomb's law, that comes from the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse with a squared force. Here it is also an inverse square with the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work.

where r is the distance from the charge and θ is the angle between $\vec{v}$ and $\vec{r}$.

Equation 29.1 is called the **Biot-Savart law** for a point charge (rhymes with *Leo* and *bazaar*), named for two French scientists whose investigations were motivated by Oersted's observations. It is analogous to Coulomb's law for the electric field of a point charge. Notice that the Biot-Savart law, like Coulomb's law, is an inverse-square law. However, the Biot-Savart law is somewhat more complex than Coulomb's law because the magnetic field depends on the angle θ between the charge's velocity and the line to the point where the field is evaluated.

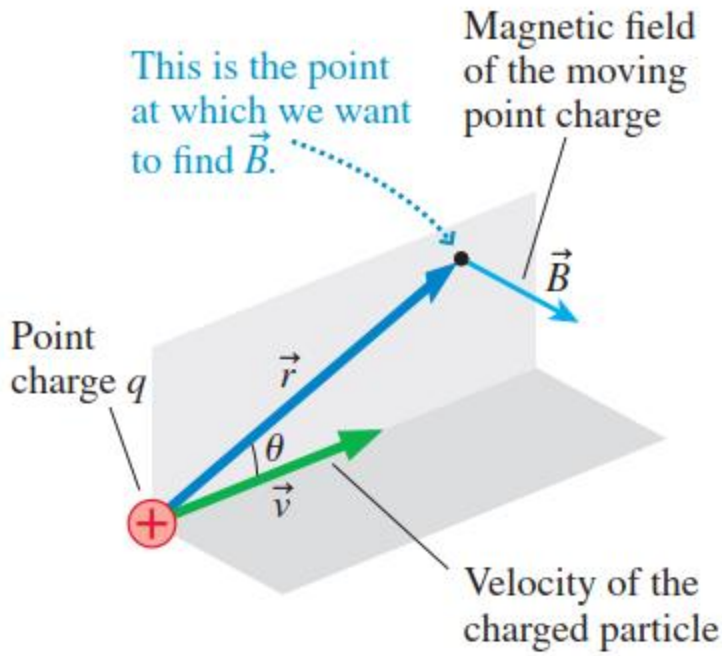
A moving charge with work and impulse

In this model the angle of the electric charge to the magnetic field is the ratio of the E𝔸/+𝕠d potential impulse to +𝕆D×e𝕒 potential work. In Coulomb's law a positive and negative charge can move towards each other, that gives the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse. If the negative charge moves at right angles, then there is no impulse.

Electrons in an orbital

This is like an electron in a circular orbital, a constant e𝕒 altitude means it does -𝕆D×e𝕪 kinetic work as a wave. When the orbital is elliptical h as -𝕠d ×e𝕐/-𝕠d is a fraction. That means it is partially a E𝕐/-𝕠d kinetic impulse as a particle, also partially -𝕆D×e𝕪 kinetic work. The angle θ as the electron moves in the ellipse gives the ratio of the work and impulse.

FIGURE 29.7 The magnetic field of a moving point charge.



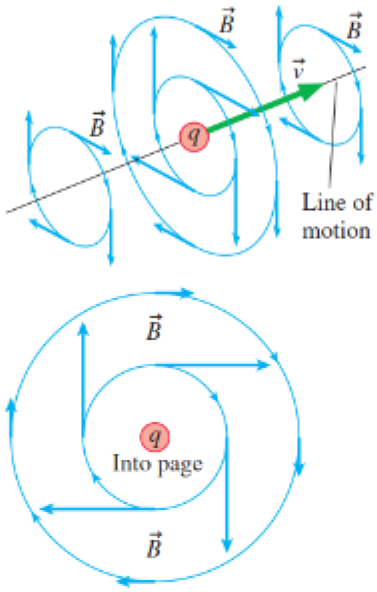
The electron magnetic field

The moving charge as an electron would have a -𝕠d kinetic magnetic field around it. This spin occurs in time on a kinetic clock gauge, not as a vortex around the charge. Here it moves with a v⃗ inertial velocity as e𝕧/-𝕚d, the -𝕚d inertial field inertial time is proportional to the -𝕠d kinetic time. When the negative charge is in an external magnetic field there is -𝕆D×e𝕪 kinetic work between them. The electron experiences a -𝕆D kinetic torque causing it to move in a spiral.

The same kinetic velocity

In this model the spiral motion occurs because of the temporal spin, its e𝕪/-𝕠d kinetic velocity would be a straight-line motion. The external magnetic field can only induce a torque not a E𝕐/-𝕠d kinetic impulse, the electron then maintains its kinetic velocity with the spiral motion.

FIGURE 29.8 Two views of the magnetic field of a moving positive charge.



The permeability and permittivity constants as squared forces

In this model the permeability constant μ is a squared force, that gives the -𝕆D×e𝕪 kinetic work its strength. The permittivity constant ϵ gives the strength of the E𝕐/-𝕠d kinetic impulse.

The Tesla

The Tesla is Newtons/Amperes^2, the Newton is -𝕠d×e𝕪/-𝕆D from F=ma. That is divided by squared amperes which are the number of electrons as -𝕠d×e𝕪/-𝕠d Coulombs moving in a second as 1/-𝕠d in kinetic time or -𝕠d×e𝕪/-𝕆D. That gives ma/(ma)^2 or 1/ma = 1/(-𝕠d×e𝕪/-𝕆D). The force here is 1/-𝕆D×e𝕪 as the inverse of the kinetic work which is +𝕆D×e𝕒 potential work.

ϵ, μ and c

In this model ϵ was reduced to 1/E𝕐 earlier, then 1/√(ϵ×μ) would be e𝕪/-𝕠d and proportional e𝕧/-𝕠d as the inertial velocity. For the values of ϵ and μ Maxwell found this formula 1/√(ϵ×μ) was the inertial velocity of light as c. That means 1/E𝕐 from the E𝕐/-𝕠d kinetic impulse gives ϵ, 1/-𝕆D gives -𝕆D×e𝕪 kinetic work as μ. Because these are squares forces they are work and impulse up to c as a limit.

ϵ and μ with α

Also α here is e$^{-𝕠d}$ where d=1, increasing the exponent d as a square gives the -𝕆D kinetic torque or probability from -𝕆D×e𝕪 kinetic work. This force would increase as a square in increments of μ. For example with gravity, a falling rock on an airless planet does constant +𝕀D×e𝕙 gravitational work as meters/second^2.

A constant acceleration

The gravitational acceleration is a constant force like μ, this can make an increase in the e𝕙/+𝕚d gravitational speed up to c. The +𝕀D×e𝕙 gravitational work reaches a limit there also with the same angle θ as in the inertial velocity with c.

Inverse square forces

A constant force as μ then would accelerate to c by itself, here it is balanced by an opposing squared force as ϵ from the E𝕐/-𝕠d kinetic impulse. Together they are in the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy where they balance. They are also in +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work, each has μ but one would be 1/μ. With the E𝔸/+𝕠d potential impulse and E𝕐/-𝕠d kinetic impulse there would be ϵ and 1/ϵ also as inverses. That is because +𝕆D is 1/-𝕆D and E𝔸 is 1/E𝕐, the two constants then also balance in stable orbitals in an atom.

The SI unit of magnetic field strength is the **tesla,** abbreviated as T. The tesla is defined as

$$1 \text{ tesla} = 1 \text{ T} \equiv 1 \text{ N/A m}$$

You will see later in the chapter that this definition is based on the magnetic force on a current-carrying wire. One tesla is quite a large field; most magnetic fields are a small fraction of a tesla. TABLE 29.1 lists a few magnetic field strengths.

The constant μ_0 in Equation 29.1 is called the **permeability constant.** Its value is

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m/A} = 1.257 \times 10^{-6} \text{ T m/A}$$

This constant plays a role in magnetism similar to that of the permittivity constant ϵ_0 in electricity.

The right-hand rule

The right-hand rule comes from the north and south designation of magnetic poles. When one is considered to be north, then an electron passing through its magnetic field would curve in one direction. It is regarded as a convention, the direction the electron curves in defines which magnetic pole is north and south. Here $B^{\rightarrow}$ is a tangent as a straight-line vector, with a negative charge this would be e𝕪.

The right-hand rule for finding the direction of $\vec{B}$ is similar to the rule used for a current-carrying wire: Point your right thumb in the direction of $\vec{v}$. The magnetic field vector $\vec{B}$ is perpendicular to the plane of $\vec{r}$ and $\vec{v}$, pointing in the direction in which your fingers curl. In other words, the $\vec{B}$ vectors are tangent to circles drawn about the charge's line of motion. FIGURE 29.8 shows a more complete view of the magnetic field of a moving positive charge. Notice that $\vec{B}$ is zero along the line of motion, where $\theta = 0°$ or $180°$, due to the $\sin\theta$ term in Equation 29.1.

NOTE The vector arrows in Figure 29.8 would have the same lengths but be reversed in direction for a negative charge.

Moving charges and magnetism

In this model a negative charge moves when it changes position, this is measured as -𝕆D×e𝕪 kinetic work. When it stays at the same position then no work is done, so there is no measurable -𝕆D magnetic probability or torque.

The requirement that a charge be moving to generate a magnetic field is explicit in Equation 29.1. If the speed v of the particle is zero, the magnetic field (but not the electric field!) is zero. This helps to emphasize a fundamental distinction between electric and magnetic fields: **All charges create electric fields, but only *moving* charges create magnetic fields.**

Superposition

In this model magnetic fields are not vectors, only a straight Pythagorean Triangle side can be a vector here. The $\vec{B}$ vector here is e𝕪 as the kinetic vector of each electron. Because the -𝕆D×e𝕪 kinetic work is being measured in $\vec{B}$ or e𝕪 positions, then the -0d kinetic probabilities of each can be added or subtracted as constructive and destructive interference.

Superposition

The Biot-Savart law is the starting point for generating all magnetic fields, just as our earlier expression for the electric field of a point charge was the starting point for generating all electric fields. Magnetic fields, like electric fields, have been found experimentally to obey the principle of superposition. If there are n moving point charges, the net magnetic field is given by the vector sum

$$\vec{B}_{\text{total}} = \vec{B}_1 + \vec{B}_2 + \cdots + \vec{B}_n \qquad (29.2)$$

where each individual $\vec{B}$ is calculated with Equation 29.1. The principle of superposition will be the basis for calculating the magnetic fields of several important current distributions.

The cross product as an integral area

In this model the cross product forms a parallelogram, that can be rearranged into two constant area Pythagorean Triangles. As the angle θ changes this is equivalent to the Pythagorean Triangle angle changing. One side of the parallelogram is removed and added to the other to form a rectangle, that is made of two Pythagorean Triangles.

A constant area parallelogram

The area of the parallelogram is an integral field with this model, the changing angle θ also changes this area in conventional math. With this model the area remains constant and the hypotenuse varies, the cross product still gives the same answers.

Sinθ and work

Using a spin Pythagorean Triangle side such as -𝕠d, that is divided by the hypotenuse ζ to give sinθ. When this angle θ decreases, the influence of the spin Pythagorean Triangle side also decreases. That means there is less -𝕆D×e𝕪 kinetic work done from a magnetic field and a larger E𝕐/-𝕠d kinetic impulse of the charged particle. If a charged particle moves parallel to a magnetic field then it is not affected by the magnet's -𝕆D×e𝕪 kinetic work. The angle to it increases the -𝕆D×e𝕪 kinetic work, the magnet exerts more -𝕆D kinetic torque on the charged particle.

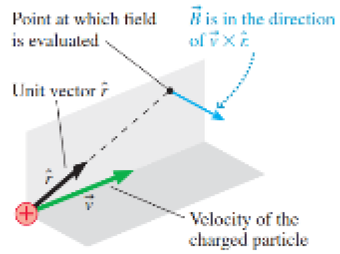
The Biot Savart law using the cross product

When the Biot Savart law is written with the cross product, the integral area of the parallelogram is like the -𝕠d×e𝕪 integral field of the -Pythagorean Triangle. This integral is associated with less -𝕆D×e𝕪 kinetic work done on the particle. The Pythagorean Triangle area is always constant here but the -𝕆D×e𝕪 kinetic work is not, that is because as the angle θ changes -𝕆D varies as a square. The e𝕪 kinetic electric charge decreases inversely and linearly.

Evaluating a point

The point at which the field is evaluated would be an e𝕒 position from the altitude above the positive charge. That varies as $1/r^2$ from the E𝔸/+𝕠d potential impulse, the evaluation is done by an observation of a charge there as a particle.

FIGURE 29.11 Unit vector $\hat{r}$ defines the direction from the moving charge to the point at which we evaluate the field.



NOTE The cross product of two vectors and the right-hand rule used to determine the direction of the cross product were introduced in « Section 12.10 to describe torque and angular momentum. A review is worthwhile.

The Biot-Savart law, Equation 29.1, can be written in terms of the cross product as

$$\vec{B}_{\text{point charge}} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2} \quad \text{(magnetic field of a point charge)} \qquad (29.4)$$

where unit vector $\hat{r}$, shown in **FIGURE 29.11**, points from charge q to the point at which we want to evaluate the field. This expression for the magnetic field $\vec{B}$ has magnitude $(\mu_0/4\pi)qv\sin\theta/r^2$ (because the magnitude of $\hat{r}$ is 1) and points in the correct direction (given by the right-hand rule), so it agrees completely with Equation 29.1.

The Coulomb as a particle/wave duality

In this model the kinetic current is e𝕪/-𝕠d, the kinetic integral or field is -𝕠d×e𝕪. These are found together in the kinetic momentum or Coulombs as -𝕠d×e𝕪/-𝕠d. That gives the Coulomb a particle/wave duality here.

29.4 The Magnetic Field of a Current

Moving charges are the source of magnetic fields, but the magnetic fields of current-carrying wires—immense numbers of charges moving together—are much more important than the feeble magnetic fields of individual charges. Real current-carrying wires, with their twists and turns, have very complex fields. However, we can once again focus on the physics by using simplified models. It turns out that three common magnetic field models are the basis for understanding a wide variety of magnetic phenomena. We present them here together as a reference; the next few sections of this chapter will be devoted to justifying and explaining these results.

Q as a single Pythagorean Triangle

In this model the electron would carry the current. Here, s is e𝕪 as the kinetic electric charge, it is multiplied by Q as a single -𝕠d and e𝕪 Pythagorean Triangle. Multiplying -𝕠d×e𝕪/-𝕠d as the kinetic momentum by e𝕪/-𝕠d as the kinetic current gives the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. When this is I×Δs that is the E𝕐/-𝕠d kinetic impulse because a particle is observed, a wave is not being measured as work.

Energy has a particle/wave duality

Using qv in the Biot Savat law, as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy, that also changes with sinθ. When sinθ increases then there is more -𝕆D×e𝕪 kinetic work done, E𝕐 decreases and -𝕆D increases inversely to it. That makes the kinetic energy increasingly -𝕆D×e𝕪 kinetic work. If sinθ decreases then E𝕐 increases and -𝕆D decreases inversely, this makes the energy more a E𝕐/-𝕠d kinetic impulse.

The same energy and different directions in a magnetic field

The ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy can be conserved in this change of angle, with an increase of -𝕆D and a decrease of E𝕐 the charged particle is turned with a torque. The particle can then be accelerated with the same F=ma force as -𝕠d×e𝕪/-𝕆D to go through a magnetic field in different directions. In some cases its energy would be particle like as a E𝕐/-𝕠d kinetic impulse, at other angles it would be wave like as -𝕆D×e𝕪 kinetic work. That means energy has a particle/wave duality.

Energy is an approximation

In this model energy is an approximation only, the two squared Pythagorean Triangle sides cannot be observed and measured at the same time and position here.

Current as a velocity

In this model the e𝕪/-𝕠d kinetic velocity of the current is an actual velocity, it is proportional to the e𝕧/-𝕚d inertial velocity. Here $\vec{B}$ gives the direction of he charged particle, in this model that is e𝕪 as the kinetic vector. In (29.6) the kinetic current times Δs gives the E𝔸/+𝕠d potential impulse for a positive charge.

Observing the charged particle

Here μ is the squared magnetic constant, in the numerator it becomes ϵ as the squared electric or permittivity constant. The charged particle is observed moving in a straight-line with impulse, it may also be in a curved path with work. To make an observation its wave function as work must be collapsed, that becomes impulse.

To begin, we need to write the Biot-Savart law in terms of current. FIGURE 29.13a shows a current-carrying wire. The wire as a whole is electrically neutral, but current I represents the motion of positive charge carriers through the wire. Suppose the small amount of moving charge ΔQ spans the small length Δs. The charge has velocity $\vec{v} = \Delta\vec{s}/\Delta t$, where the vector $\Delta\vec{s}$, which is parallel to $\vec{v}$, is the charge's displacement vector. If ΔQ is small enough to treat as a point charge, the magnetic field it creates at a point in space is proportional to $(\Delta Q)\vec{v}$. We can write $(\Delta Q)\vec{v}$ in terms of the wire's current I as

$$(\Delta Q)\vec{v} = \Delta Q\frac{\Delta\vec{s}}{\Delta t} = \frac{\Delta Q}{\Delta t}\Delta\vec{s} = I\,\Delta\vec{s} \qquad (29.5)$$

where we used the definition of current, $I = \Delta Q/\Delta t$.

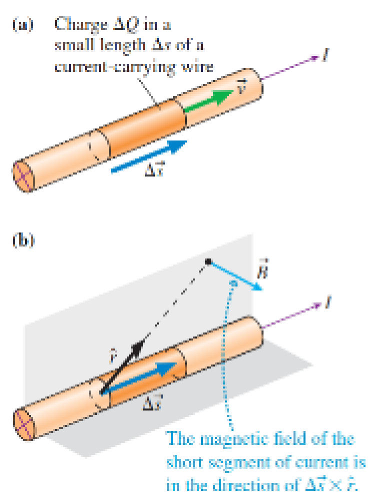
If we replace $q\vec{v}$ in the Biot-Savart law with $I\,\Delta\vec{s}$, we find that the magnetic field of a very short segment of wire carrying current I is

$$\vec{B}_{\text{current segment}} = \frac{\mu_0}{4\pi}\frac{I\,\Delta\vec{s}\times\hat{r}}{r^2} \qquad (29.6)$$

(magnetic field of a very short segment of current)

Equation 29.6 is still the Biot-Savart law, only now written in terms of current rather than the motion of an individual charge. FIGURE 29.13b shows the direction of the current segment's magnetic field as determined by using the right-hand rule.

FIGURE 29.13 Relating the charge velocity $\vec{v}$ to the current I.



The magnetic field magnitude

Here the kinetic magnetic probability -𝕆D comes from μ as a square, that is multiplied by the kinetic current e𝕪/-𝕠d in (29.7). The distance from the wire is -𝕠d, when this is measured further out from the wire there is a lower -𝕆D kinetic probability. That would correspond to a smaller e𝕧 kinetic vector, the electron would then have a slower e𝕪/-𝕠d kinetic current.

Electron orientation

The electron would be moving with its e𝕪 kinetic vector pointing towards the +𝕆D potential difference, the -𝕠d spin Pythagorean Triangle side would have a kinetic probability of pointing in different directions out from the wire. Because this is not a dimension it is not a distance, instead it can be measured as a -𝕆D kinetic probability. Then the electron would be at a position outside the wire where it was measured.

Probable electron positions

The -𝕠d kinetic magnetic field then gives a probability of where the electrons are, the largest -𝕆D value is in the wire moving with the -𝕆D kinetic difference. The electrons are then most likely to be measured there. A kinetic current can still be generated outside the wire with the -𝕆D×e𝕪 kinetic work measurement.

The magnetic field of a coil

In this model N is the number of turns in the wire, B as the e𝕪 kinetic vector increases linearly with N. The magnetic field is the same as for a straight wire in (29.7), when it is coiled there is also a -𝕆D kinetic torque as an integral field in it.

In practice, current often passes through a *coil* consisting of *N turns* of wire. If the turns are all very close together, so that the magnetic field of each is essentially the same, then the magnetic field of a coil is *N* times the magnetic field of a current loop. The magnetic field at the center ($z = 0$) of an *N*-turn coil, or *N*-turn current loop, is

$$B_{\text{coil center}} = \frac{\mu_0}{2}\frac{NI}{R} \qquad (N\text{-turn current loop}) \qquad (29.8)$$

This is the second of our key magnetic field models.

Magnetic dipoles

In this model the arrows are the e𝕪 kinetic vectors. These are turned with the -𝕠d kinetic magnetic field in a loop.

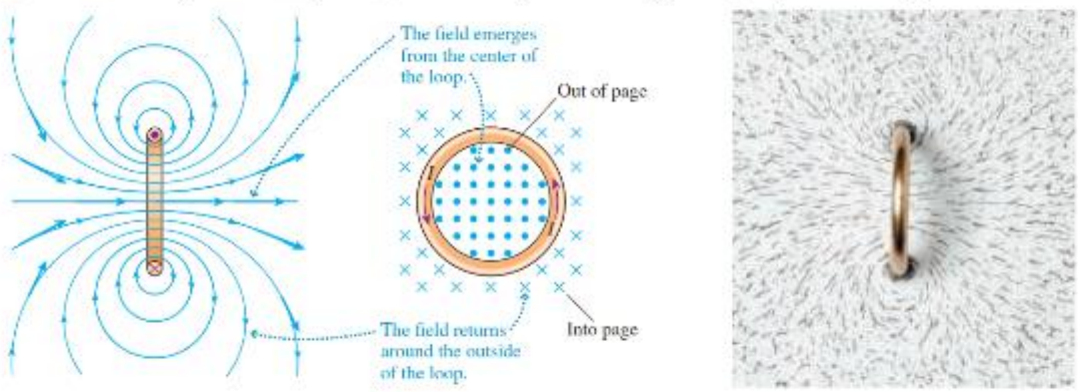
29.5 Magnetic Dipoles

We were able to calculate the on-axis magnetic field of a current loop, but determining the field at off-axis points requires either numerical integrations or an experimental mapping of the field. **FIGURE 29.19** shows the full magnetic field of a current loop. This is a field with *rotational symmetry*, so to picture the full three-dimensional field, imagine Figure 29.19a rotated about the axis of the loop. Figure 29.19b shows the magnetic field in the plane of the loop as seen from the right. There is a clear sense, seen in the photo of Figure 29.19c, that the magnetic field leaves the loop on one side, "flows" around the outside, then returns to the loop.

The magnetic field of a current loop

Here the field creates the rotating current in the loop. Because of the ring the +𝕠d kinetic magnetic field would be clockwise on one side and counterclockwise on the other, this would be on a kinetic clock gauge. That gives destructive interference between them, as with like poles, the two magnetic fields diverge from each other. In the middle there is constructive interference as the ey kinetic vectors points in the same direction. Additional rings from a coil of wire would increase the -𝕆D×ey kinetic work done.

FIGURE 29.19 The magnetic field of a current loop.



There are two versions of the right-hand rule that you can use to determine which way a loop's field points. Try these in Figure 29.19. Being able to quickly ascertain the field direction of a current loop is an important skill.

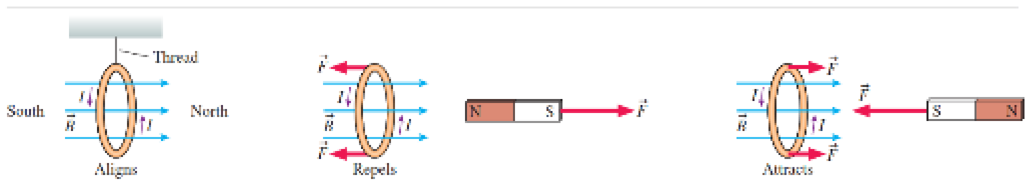
Direction of the kinetic vectors

In the diagram $\vec{B}$ as the ey kinetic vector points to the right. When the North side has ey kinetic vectors pointing to the left, then the -𝕠d kinetic magnetic field spins are opposed in destructive interference. This gives a -𝕆D kinetic probability that is less between them, the magnet and loop are less likely to be measured there so they are repelled from each other. When the ey kinetic vectors both point to the right, then there is a -𝕆D kinetic constructive interference and they attract each other.

A Current Loop Is a Magnetic Dipole

A current loop has two distinct sides. Bar magnets and flat refrigerator magnets also have two distinct sides or ends, so you might wonder if current loops are related to these permanent magnets. Consider the following experiments with a current loop. Notice that we're showing the magnetic field only in the plane of the loop.

Investigating current loops



A current loop hung by a thread aligns itself with the magnetic field pointing north.

The north pole of a permanent magnet repels the side of a current loop from which the magnetic field is emerging.

The south pole of a permanent magnet attracts the side of a current loop from which the magnetic field is emerging.

A magnetic spin in time not space

In this model the -𝕠d magnetic field does not come out of one side of a magnet. The kinetic spin is forwards in time not in space. This direction is a convention to name one end of a magnet as North. The atoms in the magnet have some electrons with a spin the same direction, others remain in boson pairs and are not part of the magnetic field. When there is constructive interference, they attract other electrons in a bar or electromagnet. With destructive interference they repel.

Electrons in a wire

When electrons move in a wire their e𝕪 kinetic electric charges point as a vector towards the +𝕆D potential difference, away from the -𝕆D kinetic difference. All the free electrons point in this direction, that is unlike the electrons in a bar magnet where only some do. The -𝕆D kinetic probability of the electron is measured at e𝕪 positions along this e𝕪 kinetic vector. It is more likely the e𝕪 positions are moving closer to the +𝕆D potential difference.

Constructive interference in a current

The electrons have a -𝕆D constructive interference with each other and so they are like a magnet. Because of the constructive interference the -𝕆D kinetic difference is maintained, that keeps the kinetic current moving. The e𝕪 kinetic vectors point towards the +𝕆D potential difference, the -𝕠d kinetic magnetic field is orthogonal to this extending out around the wire.

Moving electrons or the electrons move others

The -𝕆D kinetic difference as the voltage is the same as the kinetic probability. Here the -𝕆D kinetic probability moves the electrons with their constructive interference, in a magnet the electrons are fixed. The -𝕆D kinetic difference or probability there makes it more likely other electrons, in a wire or another magnet will move in relation to it.

The potential difference in a magnet

The +𝕆D potential difference is in the nuclei of the magnet's atoms, the kinetic difference comes from the electron spins being fixed in one direction. That is different from a current, the electrons have their spins aligned while moving towards the +𝕆D kinetic difference.

A bar magnet in a wire loop

When a bar magnet moves through a wire loop, it does -𝕆D×e𝕪 kinetic work on the electrons in the wire. Because the bar magnet is changing its e𝕪 positions, the electrons also change their positions and flow in a current. A stationary magnet does not change its e𝕪 position and so there is no -𝕆D×e𝕪 kinetic work and no induced current in the wire.

The motion of the magnet

The motion of the magnet induces a kinetic current in the loop. That is because the center of the loop has a constructive interference in one direction from the magnet's motion. This forms a kinetic current where opposite sides of the loop have a magnetic destructive interference with each other. That is also like the opposite sides of a magnet, not the poles, having destructive interference with each other.

The magnet creates a kinetic difference

This kinetic current creates a -𝕆D kinetic difference on one end of the wire and a +𝕆D potential difference on the other. The magnet can then charge a capacitor or battery. When it instead spins in the center of the loop, the electrons have a constructive interference in the same way. That is a generator which also charges the capacitor and battery.

The inertia of the magnet creates a kinetic difference

The motion of the magnet also does -𝕀D×e𝕧 inertial work proportional to the -𝕆D×e𝕪 kinetic work, that is in Biv space-time. The turning of magnets in a generator has a -𝕀D inertial torque which is also proportional to the -𝕆D kinetic torque.

An electric motor as the inverse

The inverse of this is an electric motor, the +𝕆D potential difference and -𝕆D kinetic difference from the capacitor or battery cause the central magnet to turn. If there was a bar magnet in a loop then it would be moved to one side, that is the inverse of the magnet's motion creating the kinetic current.

A back and forth motion of the magnet

When the bar magnet moves in one direction, then the kinetic current flows in one direction to make a potential and kinetic difference with voltage. If the direction of the magnet reverses, then so does the -𝕆D×e𝕪 kinetic work, then the kinetic current also reverses. That can make an alternating current.

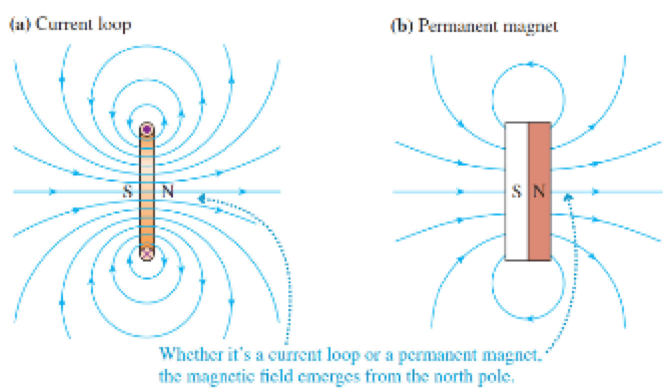
An electromagnet and constructive interference

With a current loop there is constructive interference in the center, that increases the strength of the electromagnet. A bar magnet has individual electrons with their e𝕪 kinetic vectors pointing in the same direction. The electromagnet then gets its strength from constructive interference with the other side of the loop. The bar magnet gets its strength from other electrons with their e𝕪 kinetic vectors pointing in the same direction.

These investigations show that **a current loop is a magnet,** just like a permanent magnet. A magnet created by a current in a coil of wire is called an **electromagnet.** An electromagnet picks up small pieces of iron, influences a compass needle, and acts in every way like a permanent magnet.

In fact, **FIGURE 29.20** shows that a flat permanent magnet and a current loop generate the same magnetic field—the field of a magnetic dipole. For both, **you can identify the north pole as the face or end *from which* the magnetic field emerges.** The magnetic fields of both point *into* the south pole.

FIGURE 29.20 A current loop has magnetic poles and generates the same magnetic field as a flat permanent magnet.



No magnetic vector

In this model μ⃗ would be e𝕪 as the kinetic vector. In a wire each electron would have e𝕪 point towards the +𝕆D potential difference.

As if there was a bar magnet

The circular current loop here would have -𝕠d and e𝕪 Pythagorean Triangle moving around it, the e𝕪 kinetic electric charge is a vector pointing in the direction of the kinetic current down the wire. That is as if there was a bar magnet moving through the loop, the electron spins do -𝕆D×e𝕪 kinetic work in the loop moving the electrons in one direction. That is shown as μ⃗, in this model each loop has a -𝕆D kinetic torque as an integral field inside the loop shown.

North and south poles as a convention

The north and south poles are a convention, they are defined by what moves the electrons in a particular direction around the loop. In this model there is no actual handedness, the -𝕠d magnetic spin on a clock gauge is the passage of kinetic time into the future. It is not a spin direction in terms of distance, such as a spin defined as from one point on the loop to another. That is from -𝕆D×e𝕪 kinetic work where different positions measure the work, but the -𝕆D kinetic torque itself is measured in positions.

Time and spin are not positions

Time and spin are not positions themselves. For example, the time of day cannot be answered by a number of centimeters on a ruler. It can measure the changing angle of the sun on a sundial, but not time itself. The E𝕐/-𝕠d kinetic impulse can be observed on a clock gauge, but the acceleration would not define the time itself. A car might move with a E𝕐/-𝕠d kinetic impulse, but the same time per day cannot be defined with a car's acceleration.

Changing the north and south names

If a pole is marked north and moving upwards, then it might have a clockwise kinetic current looking from the top of the loop. If the same pole was called south, then the opposite left-hand rule would work.

Magnetic poles cannot be differentiated

This is consistent in between magnets because the spin direction as a constructive interference is the same, north to south is like south to north and the two poles cannot be differentiated. This is because differentiation itself comes from derivatives, that can only be observed as impulse. Spin is a loop which looks the same from above or below, a straight-line vector has a direction and so it is differentiated by which way it goes.

Like poles repel, unlike poles attract

Unlike poles always repel whether the same pole is called north or south. If two magnets had their poles repel, there is no way to tell whether they are a pair of north or south poles.

A clock direction is a convention

The spin moves forward in time here, if looking at a kinetic clock gauge showed clockwise then that pole could be called north. If it was called south, then that would be clockwise. It comes from the convention of which way a clock spins. If counterclockwise had been the default, then that might have been called clockwise.

Like a bar magnet in the loop

With the kinetic current it acts as if there was a bar magnet going through the loop, the direction of this would be e𝕪 as the kinetic vector. It would move with a e𝕪/-𝕚d kinetic velocity, that is proportional to a e𝕧/-𝕚d inertial velocity. If a bar magnet was placed in the loop it would move with this inertial velocity in one direction.

The kinetic probability is a square not a volume

In (29.10) μ⃗ would then be e𝕪, that is divided by z^2 which here would be -𝕆D to give the kinetic work. The -𝕆D magnetic probability is a square in this model, as an area it can be measured in different directions as if it was a volume.

Three kinetic torques

In this model the kinetic current moves down the wire, there is a -𝕆D kinetic difference behind it and it moves towards a +𝕆D kinetic difference. The straight-line motion is e𝕪, that is also referred to as B⃗ here. When the -𝕆D×e𝕪 kinetic work of the current is measured then e𝕪 is also B⃗. When the wire is in a loop it appears as if μ⃗ is different to e𝕪 as this is orthogonal to the kinetic current's direction. The loop means the -𝕆D kinetic difference also has a -𝕆D kinetic torque, the center of the torque is the center of the loop.

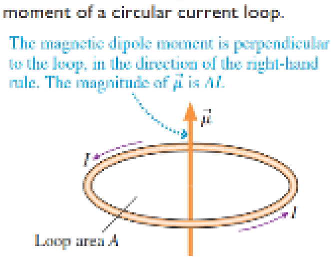
Kinetic probability outside the wire

This -𝕆D kinetic torque is also around a straight wire, the -𝕆D×e𝕪 kinetic work can be measured in the wire but also outside weakening with a -𝕆D inverse square law. An electron has a -𝕆D kinetic probability of being measured outside the wire, it has a direction according to e𝕪 as the same kinetic vector.

Kinetic torque pushes the bar magnet

The loop has the same -𝕆D kinetic torque as is measured around the wire, it is also the same as the -𝕆D kinetic difference from the negative terminal of a battery. That kinetic torque has a direction in which the work is done, instead of pushing an electron down the wire μ⃗ as e𝕪 pushes a bar magnet in the solenoid.

FIGURE 29.21 The magnetic dipole moment of a circular current loop.



The magnetic dipole moment, like the electric dipole moment, is a vector. It has the same direction as the on-axis magnetic field. Thus the right-hand rule for determining the direction of $\vec{B}$ also shows the direction of $\vec{\mu}$. **FIGURE 29.21** shows the magnetic dipole moment of a circular current loop.

Because the on-axis magnetic field of a current loop points in the same direction as $\vec{\mu}$, we can combine Equation 29.9 and the definition of $\vec{\mu}$ to write the on-axis field of a magnetic dipole as

$$\vec{B}_{\text{dipole}} = \frac{\mu_0}{4\pi}\frac{2\vec{\mu}}{z^3} \quad \text{(on the axis of a magnetic dipole)} \qquad (29.10)$$

If you compare $\vec{B}_{\text{dipole}}$ to $\vec{E}_{\text{dipole}}$, you can see that the magnetic field of a magnetic dipole is very similar to the electric field of an electric dipole.

A permanent magnet also has a magnetic dipole moment and its on-axis magnetic field is given by Equation 29.10 when z is much larger than the size of the magnet. Equation 29.10 and laboratory measurements of the on-axis magnetic field can be used to determine a permanent magnet's dipole moment.

A line integral with an orbit

In this model a line integral is like an orbit in Biv space-time. A satellite can be moving with a e𝕧/-𝕚d inertial velocity, a circular orbit can be regarded as containing the +𝕀D gravitational integral probability or torque. That makes the satellite turn in its orbit, the same would describe the gravitational and inertial aspects of an electron in an orbital.

Combining two Pythagorean Triangles

As a line integral it combines two Pythagorean Triangles, the e𝕧 length if from the -𝕚d and e𝕧 Pythagorean Triangle with inertia. The +𝕀D gravitational probability is from the +𝕚d and e𝕙 Pythagorean Triangle with gravity.

Proportional Pythagorean Triangle sides

Here +𝕚d as the gravitational field is proportional to e𝕧, if one doubles then so does the other. They are not inverted because one is a straight Pythagorean Triangle side and the other is a spin Pythagorean Triangle side from its inverse.

The gravitational and inertial torques balance

A second line integral would combine the e𝕙 height of the satellite above a planet, and its -𝕀D×e𝕧 inertial work being done. The -𝕀D inertial probability can be regarded as the same area as +𝕀D but with an inverse strength. That inertial torque reacts against the +𝕀D gravitational torque, at a e𝕙 height they balance otherwise the orbit would change shape. The same happens with an electron in an orbital, its -𝕆D kinetic torque balances against the +𝕆D potential torque from the nucleus. There are then two line integrals here, +𝕀D×e𝕧 and -𝕀D×e𝕙.

A kinetic difference in the loop

In Roy electromagnetism there are these two line integrals, the current loop's electrons have a e𝕪/-𝕚d kinetic velocity from the motion of the bar magnet. There is a -𝕆D kinetic torque from this magnet, that moves the negative electric charges around the loop. The +𝕆D potential difference in the loop comes from the atoms in the wire. The nuclei do +𝕆D×e𝕒 potential work against the -𝕆D×e𝕪 kinetic work of the current, that reacts against their motion slowing them. In some cases the +𝕆D×e𝕒 potential work can make electrons move back into atomic orbitals.

The kinetic torque in the loop and magnet

The -𝕆D kinetic torque in the loop is like the -𝕆D kinetic torques of the electrons in the bar magnet, when it moves through the loop the bar magnet creates the -𝕆D kinetic torque in the loop that moves the kinetic current in the wire. When the kinetic current is from a battery, then the -𝕆D kinetic torque as the battery's kinetic difference or voltage attracts or repels the bar magnet's -𝕆D kinetic torque depending on which pole is in the loop.

Potential work in the magnet's nuclei

The magnet also has a +𝕆D potential difference in its atoms, that reacts with +𝕆D×e𝕒 potential work against more electrons being magnetized into the same spin orientation.

Balancing torques

The two line integrals in Roy electromagnetism would be +𝕆D×e𝕪 and -𝕆D×e𝕒, the loop can be regarded as containing these kinetic and potential probabilities. They make it more probable the electrons would be measured moving in a direction from the kinetic and potential torque.

One torque would accelerate

If there was only one -𝕆D kinetic torque the electrons would continue to accelerate, the bar magnet produces the +𝕆D potential torque so that they balance at a current kinetic velocity. The +𝕆D potential torque comes from the nuclei in the magnet and loop. For example, a metal with a lower +𝕆D×e𝕒 potential work would make a stronger magnet. A faster motion of the bar magnet would increase the current's kinetic velocity.

Line integrals not measured

When the line integrals are not measured, then they can be modeled as +𝕠d×e𝕪 and -𝕠d×e𝕒, these are not actual Pythagorean Triangles here. These need not be line integrals, they can be regarded as line derivatives. These would be e𝕪/+𝕠d and e𝕒/-𝕠d, in each case d and e remain proportional to each other not as inverses.

Surface and line integrals

In this model a surface integral is the same as a line integral, there is only a e𝕪 kinetic vector whether it is on a line or a surface. There is no volume except as an approximation, a curve in a line would be from torque on this straight-line vector. If the surface was non-spherical, then its change in shape would also be from torque on a straight-line vector.

29.6 Ampère's Law and Solenoids

In principle, the Biot-Savart law can be used to calculate the magnetic field of any current distribution. In practice, the integrals are difficult to evaluate for anything other than very simple situations. We faced a similar situation for calculating electric fields, but we discovered an alternative method—Gauss's law—for calculating the electric field of charge distributions with a high degree of symmetry.

Likewise, there's an alternative method, called *Ampère's law*, for calculating the magnetic fields of current distributions with a high degree of symmetry. Whereas Gauss's law is written in terms of a surface integral, Ampère's law is based on the mathematical procedure called a *line integral*.

A curved path through asteroids

In the diagram this could be a satellite moving with a curved path through an asteroid belt with their many different +𝕚d gravitational fields. Then Δs would be e𝕧 from the rocket's e𝕧/-𝕚d inertial velocity. Its path could also be created by the -𝕆D kinetic torque of a rocket moto, firing to turn it in the same path. The e𝕧/+𝕀D line integral would be where the +𝕀D gravitational torque of the asteroids turned the rocket.

Describing the same with two Pythagorean Triangles

The same path can be described by the +𝕚d and e𝕙 Pythagorean Triangle and -𝕚d and e𝕧 Pythagorean Triangle, gravity is turning the satellite while it continues on with its inertia. Instead of using the line integral as e𝕧/+𝕀D the +𝕀D×e𝕙 gravitational work gives the height above each asteroid and the strength of the +𝕀D gravitational torque turning the satellite.

Deriving inertia from the line integral

The -𝕚d and e𝕧 Pythagorean Triangle values can be derived from the changes in e𝕧 as its e𝕧/-𝕚d inertial velocity, that also gives the -𝕀D inertial torque in how the satellite reacts against the +𝕀D gravitational torque.

Creating the line integral

In this model e𝕧 is an infinitesimal, for a position e𝕧 there is a +𝕀D×e𝕙 gravitational work measurement with a e𝕙 height. The e𝕧 length is the inverse of the height to give +𝕀D×e𝕧. The same answers can come from the +𝕀D×e𝕙 gravitational work and -𝕀D×e𝕧 inertial work, the line integral is an approximation to model the curved path.

The paradox of points on a line

In the diagram Δs is a point which adds up to a line, here this goes against Zeno's paradoxes of points on a line. To overcome this a e𝕧 point for example is measuring a squared time as a -𝕀D probability. A line is a displacement, it is drawn by starting at a point and displacing the pen to a final point.

Multiplying derivatives and integrals

In the Pascal's Triangle calculus this is also overcome by multiplying derivatives with integrals. That gives the cells which have permutations and combinations, exponentials and inverse exponentials as normal curves. This becomes work multiplied by impulse, that is similar to their combining in energy such as the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy.

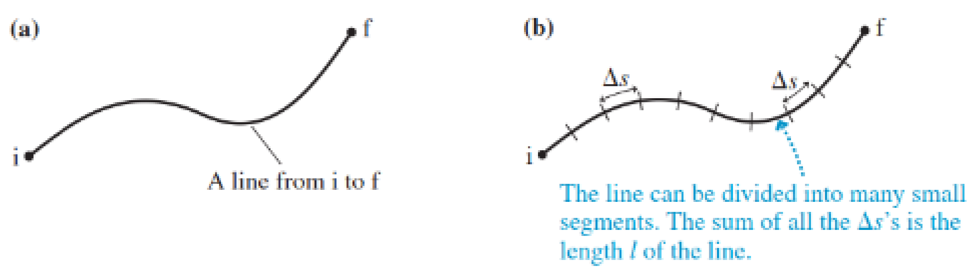
Instants and durations

Impulse is observed with respect to an instant of time, the same problem can occur with adding up instants to form a finite amount of elapsed time. In this model that is overcome with a duration, that is in between a starting and final instant. On a clock gauge this is a torque, a clock hand accelerates from a starting instant and then decelerates to arrive at a final instant. A duration is the like a timeline but as an arc.

Line Integrals

We've flirted with the idea of a line integral ever since introducing the concept of work in Chapter 9, but now we need to take a more serious look at what a line integral represents and how it is used. **FIGURE 29.22a** shows a curved line that goes from an initial point i to a final point f.

FIGURE 29.22 Integrating along a line from i to f.



An infinitesimal measuring torque

In conventional calculus there is a jump from an infinitesimal to a finite line value. Here the integral is measuring the changes in B⃗ as positions on the line. These are referred to as Δs, in this model they are the e𝕪 kinetic positions from the straight Pythagorean Triangle side. B⃗ itself is not squared here, the time component of the changing speed along the curved path is. That becomes work where the duration between instants becomes a torque measured at these Δs positions.

The line integral as positions and torque

These positions are added together as a line in conventional calculus, here there is a displacement between the positions as an impulse. A line integral in this model is comparing a line as a series of positions with an integral as a torque turning the line.

> Suppose, as shown in FIGURE 29.22b, we divide the line into many small segments of length Δs. The first segment is Δs_1, the second is Δs_2, and so on. The sum of all the Δs's is the length l of the line between i and f. We can write this mathematically as
>
> $$l = \sum_k \Delta s_k \rightarrow \int_i^f ds \qquad (29.11)$$
>
> where, in the last step, we let $\Delta s \rightarrow ds$ and the sum become an integral.
>
> This integral is called a **line integral.** All we've done is to subdivide a line into infinitely many infinitesimal pieces, then add them up. This is exactly what you do in calculus when you evaluate an integral such as $\int x\,dx$. In fact, an integration along the x-axis *is* a line integral, one that happens to be along a straight line. Figure 29.22 differs only in that the line is curved. **The underlying idea in both cases is that an integral is just a fancy way of doing a sum.**

B⃗ with a particle/wave duality

In this model B⃗ is the e𝕪 kinetic vector for electrons. There is not a change of B⃗ as a position with respect to Δs positions, if so then all speeds would have the same values. Instead B⃗ is Δs and the change in B⃗ is the -𝕆D kinetic torque in turning the line.

Time is equivalent to mass and magnetism

Here time is equivalent to mass, with -𝕠d as the kinetic magnetic field that can be referred to here as the -𝕠d kinetic mass or the -𝕠d kinetic time. -𝕠d as the kinetic mass is proportional to -𝕚d as the inertial mass or time.

> The line integral of Equation 29.11 is not terribly exciting. FIGURE 29.23a makes things more interesting by allowing the line to pass through a magnetic field. FIGURE 29.23b again divides the line into small segments, but this time $\Delta\vec{s}_k$ is the displacement vector of segment k. The magnetic field at this point in space is $\vec{B}_k$.
>
> Suppose we were to evaluate the dot product $\vec{B}_k \cdot \Delta\vec{s}_k$ at each segment, then add the values of $\vec{B}_k \cdot \Delta\vec{s}_k$ due to every segment. Doing so, and again letting the sum become an integral, we have
>
> $$\sum_k \vec{B}_k \cdot \Delta\vec{s}_k \rightarrow \int_i^f \vec{B} \cdot d\vec{s} = \text{the line integral of } \vec{B} \text{ from i to f}$$

Line and path integrals

In (29.12) the -𝕠d and e𝕪 Pythagorean Triangle electron has its e𝕪 straight Pythagorean Triangle side as being perpendicular to its -𝕠d spin Pythagorean Triangle side. The line integral can be illustrated by an electron in a circular orbital. It moves with a e𝕪/-𝕠d kinetic velocity around it like the electrons move in a wire.

Electrons move towards the potential difference

There is -𝕆D×e𝕪 kinetic work done in the wire because the electrons move towards the +𝕆D potential difference, then the -𝕆D×e𝕪 kinetic work is in the direction of e𝕪. In the orbital the electron also moves towards the +𝕆D potential difference, but this is from the protons in the nucleus doing +𝕆D×e𝕒 potential work.

The line integral and the altitude

The electron then moves with a circular orbital around the nucleus, its -𝕆D×e𝕪 kinetic work is orthogonal to the nucleus under it. The e𝕒 altitude is how high the orbital is above the nucleus. The line integral here would be the -𝕆D kinetic torque contained inside the orbital at an e𝕒 altitude as e𝕒/-𝕆D. In the wire the line integral would be -𝕆D as the kinetic torque moving towards the +𝕆D potential difference of the positive battery terminal. The distance to that is the e𝕒 altitude in e𝕒/+𝕆D.

The magnetic field cannot be a tangent to the kinetic vector

When the integral below is zero there is no -𝕆D×e𝕪 kinetic work being done, the line integral is also zero because -𝕆D is no longer a kinetic torque or difference. In this model the -𝕠d kinetic magnetic field cannot be tangent to the e𝕪 kinetic vector, if it was then there would be no constant area in the -𝕠d and e𝕪 Pythagorean Triangle and so there is no electron there. With no integral it also means there is no -𝕆D×e𝕪 kinetic work being done, the electron would then be observed to move with a E𝕐/-𝕠d kinetic impulse.

Once again, the integral is just a shorthand way to say: Divide the line into lots of little pieces, evaluate $\vec{B}_k \cdot \Delta\vec{s}_k$ for each piece, then add them up.

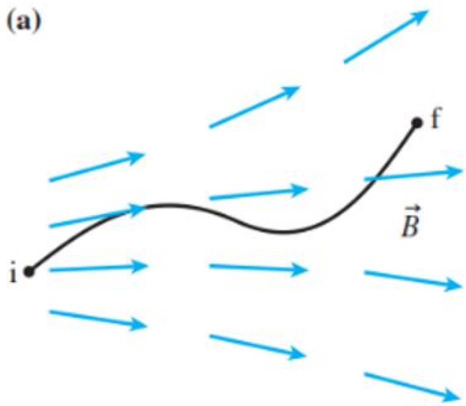
Although this process of evaluating the integral could be difficult, the only line integrals we'll need to deal with fall into two simple cases. If the magnetic field is *everywhere perpendicular* to the line, then $\vec{B} \cdot d\vec{s} = 0$ at every point along the line and the integral is zero. If the magnetic field is *everywhere tangent* to the line *and* has the same magnitude B at every point, then $\vec{B} \cdot d\vec{s} = B\,ds$ at every point and

$$\int_i^f \vec{B} \cdot d\vec{s} = \int_i^f B\,ds = B\int_i^f ds = Bl \qquad (29.12)$$

The magnetic field as a probability or torque

In the diagram the divergence of the magnetic field gives a -𝕆D kinetic torque, it is also a kinetic probability of where the line is likely to go. It can also be observed as a E𝕐/-𝕠d kinetic impulse, a negative charge would have an E𝕐 kinetic displacement as it accelerated.

FIGURE 29.23 Integrating $\vec{B}$ along a line from i to f.



The line passes through a magnetic field.

A displacement between segments

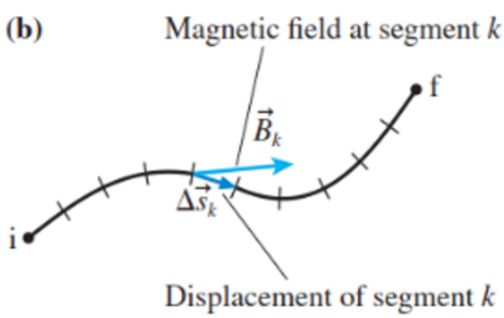
In this model the distance between values of Δs would be a displacement, they would be observed here as a E𝕐/-𝕠d kinetic impulse. When Δs is a kinetic position as e𝕪, the jump to a displacement between points means they are not next to each other.

Work and impulse

Because the path is curved there is work and impulse. The -𝕆D×e𝕪 kinetic work can be measured or an observation can show a negative charge moving with a E𝕐/-𝕠d kinetic impulse. That is because of the particle/wave duality. $\vec{B}$ with impulse would then be observed at an instant of -𝕠d kinetic time, the motion in the E𝕐 kinetic displacement would be observed at different -𝕠d kinetic times.

Several magnets interfering

For this path to occur there must be at least two forces, for example the protons in several wires could do +𝕆d×e𝕣 potential work and have a E𝔸/+𝕠d potential impulse. An electron might then move near them with this path, it would be a combination of -𝕆D×e𝕪 kinetic work and a E𝕐/-𝕠d kinetic impulse. It could also be several magnets with constructive and destructive interferences from their north and south poles. That is like the satellite moving through the asteroid belt.

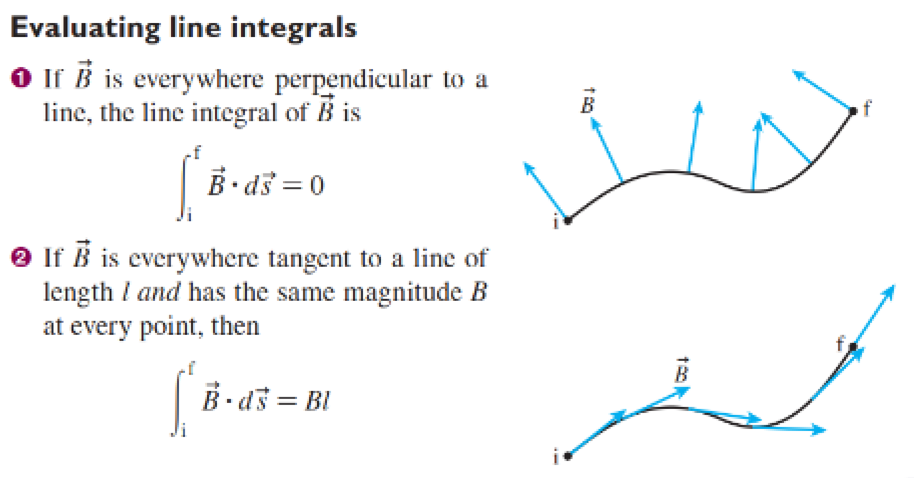


An electron in a circular orbital

If B⃗ is the e𝕪 kinetic vector then there is no -𝕆D×e𝕪 kinetic work being done, the curved path does not change with the -𝕆D kinetic torque from B⃗. That is like an electron in a circular orbital, B⃗ would then be the e𝕒 altitude above the nucleus. No -𝕆D×e𝕪 kinetic work is done because the altitude is not changing, the electron has a constant e𝕪/-𝕠d kinetic velocity in the orbital.

Moving towards a potential difference

The +𝕆D potential difference is in the center of the orbital, the -𝕆D kinetic difference is the -𝕆D kinetic torque the electron has in the orbital. These balance as inverses, the same as they balance in a wire with a voltage. The electrons in the wire then also have a constant e𝕪/-𝕠d kinetic velocity.



Potential work and Ampere's law

When the line integral is in a circle, this is the kinetic magnetic field with a vector e𝕪 pointing along it as a tangent. The spin is then orthogonal to this. The forces are like a weight on a spinning rope, the e𝕒 altitude around the wire is paired with the -𝕆D kinetic torque of the electron in the line integral. That can also be the +𝕆D×e𝕒 potential work of the wire, the +𝕆D potential torque comes from the center of the loop.

A satellite moving with gravity

It is also like a satellite around a planet, the +𝕀D×e𝕙 gravitational work at a e𝕙 height exerts a +𝕀D gravitational torque on the satellite making it turn in a circle.

The two torques as inverses

For example an electron might be measured in an orbital doing -𝕆D×e𝕪 kinetic work at an e𝕒 altitude, where the +𝕆D potential probability or torque equals the -𝕆D kinetic torque. Together each torque gives the inverse square law. With the satellite, it does -𝕀D×e𝕧 inertial work so that its -𝕀D inertial torque equals the +𝕀D gravitational torque at some e𝕙 height. If these torques change then the e𝕙 height of a satellite can also change to make a new circle.

Color code changes

To conform to the color codes, making the names easier to remember, e𝕓 can be used instead of e𝕙 height as a base or basis. That would be the size of the height vector, starting with b it would conform to blue in Biv space-time. Also the e𝕒 altitude could be replaced with the radius as e𝕣 here.

That is because radius and red begin with the same letter, so remembering red gives a radius and remembering blue gives a basis vector.

Radius instead of altitude, basis instead of height

Initially here e𝕣 referred to as a kind of depth, also like a line integral as +𝕆D×e𝕣. As a convention using e𝕓 as a base or basis instead of the e𝕙 height, e𝕣 as a radius instead of the e𝕒 altitude, would be easier to remember. To avoid confusion these are not changed here, but can be at a later time.

Ampère's Law

FIGURE 29.24 shows a wire carrying current I into the page and the magnetic field at distance r. The magnetic field of a current-carrying wire is everywhere tangent to a circle around the wire *and* has the same magnitude $\mu_0 I/2\pi r$ at all points on the circle. According to Tactics Box 29.3, these conditions allow us to easily evaluate the line integral of $\vec{B}$ along a circular path around the wire. Suppose we were to integrate the magnetic field *all the way around* the circle. That is, the initial point i of the integration path and the final point f will be the same point. This would be a line integral around a *closed curve*, which is denoted

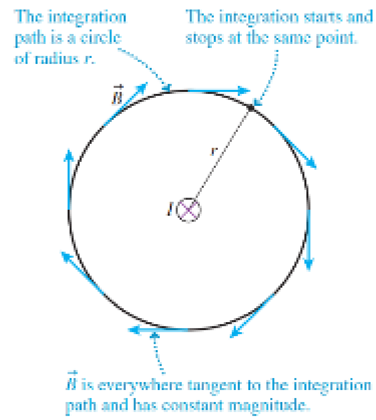
$$\oint \vec{B} \cdot d\vec{s}$$

The little circle on the integral sign indicates that the integration is performed around a closed curve. The notation has changed, but the meaning has not.

Because $\vec{B}$ is tangent to the circle *and* of constant magnitude at every point on the circle, we can use Option 2 from Tactics Box 29.3 to write

$$\oint \vec{B} \cdot d\vec{s} = Bl = B(2\pi r) \qquad (29.13)$$

FIGURE 29.24 Integrating the magnetic field around a wire.



B⃗ as e𝕪

In the previous diagram B⃗ is e𝕪 as the kinetic electric charge of an electron, that would be where it is measured with -𝕆D×e𝕪 kinetic work inside the wire.

Multiplying the kinetic current by μ

Here the integral becomes the -𝕆D×e𝕪 kinetic work on the left, on the right the e𝕪/-𝕠d kinetic current is I. That is multiplied by the squared constant μ to be equivalent to the -𝕆D×e𝕪 kinetic work. The amount of current passing through the circle is the number of -𝕠d and e𝕪 Pythagorean Triangle electrons, that does not change with the size of the circle.

where, in this case, the path length l is the circumference $2\pi r$ of the circle. The magnetic field strength of a current-carrying wire is $B = \mu_0 I/2\pi r$, thus

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I \qquad (29.14)$$

The interesting result is that the line integral of $\vec{B}$ around the current-carrying wire is independent of the radius of the circle. Any circle, from one touching the wire to one far away, would give the same result. The integral depends only on the amount of current passing *through* the circle that we integrated around.

The electric and magnetic flux

In this model the +𝕠d and e𝕒 Pythagorean Triangles and -𝕠d and e𝕪 Pythagorean Triangles are constant, so that the electric and magnetic flux does not change with the shape of the enclosed surface. There can be a different value of work or impulse, but the protons and electrons remain the same. The magnetic field comes from the -𝕠d×e𝕪 integral area of the -𝕠d and e𝕪 Pythagorean Triangle. The electric flux is not an integral here, it moves as a flow as e𝕪/-𝕠d. Because of the particle/wave duality, the magnetic flux integral is associated with the electric flux which comes from derivatives. The term flux can be regarded as having a duality itself, part integral and part derivative.

> This is reminiscent of Gauss's law. In our investigation of Gauss's law, we started with the observation that the electric flux Φ_e through a sphere surrounding a point charge depends only on the amount of charge inside, not on the radius of the sphere. After examining several cases, we concluded that the shape of the surface wasn't relevant. The electric flux through *any* closed surface enclosing total charge Q_{in} turned out to be $\Phi_e = Q_{in}/\epsilon_0$.
>
> Although we'll skip the details, the same type of reasoning that we used to prove Gauss's law shows that the result of Equation 29.14
>
> - Is independent of the shape of the curve around the current.
> - Is independent of where the current passes through the curve.
> - Depends only on the total amount of current through the area enclosed by the integration path.

Two Pythagorean Triangles as inverses

In (29.15) this can be the +𝕆D×e𝕒 potential work on the left equals the -𝕆D×e𝕪 kinetic work on the right. These are inverses to each other so that (+𝕆D×e𝕒)/(-𝕆D×e𝕪) is a constant because of the constant Pythagorean Triangle areas. These can be recombined into two line integrals as +𝕆D/e𝕪 and -𝕆D/e𝕒.

> Thus whenever total current $I_{through}$ passes through an area bounded by a *closed curve*, the line integral of the magnetic field around the curve is
>
> $$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{through} \tag{29.15}$$
>
> This result for the magnetic field is known as **Ampère's law.**

Torques in different directions

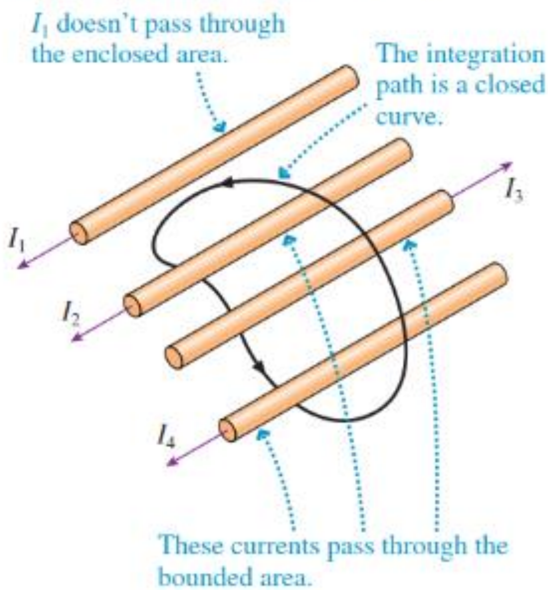
In this model a positive charge would be deflected with a magnetic field in the opposite direction to a negative charge, that is because of the +𝕆D potential torque and -𝕆D kinetic torque being inverses. Currents can be vector added in this model.

> To make practical use of Ampère's law, we need to determine which currents are positive and which are negative. The right-hand rule is once again the proper tool. If you curl your right fingers around the closed path in the direction in which you are going to integrate, then any current passing though the bounded area in the direction of your thumb is a positive current. Any current in the opposite direction is a negative current. In **FIGURE 29.25**, for example, currents I_2 and I_4 are positive, I_3 is negative. Thus $I_{through} = I_2 - I_3 + I_4$.

An integration path

In the diagram there is -𝕆D×e𝕪 kinetic work being done in the wire as the electrons move towards the +𝕆D potential difference. There is also +𝕆D×e𝕒 potential work being done by the protons in the nuclei of each atom. An integration path can be regarded as where the -𝕆D kinetic torque turns the path into a loop. It can also be the -𝕆D kinetic probabilities of where electrons would be measured in it. The loop can change shape without changing the magnetic flux, this is because there are the same number of -𝕠d and e𝕪 Pythagorean Triangle electrons in it.

FIGURE 29.25 Using Ampère's law.



A uniform magnetic field

In this model the loops of the solenoid interfere constructively like many magnets laid north to south. This makes the -𝕆D×e𝕪 kinetic work inside relatively even. Each does -𝕆D×e𝕪 kinetic work along the same $\vec{B}$ direction as e𝕪.

The Magnetic Field of a Solenoid

In our study of electricity, we made extensive use of the idea of a uniform electric field: a field that is the same at every point in space. We found that two closely spaced, parallel charged plates generate a uniform electric field between them, and this was one reason we focused so much attention on the parallel-plate capacitor.

Similarly, there are many applications of magnetism for which we would like to generate a **uniform magnetic field,** a field having the same magnitude and the same direction at every point within some region of space. None of the sources we have looked at thus far produces a uniform magnetic field.

In practice, a uniform magnetic field is generated with a **solenoid.** A solenoid, shown in FIGURE 29.28, is a helical coil of wire with the same current *I* passing through each loop in the coil. Solenoids may have hundreds or thousands of coils, often called *turns,* sometimes wrapped in several layers.

$\vec{B}$ as the e𝕪 kinetic vector

In the diagram the direction of the e𝕪/-𝕠d kinetic current is the same in each loop, the -𝕆D×e𝕪 kinetic work interferes constructively making the magnet stronger in the $\vec{B}$ direction as e𝕪.

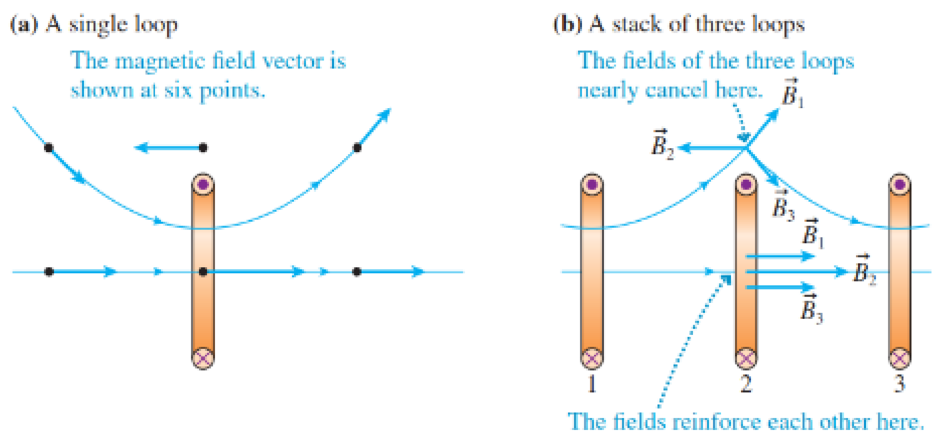
We can understand a solenoid by thinking of it as a stack of current loops. FIGURE 29.29a shows the magnetic field of a single current loop at three points on the axis and three points equally distant from the axis. The field directly above the loop is opposite in direction to the field inside the loop. FIGURE 29.29b then shows three parallel loops. We can use information from Figure 29.29b to draw the magnetic fields of each loop at the center of loop 2 and at a point above loop 2.

The superposition of the three fields at the center of loop 2 produces a *stronger* field than that of loop 2 alone. But the superposition at the point above loop 2 produces a net magnetic field that is very much weaker than the field at the center of the loop. We've used only three current loops to illustrate the idea, but these tendencies are reinforced by including more loops. With many current loops along the same axis, **the field in the center is strong and roughly parallel to the axis, whereas the field outside the loops is very close to zero.**

Constructive interference between the loops

In (b) below there is a partially destructive interference as the curving of the fields overlaps with each loop. The B⃗ direction is partially opposing as e𝕪, that means the -𝕆D×e𝕪 kinetic work is partially interfering destructively. The -𝕆D kinetic probabilities are more canceled out, so the electromagnet does not make another magnet be more likely to be measured at a different e𝕪 position.

FIGURE 29.29 Using superposition to find the magnetic field of a stack of current loops.



The magnetic outside is a minimum

Here each loop has its -𝕠d kinetic magnetic field with an opposing direction to the next loop, this causes destructive interference reducing the -𝕆D×e𝕪 kinetic work. That means the magnetic field outside the coil approaches a minimum. The same happens with a bar magnet, each electron pointing in the same direction increases the magnet's strength with constructive interference. With the electrons alongside it there is destructive interference, that adds to a minimum of -𝕆D×e𝕪 kinetic work done perpendicular to the north and south poles.

FIGURE 29.30a is a photo of the magnetic field of a short solenoid. You can see that the magnetic field inside the coils is nearly uniform (i.e., the field lines are nearly parallel) and the field outside is much weaker. Our goal of producing a uniform magnetic field can be achieved by increasing the number of coils until we have an *ideal solenoid* that is infinitely long and in which the coils are as close together as possible. As FIGURE 29.30b **shows, the magnetic field inside an ideal solenoid is uniform and parallel to the axis; the magnetic field outside is zero.** No real solenoid is ideal, but a very uniform magnetic field can be produced near the center of a tightly wound solenoid whose length is much larger than its diameter.

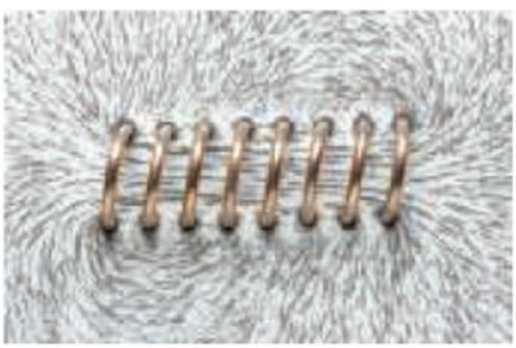
We can use Ampère's law to calculate the field of an ideal solenoid. FIGURE 29.31 on the next page shows a cross section through an infinitely long solenoid. The integration path that we'll use is a rectangle of width l, enclosing N turns of the solenoid coil. Because this is a mathematical curve, not a physical boundary, there's no difficulty with letting it protrude through the wall of the solenoid wherever we wish. The solenoid's magnetic field direction, given by the right-hand rule, is left to right, so we'll integrate around this path in the ccw direction.

$\vec{B}$ as a straight-line kinetic vector

The $\vec{B}$ kinetic vector as ey is a straight-line, the -𝕆D kinetic torque in the wires does -𝕆D×ey kinetic work out one end of the coil.

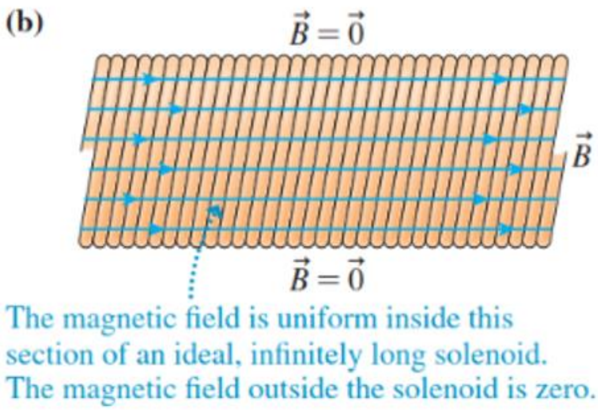
FIGURE 29.30 The magnetic field of a solenoid.

(a) A short solenoid



Straight-line vectors

In the diagram $\vec{B}$ is shown as straight-line vectors, this would be the ey straight Pythagorean Triangle sides.



Loops in constructive interference

In (29.16) this is -𝕆D×e𝕪 kinetic work, it increases with the number of loops in constructive interference. The kinetic current I moves with the -𝕆D×e𝕪 kinetic work done by the voltage in the wires.

Each of the N wires enclosed by the integration path carries current I, so the total current passing through the rectangle is $I_{\text{through}} = NI$. Ampère's law is thus

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{\text{through}} = \mu_0 NI \qquad (29.16)$$

The line integral around this path is the sum of the line integrals along each side. Along the bottom, where $\vec{B}$ is parallel to $d\vec{s}$ and of constant value B, the integral is simply Bl. The integral along the top is zero because the magnetic field outside an ideal solenoid is zero.

The left and right sides sample the magnetic field both inside and outside the solenoid. The magnetic field outside is zero, and the interior magnetic field is everywhere *perpendicular* to the line of integration. Consequently, as we recognized in Option 1 of Tactics Box 29.3, the line integral is zero.

Uniform magnetic field in a solenoid

Here l is the e𝕪 kinetic vector as a distance, the e𝕧 length of the wire in N loops.

Only the integral along the bottom path is nonzero, leading to

$$\oint \vec{B} \cdot d\vec{s} = Bl = \mu_0 NI$$

Thus the strength of the uniform magnetic field inside a solenoid is

$$B_{\text{solenoid}} = \frac{\mu_0 NI}{l} = \mu_0 nI \qquad \text{(solenoid)} \qquad (29.17)$$

where $n = N/l$ is the number of turns per unit length. Measurements that need a uniform magnetic field are often conducted inside a solenoid, which can be built quite large.

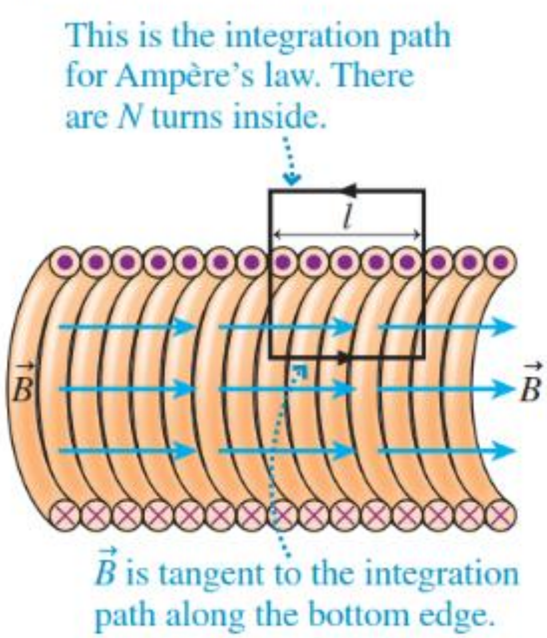
A closed path

In the integration path there are +𝕠d and e𝕒 Pythagorean Triangle protons, these have an e𝕒 altitude and +𝕠d potential magnetic field. with +𝕠d×e𝕒 this is an integral area like the square, the inverse of this is the -𝕠d×e𝕪 kinetic integral. There is also an integration path for electrons as the -𝕠d×e𝕪 integral. If the closed curve around an electron is larger it still only contains one electron, it is less kinetically probable the electron is measured on the surface the larger the integration curve is.

Integrations paths and path integrals

An integration path can be regarded as a path integral here, the -𝕆D×e𝕪 kinetic work has -𝕆D kinetic probabilities as to where the electrons are measured. These can mainly be in the wire, then there is constructive interference with the neighboring loops. They can also be measured outside the loops with a lower -𝕆D kinetic probability, even going backwards. These have two symmetric probabilities which cancel destructively, for example an electron might be measured to the left or right of the wire with an equal probability. These cancel and so the most kinetically probable distribution of electrons is through the wire and an integral field around them.

FIGURE 29.31 A closed path inside and outside an ideal solenoid.

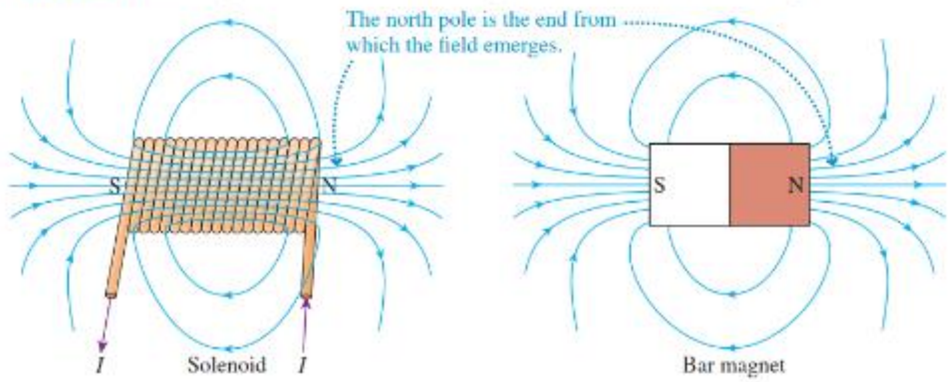


A bar and electromagnet

In this model the loop acts like electrons pointing along the bar magnet. The -𝕆D×e𝕪 kinetic work goes around each loop, the -𝕆D kinetic torque is in the middle of the loop as if rotating around a point there. With each loop having the same -𝕆D kinetic torque as electrons in a bar magnet, they combine to give a similar -𝕠d kinetic magnetic field.

The magnetic field of a finite-length solenoid is approximately uniform *inside* the solenoid and weak, but not zero, outside. As FIGURE 29.32 shows, the magnetic field outside the solenoid looks like that of a bar magnet. Thus **a solenoid is an electromagnet,** and you can use the right-hand rule to identify the north-pole end. A solenoid with many turns and a large current can be a very powerful magnet.

FIGURE 29.32 The magnetic fields of a finite-length solenoid and of a bar magnet.



Both wires attracted to the potential difference

In this model two current carrying wires, in the same direction, have a -𝕠d kinetic magnetic field around them. They each do -𝕆D×e𝕪 kinetic work on the other, the electrons are attracted towards the +𝕆D potential difference in the other wire as well as their own. That makes them attract each other.

Each wire as an electromagnet

The two wires can also be regarded as being in loops, then each acts like an electromagnet. That is an unlike pole interaction between them, similar to a bar magnet cut in half where the parts attract each other. The left side of one wire attracts the right side of the other as in the loops of a solenoid.

29.7 The Magnetic Force on a Moving Charge

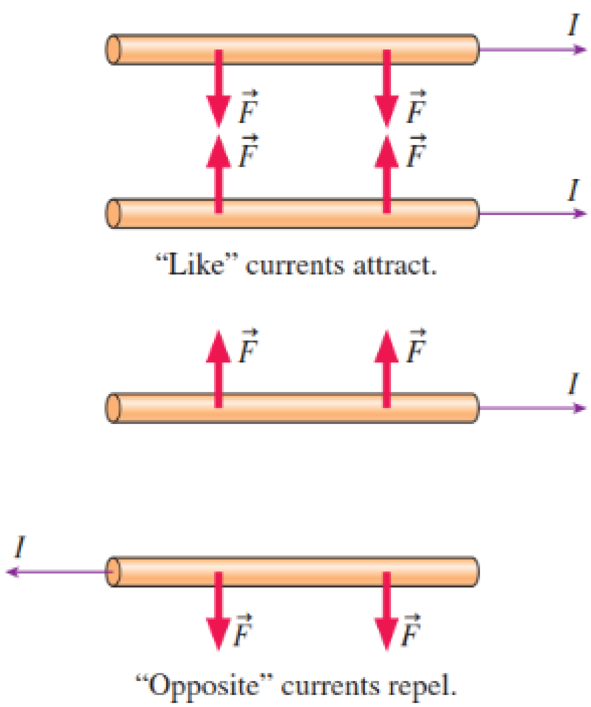
It's time to switch our attention from how magnetic fields are generated to how magnetic fields exert forces and torques. Oersted discovered that a current passing through a wire causes a magnetic torque to be exerted on a nearby compass needle. Upon hearing of Oersted's discovery, André-Marie Ampère, for whom the SI unit of current is named, reasoned that the current was acting like a magnet and, if this were true, that two current-carrying wires should exert magnetic forces on each other.

To find out, Ampère set up two parallel wires that could carry large currents either in the same direction or in opposite (or "antiparallel") directions. FIGURE 29.33 shows the outcome of his experiment. Notice that, for currents, "likes" attract and "opposites" repel. This is the opposite of what would have happened had the wires been charged and thus exerting electric forces on each other. Ampère's experiment showed that **a magnetic field exerts a force on a current.**

Opposing currents as like pole repulsion

The converse is that two wire loops with opposing currents would repel each other with like poles having a destructive interference. That is like two solenoids opposing each other, each current goes in opposite directions to that of the other solenoid.

FIGURE 29.33 The forces between parallel current-carrying wires.



Parallel kinetic differences

When the electrons are moving in the wire, they do -𝕆D×e𝕪 kinetic work. The direction of the -𝕆D kinetic probability is along the wire towards the +𝕆D potential probability or difference. When the two wires are parallel this adds with a constructive interference as if they were in the same wire.

Magnetic Force

Because a current consists of moving charges, Ampère's experiment implies that **a magnetic field exerts a force on a *moving* charge**. It turns out that the magnetic force is somewhat more complex than the electric force, depending not only on the charge's velocity but also on how the velocity vector is oriented relative to the magnetic field. Consider the following experiments:

Impulse perpendicular to a magnetic field

When a positively charged particle moves parallel to a magnetic field it only has a E𝔸/+𝕠d potential impulse. For example, an electron in a circular orbital only does -𝕆D×e𝕪 kinetic work, it moves in a circle perpendicular to the e𝕒 altitude. That has the -𝕆D kinetic torque perpendicular to the e𝕒 potential vector, conversely then the torque would act on the E𝔸/+𝕠d potential impulse from the nucleus turning it at 90°.

An elliptical orbit with torque on the nucleus

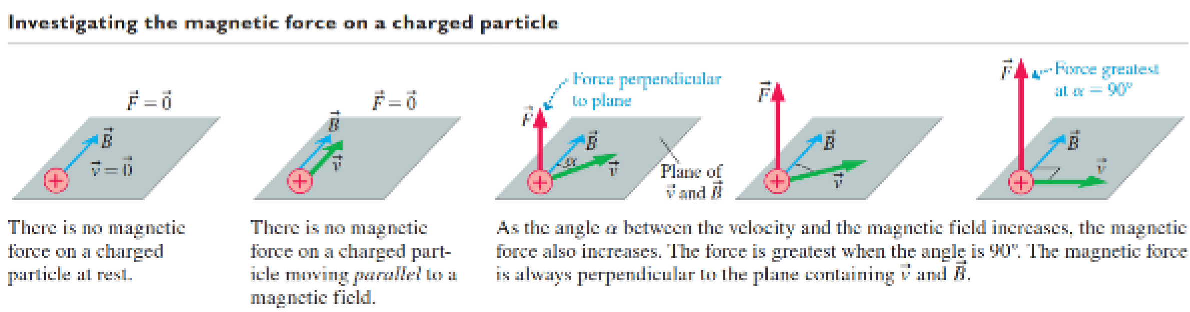
That is the same as the last diagram on the right, in between an electron in an elliptical orbit would affect the nucleus with a combination of -𝕆D×e𝕪 kinetic work and the E𝕐/-𝕠d kinetic impulse depending on the sinθ angle.

The potential and kinetic vectors as B⃗

With a bar or electromagnet, the B⃗ or e𝕪 kinetic vector would also be the e𝕒 potential vector from the positive charge below. When the magnet exerts a torque at 90° this is its maximum -𝕆D×e𝕪 kinetic work, moving closer to the magnet being parallel to the positive charge's e𝕒/+𝕠d potential speed there is less -𝕆D×e𝕪 kinetic work done. Then there is less force on the positive charge.

Parallel with destructive interference

Also then moving parallel to a magnet, the destructive interference from the electrons in it means that it doesn't change the -𝕆D kinetic probability of where the positive charge goes.



The magnetic force

In (29.18) the force F on q is qv×B⃗, That is -𝕠d×e𝕪/-𝕠d × e𝕪/-𝕠d to give the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy. If this is divided by B⃗ that gives -𝕠d×e𝕪/-𝕆D from F=ma. Another interpretation is that the ½×e𝕐/-𝕆d ×-𝕠d linear kinetic energy has its E𝕐/-𝕆D ratio changed by sinθ changing. This gives a different force F as the -𝕆D×e𝕪 kinetic work.

Three forces perpendicular to each other

There are three forces here perpendicular to each other, this can be illustrated by a positive charge moving in one horizontal direction as v with an e𝕒 /+𝕠d potential speed. B⃗ would be a magnet under the charges motion, it points upward. These two are perpendicular to each other. The -𝕆D×e𝕪 kinetic work done by the magnet has the -𝕆D kinetic torque perpendicular to B⃗ as e𝕪.

Two directions are impulse, one is work

It cannot move the charge in the same straight-line by accelerating it, that would be a E𝔸/+𝕠d potential impulse of the charge. It also cannot move the charge in the direction of B⃗ as the e𝕪 kinetic vector. That would be the E𝕐/-𝕠d kinetic impulse which is not a magnetic force. The only other direction is perpendicular to that, so the charge moves sideways with the -𝕆D kinetic torque. If there was no force in this direction then the magnet's -𝕆D×e𝕪 kinetic work would not be conserved.

Notice that the relationship among $\vec{v}$, $\vec{B}$, and $\vec{F}$ is exactly the same as the geometric relationship among vectors $\vec{C}$, $\vec{D}$, and $\vec{C} \times \vec{D}$. The magnetic force on a charge q as it moves through a magnetic field $\vec{B}$ with velocity $\vec{v}$ can be written

$$\vec{F}_{\text{on } q} = q\vec{v} \times \vec{B} = (qvB\sin\alpha, \text{ direction of right-hand rule}) \qquad (29.18)$$

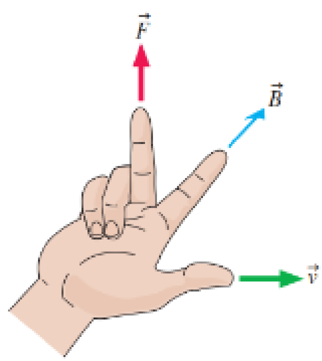
where α is the angle between $\vec{v}$ and $\vec{B}$.

The right-hand rule is that of the cross product, shown in FIGURE 29.34. Notice that **the magnetic force on a moving charged particle is perpendicular to both $\vec{v}$ and $\vec{B}$.**

The magnetic force has several important properties:

- Only a *moving* charge experiences a magnetic force. There is no magnetic force on a charge at rest ($\vec{v} = \vec{0}$) in a magnetic field.
- There is no force on a charge moving parallel ($\alpha = 0°$) or antiparallel ($\alpha = 180°$) to a magnetic field.
- When there is a force, the force is perpendicular to *both* $\vec{v}$ and $\vec{B}$.
- The force on a negative charge is in the direction *opposite* to $\vec{v} \times \vec{B}$.
- For a charge moving perpendicular to $\vec{B}$ ($\alpha = 90°$), the magnitude of the magnetic force is $F = |q|vB$.

FIGURE 29.34 The right-hand rule for magnetic forces.

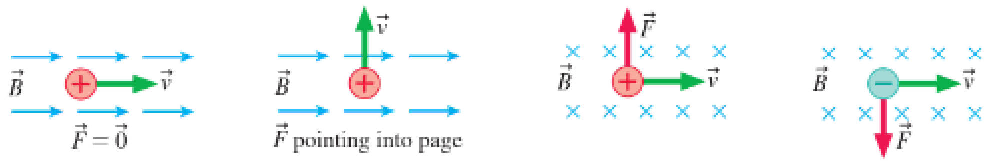


Magnetic forces on moving charges

In the diagram the -𝕆D×e𝕪 kinetic work is perpendicular to both the E𝔸/+𝕠d potential impulse of the change and the E𝕐/-𝕠d kinetic impulse that would have to be B⃗ as e𝕪.

FIGURE 29.35 shows the relationship among $\vec{v}$, $\vec{B}$, and $\vec{F}$ for four moving charges. (The *source* of the magnetic field isn't shown, only the field itself.) You can see the inherent three-dimensionality of magnetism, with the force perpendicular to both $\vec{v}$ and $\vec{B}$. The magnetic force is very different from the electric force, which is parallel to the electric field.

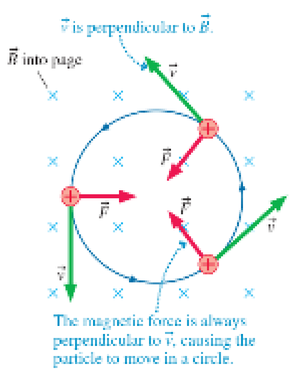
FIGURE 29.35 Magnetic forces on moving charges.



Cyclotron motion

In cyclotron motion the positive charge is move with a -𝕆D kinetic torque in a circle. The $\vec{v}$ direction would be its e𝕒/+𝕠d potential speed, accelerating it that was would be the E𝔸/+𝕠d potential impulse. Accelerating it in the direction of $\vec{B}$ would be e𝕪 as the kinetic vector, that would be the E𝕐/-𝕠d kinetic impulse. The only other force direction is perpendicular to both, it must also be a torque.

FIGURE 29.37 Cyclotron motion of a charged particle moving in a uniform magnetic field.



We can draw an interesting and important conclusion at this point. You have seen that the magnetic field is *created by* moving charges. Now you also see that magnetic forces are *exerted on* moving charges. Thus it appears that **magnetism is an interaction between moving charges.** Any two charges, whether moving or stationary, interact with each other through the electric field. In addition, two *moving* charges interact with each other through the magnetic field.

Cyclotron Motion

Many important applications of magnetism involve the motion of charged particles in a magnetic field. Older television picture tubes use magnetic fields to steer electrons through a vacuum from the electron gun to the screen. Microwave generators, which are used in applications ranging from ovens to radar, use a device called a *magnetron* in which electrons oscillate rapidly in a magnetic field.

You've just seen that there is no force on a charge that has velocity $\vec{v}$ parallel or antiparallel to a magnetic field. Consequently, **a magnetic field has no effect on a charge moving parallel or antiparallel to the field.** To understand the motion of charged particles in magnetic fields, we need to consider only motion *perpendicular* to the field.

FIGURE 29.37 shows a positive charge q moving with a velocity $\vec{v}$ in a plane that is perpendicular to a *uniform* magnetic field $\vec{B}$. According to the right-hand rule, the

Work cannot change a speed or velocity

The -𝕆D×e𝕪 kinetic work here cannot change the charge's potential speed, if it did that would be the E𝔸/+𝕠d potential impulse not a magnetic force. A negative charge would be turned in the opposite direction to this.

magnetic force on this particle is *perpendicular* to the velocity $\vec{v}$. A force that is always perpendicular to $\vec{v}$ changes the *direction* of motion, by deflecting the particle sideways, but it cannot change the particle's speed. Thus **a particle moving perpendicular to a uniform magnetic field undergoes uniform circular motion at constant speed.** This motion is called the **cyclotron motion** of a charged particle in a magnetic field.

> **NOTE** A negative charge will orbit in the opposite direction from that shown in Figure 29.37 for a positive charge.

The radius of the torque

Here the force F equals -𝕠d×E𝕍/-𝕆D × 1/e𝕪, that gives -𝕠d×e𝕪/-𝕆D. The radius here as e𝕪 can be regarded as being spun around with a -𝕆D kinetic torque, with the positive charge that is like e𝕒 as the altitude with a +𝕆D potential torque around it. This is how the +𝕆D×e𝕒 potential work surrounding a nucleus turns electrons in orbitals, the inverse of this is the -𝕆D×e𝕪 kinetic work where the -𝕆D kinetic torque can have the e𝕪 kinetic vector in the negative charge's e𝕪/-𝕠d kinetic velocity being turned around in a circle.

You've seen many analogies to cyclotron motion earlier in this text. For a mass moving in a circle at the end of a string, the tension force is always perpendicular to $\vec{v}$. For a satellite moving in a circular orbit, the gravitational force is always perpendicular to $\vec{v}$. Now, for a charged particle moving in a magnetic field, it is the magnetic force of strength $F = qvB$ that points toward the center of the circle and causes the particle to have a centripetal acceleration.

Newton's second law for circular motion, which you learned in Chapter 8, is

$$F = qvB = ma_r = \frac{mv^2}{r} \qquad (29.19)$$

Thus the radius of the cyclotron orbit is

$$r_{cyc} = \frac{mv}{qB} \qquad (29.20)$$

The cyclotron frequency

Here the frequency comes from the e𝕪/-𝕠d kinetic velocity with a negative charge for example. When this is divided by the radius e𝕪 that gives 1/-𝕠d as the frequency 1/second.

The inverse dependence on B indicates that the size of the orbit can be decreased by increasing the magnetic field strength.

We can also determine the frequency of the cyclotron motion. Recall from your earlier study of circular motion that the frequency of revolution f is related to the speed and radius by $f = v/2\pi r$. A rearrangement of Equation 29.20 gives the **cyclotron frequency:**

$$f_{cyc} = \frac{qB}{2\pi m} \qquad (29.21)$$

where the ratio q/m is the particle's *charge-to-mass ratio.* Notice that the cyclotron frequency depends on the charge-to-mass ratio and the magnetic field strength but *not* on the charge's speed.

Accelerating the charge with impulse

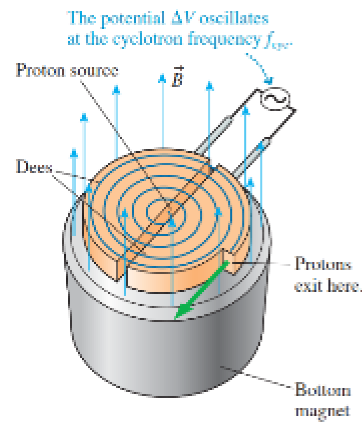
Here the positive charge is accelerated with a E𝔸/+𝕠d potential impulse in between the Dees, then it is turned with the -𝕆D×e𝕪 kinetic work of the magnet. The magnet does not change the e𝕒/+𝕠d potential speed, that can only happen with a E𝔸/+𝕠d potential impulse.

A cyclotron, shown in **FIGURE 29.40**, consists of an evacuated chamber within a large, uniform magnetic field. Inside the chamber are two hollow conductors shaped like the letter D and hence called "dees." The dees are made of copper, which doesn't affect the magnetic field; are open along the straight sides; and are separated by a small gap. A charged particle, typically a proton, is injected into the magnetic field from a source near the center of the cyclotron, and it begins to move in and out of the dees in a circular cyclotron orbit.

The cyclotron operates by taking advantage of the fact that the cyclotron frequency f_{cyc} of a charged particle is independent of the particle's speed. An *oscillating* potential difference ΔV is connected across the dees and adjusted until its frequency is exactly the cyclotron frequency. There is almost no electric field inside the dees (you learned in Chapter 24 that the electric field inside a hollow conductor is zero), but a strong electric field points from the positive to the negative dee in the gap between them.

Suppose the proton emerges into the gap from the positive dee. The electric field in the gap *accelerates* the proton across the gap into the negative dee, and it gains kinetic energy $e\Delta V$. A half cycle later, when it next emerges into the gap, the potential of the dees (whose potential difference is oscillating at f_{cyc}) will have changed sign. The proton will *again* be emerging from the positive dee and will *again* accelerate across the gap and gain kinetic energy $e\Delta V$.

FIGURE 29.40 A cyclotron.



A large potential probability

The proton would have a ½×+e𝔸/+𝕆d ×+𝕠d rotational potential energy not kinetic energy here. It accumulates a large +𝕆D potential difference or probability from this potential torque. That makes it more potentially probable to be measured further away from the cyclotron, this corresponds to a higher e𝕒/+𝕠d potential speed.

This pattern will continue orbit after orbit. The proton's kinetic energy increases by $2e\Delta V$ every orbit, so after N orbits its kinetic energy is $K = 2Ne\Delta V$ (assuming that its initial kinetic energy was near zero). The radius of its orbit increases as it speeds up; hence the proton follows the *spiral* path shown in Figure 29.40 until it finally reaches the outer edge of the dee. It is then directed out of the cyclotron and aimed at a target. Although ΔV is modest, usually a few hundred volts, the fact that the proton can undergo many thousands of orbits before reaching the outer edge allows it to acquire a very large kinetic energy.

The Hall effect

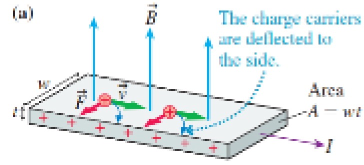
In the Hall effect electrons have a e𝕪/-𝕠d kinetic velocity, the $\vec{B}$ or e𝕪 direction is perpendicular to this from the side. The -𝕆D×e𝕪 kinetic work makes the electrons more likely to be measured at the bottom of the wire. They are also quantized there in steps because -𝕆D×e𝕪 kinetic work is in whole numbers as integers. If it was fractions or continuous it would be the E𝕐/-𝕠d kinetic impulse.

The Hall Effect

A charged particle moving through a vacuum is deflected sideways, perpendicular to $\vec{v}$, by a magnetic field. In 1879, a graduate student named Edwin Hall showed that the same is true for the charges moving through a conductor as part of a current. This phenomenon—now called the **Hall effect**—is used to gain information about the charge carriers in a conductor. It is also the basis of a widely used technique for measuring magnetic field strengths.

FIGURE 29.41a shows a magnetic field perpendicular to a flat, current-carrying conductor. You learned in Chapter 27 that the charge carriers move through a conductor at the drift speed v_d. Their motion is perpendicular to $\vec{B}$, so each charge carrier experiences a magnetic force $F_B = ev_dB$ perpendicular to both $\vec{B}$ and the current I. However, for the first time we have a situation in which it *does* matter whether the charge carriers are positive or negative.

FIGURE 29.41 In a magnetic field, the charge carriers of a current are deflected to one side.

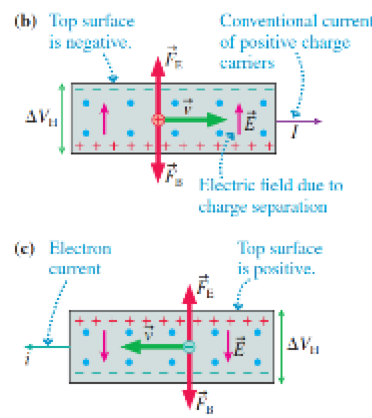


Creating a potential and kinetic difference

The Hall effect does -𝕆D×e𝕪 kinetic work moving the electrons to the bottom of the wire, the top becomes positively charged with +𝕆D×e𝕒 potential work. That gives a +𝕆D potential difference on the top and a -𝕆D kinetic difference on the bottom like a battery or capacitor.

FIGURE 29.41b, with the field out of the page, shows that positive charge carriers moving in the direction of I are pushed toward the bottom surface of the conductor. This creates an excess positive charge on the bottom surface and leaves an excess negative charge on the top. FIGURE 29.41c, where the electrons in an electron current i move opposite the direction of I, shows that electrons would be pushed toward the bottom surface. (Be sure to use the right-hand rule and the sign of the electron charge to confirm the deflections shown in these figures.) Thus the sign of the excess charge on the bottom surface is the same as the sign of the charge carriers. Experimentally, the bottom surface is negative when the conductor is a metal, and this is one more piece of evidence that the charge carriers in metals are electrons.

Electrons are deflected toward the bottom surface once the current starts flowing, but the process can't continue indefinitely. As excess charge accumulates on the top and bottom surfaces, it acts like the charge on the plates of a capacitor, creating a potential difference ΔV between the two surfaces and an electric field $E = \Delta V/w$ *inside* the conductor of width w. This electric field increases until the upward electric force $\vec{F}_E$



The steady state condition from work

In this model the force F_B would be ΔV as -𝕆D divided by w as a e𝕪 distance. Here e refers to single electrons as the -𝕠d and e𝕪 Pythagorean Triangles. This is also affected by the e𝕪/-tof kinetic velocity of the current, it might move further before being pushed down to the bottom of the wire.

on the charge carriers exactly balances the downward magnetic force $\vec{F}_B$. Once the forces are balanced, a steady state is reached in which the charge carriers move in the direction of the current and no additional charge is deflected to the surface.

The steady-state condition, in which $F_B = F_E$, is

$$F_B = ev_dB = F_E = eE = e\frac{\Delta V}{w} \tag{29.22}$$

Thus the steady-state potential difference between the two surfaces of the conductor, which is called the **Hall voltage** ΔV_H, is

$$\Delta V_H = wv_dB \tag{29.23}$$

Current and the kinetic difference

In this model the kinetic current is repelled by the -𝕆D kinetic difference, that comes from the negative terminal of a battery. The external magnetic field also has a -𝕆D kinetic difference as the torque or probability. The current kinetic velocity and drift speed then affects the Hall voltage needed.

You learned in Chapter 27 that the drift speed is related to the current density J by $J = nev_d$, where n is the charge-carrier density (charge carriers per m^3). Thus

$$v_d = \frac{J}{ne} = \frac{I/A}{ne} = \frac{I}{wtne} \qquad (29.24)$$

where $A = wt$ is the cross-section area of the conductor. If we use this expression for v_d in Equation 29.23, we find that the Hall voltage is

$$\Delta V_H = \frac{IB}{tne} \qquad (29.25)$$

A current carrying wire parallel to a magnet

In this model the wire running parallel to the magnetic field has a destructive interference between the electrons all pointing in the same direction. That cancels out the -𝕆D kinetic torque parallel to the magnet.

29.8 Magnetic Forces on Current-Carrying Wires

Ampère's observation of magnetic forces between current-carrying wires motivated us to look at the magnetic forces on moving charges. We're now ready to apply that knowledge to Ampère's experiment. As a first step, let us find the force exerted by a uniform magnetic field on a long, straight wire carrying current I through the field. As FIGURE 29.42a shows, there's *no* force on a current-carrying wire *parallel* to a magnetic field. This shouldn't be surprising; it follows from the fact that there is no force on a charged particle moving parallel to $\vec{B}$.

Magnetic forces on a current carrying wire

In the diagram the F force is the -𝕆D×eႸ kinetic work to the left. Here the charge Q has differing definitions in conventional physics. As the Coulomb it would be -𝕠d×eႸ/-𝕠d, if this is multiplied by B⃗ as eႸ that gives -𝕠d×E𝕐/-𝕠d as the E𝕐/-𝕠d kinetic impulse. That would be observing the motion as particles, the force F would be the inverse of this where B⃗ as eႸ is 1/-𝕠d to give ma as -𝕠d×eႸ/-𝕆D. This can also be used because of the particle/wave duality of eႸ and -𝕠d. The velocity v would then be a constant here. The length l of the wire also affects the number of -𝕠d and eႸ Pythagorean Triangle electrons in it and the -𝕆D×eႸ kinetic work done.

FIGURE 29.42b shows a wire *perpendicular* to the magnetic field. By the right-hand rule, each charge in the current has a force of magnitude qvB directed to the left. Consequently, the entire length of wire within the magnetic field experiences a force to the left, perpendicular to both the current direction and the field direction.

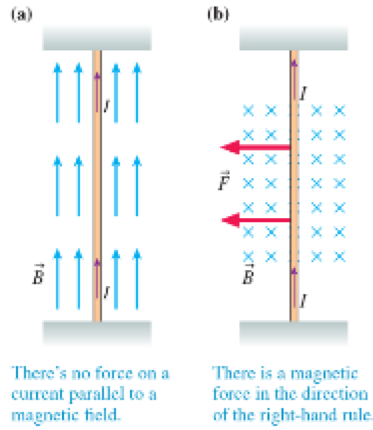
A current is moving charge, and the magnetic force on a current-carrying wire is simply the net magnetic force on all the charge carriers in the wire. FIGURE 29.43 shows a wire carrying current I and a segment of length l in which the charge carriers—moving with drift velocity $\vec{v}_d$—have total charge Q. Because the magnetic force is proportional to q, the *net* force on all the charge carriers in the wire is the force on the net charge: $\vec{F} = Q\vec{v}_d \times \vec{B}$. But we need to express this in terms of the current.

By definition, the current I is the amount of charge Q divided by the time t it takes the charge to flow through this segment: $I = Q/t$. The charge carriers have drift speed v_d, so they move distance l in $t = l/v_d$. Combining these equations, we have

$$I = \frac{Qv_d}{l}$$

and thus $Qv_d = Il$. If we define vector $\vec{l}$ to point in the direction of $\vec{v}_d$, the current direction, then $Q\vec{v}_d = I\vec{l}$. Substituting $I\vec{l}$ for $Q\vec{v}_d$ in the force equation, we find that the magnetic force on length l of a current-carrying wire is

FIGURE 29.42 Magnetic force on a current-carrying wire.



The force on a current

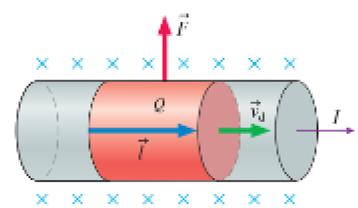
Here the force F in conventional physics us mass times acceleration. I is the kinetic current as eγ/-ⓞd, when multiplied by B⃗ this is the EΥ/-ⓞd kinetic impulse not -ⓄD×eγ kinetic work. Electrons also move as particle with impulse, colliding with each other. This would be the inverse of F=ma, it is approximately equivalent except it is an observation not a measurement. In Biv space-time this would have dimensions of the inertial mass×meters²/second instead of the inertial mass×meters/second².

$$\vec{F}_{wire} = I\vec{l} \times \vec{B} = (IlB\sin\alpha, \text{direction of right-hand rule}) \qquad (29.26)$$

where α is the angle between $\vec{l}$ (the direction of the current) and $\vec{B}$. As an aside, you can see from Equation 29.26 that the magnetic field B must have units of N/A m. This is why we defined 1 T = 1 N/A m in Section 29.3.

NOTE The familiar right-hand rule applies to a current-carrying wire. Point your right thumb in the direction of the current (parallel to $\vec{l}$) and your index finger in the direction of $\vec{B}$. Your middle finger is then pointing in the direction of the force $\vec{F}$ on the wire.

FIGURE 29.43 The force on a current is the force on the charge carriers.



Measuring the kinetic magnetic field

Here B is the magnetic field force as μ, it comes from the -ⓄD×eγ kinetic work on the eγ/-ⓞd kinetic current. Measuring this work is increasingly less likely away from the wire where r is eγ as the kinetic vector. That can be regarded as a eγ radius connected to a circle with a -ⓄD kinetic torque, like a spinning weight on a rope having a -ⅅD inertial torque. Here eγ can be regarded as pointing in different directions, such as parallel to the wire but outside it. As long as -ⓞd is orthogonal to it then the -ⓞd and eγ Pythagorean Triangle is measurable there.

Potential work added to kinetic work

There is also the +ⓄD×eⓐ potential work from the protons in the wire, that have a +ⓄD potential difference extending out from the wire as well. That adds to the -ⓄD kinetic difference making it weaker further from the wire.

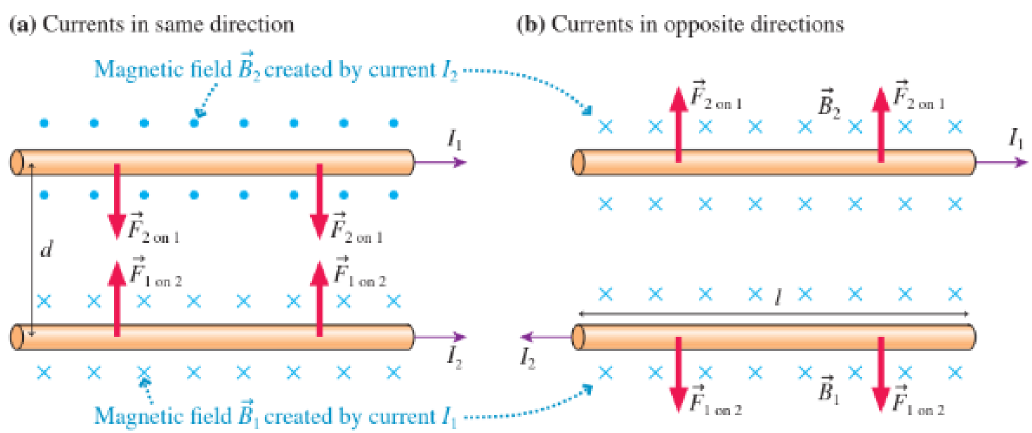
Force Between Two Parallel Wires

Now consider Ampère's experimental arrangement of two parallel wires of length l, distance d apart. **FIGURE 29.45a** on the next page shows the currents I_1 and I_2 in the same direction; **FIGURE 29.45b** shows the currents in opposite directions. We will assume that the wires are sufficiently long to allow us to use the earlier result for the magnetic field of a long, straight wire: $B = \mu_0 I/2\pi r$.

Magnetic forces between wires

Here the direction of the magnetic field is shown by B⃗ as the eɏ kinetic vector. When the kinetic current moves in the same direction then The -Od kinetic probability or torque in each wire tends to be measured closer to the +𝕆D potential probability or torque in the other wire. Conversely when the kinetic currents are opposed either the +𝕆D potential difference or -𝕆D kinetic difference is also opposed. The electrons would be moving away from a -𝕆D kinetic probability in their wire, but the other wire would have them moving towards its -𝕆D kinetic probability. These The destructive interference means the wires are less likely to be measured close together, so they repel each other.

FIGURE 29.45 Magnetic forces between parallel current-carrying wires.



As Figure 29.45a shows, the current I_2 in the lower wire creates a magnetic field $\vec{B}_2$ at the position of the upper wire. $\vec{B}_2$ points out of the page, perpendicular to current I_1. **It is field $\vec{B}_2$, due to the lower wire, that exerts a magnetic force on the upper wire.** Using the right-hand rule, you can see that the force on the upper wire is downward, thus attracting it toward the lower wire. The field of the lower current is not a uniform field, but it is the *same* at all points along the upper wire because the two wires are parallel. Consequently, we can use the field of a long, straight wire, with $r = d$, to determine the magnetic force exerted by the lower wire on the upper wire:

$$F_{\text{parallel wires}} = I_1 l B_2 = I_1 l \frac{\mu_0 I_2}{2\pi d} = \frac{\mu_0 l I_1 I_2}{2\pi d} \qquad (29.27)$$

Action/reaction pairs

In this model there is an equal and opposite reaction in action/reaction pairs. The protons in the wire do +𝕆D×eⱥ potential work as equal and opposite reactions against electron with -𝕆D×eɏ kinetic work. The -𝕆D×e𝕪 kinetic work done by the electrons has -𝕀D×e𝕧 inertial work doing an equal and opposite reaction against them. This is like pushing a block on a surface with -𝕆D×e𝕪 kinetic work, it is measured to push back with -𝕀D×e𝕧 inertial work. Moving the electrons kinetically has an inertial reaction, the tendency is for the electrons to stay around the same positions.

Not combining kinetic work

In this model -𝕆D×e𝕪 kinetic work would not be combined in one equation like (29.27), the first wire does -𝕆D×e𝕪 kinetic work on the second from its own electrons. It is attracted to the +𝕆D×e𝕒 potential work of the protons there. The second wire does -𝕆D×e𝕪 kinetic work on the first wire, multiplying them together implies there is a common force between them. Instead here each -𝕠d and e𝕪 Pythagorean Triangle electron does it won -𝕆D×e𝕪 kinetic work.

As an exercise, you should convince yourself that the current in the upper wire exerts an upward-directed magnetic force on the lower wire with exactly the same magnitude. You should also convince yourself, using the right-hand rule, that the forces are repulsive and tend to push the wires apart if the two currents are in opposite directions.

Thus two parallel wires exert equal but opposite forces on each other, as required by Newton's third law. **Parallel wires carrying currents in the same direction attract each other; parallel wires carrying currents in opposite directions repel each other.**

Loops and interference

In this model each loop acts like an electromagnet, when the kinetic current moves in the same direction then there is a -𝕆D kinetic torque inside each loop. That has the e𝕪 kinetic vector as $\vec{B}$ pointing in the same direction, they attract each other with constructive interference. Conversely loops with opposing kinetic currents repel each other with destructive interference.

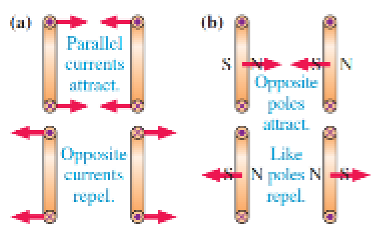
29.9 Forces and Torques on Current Loops

You have seen that a current loop is a magnetic dipole, much like a permanent magnet. We will now look at some important features of how current loops behave in magnetic fields. This discussion will be largely qualitative, but it will highlight some of the important properties of magnets and magnetic fields. We will use these ideas in the next section to make the connection between electromagnets and permanent magnets.

FIGURE 29.47a shows two current loops. Using what we just learned about the forces between parallel and antiparallel currents, you can see that **parallel current loops exert attractive magnetic forces on each other if the currents circulate in the same direction; they repel each other when the currents circulate in opposite directions.**

We can think of these forces in terms of magnetic poles. Recall that the north pole of a current loop is the side from which the magnetic field emerges, which you can determine with the right-hand rule. FIGURE 29.47b shows the north and south magnetic poles of the current loops. When the currents circulate in the same direction, a north and a south pole face each other and exert attractive forces on each other. When the currents circulate in opposite directions, the two like poles repel each other.

FIGURE 29.47 Two alternative but equivalent ways to view magnetic forces.



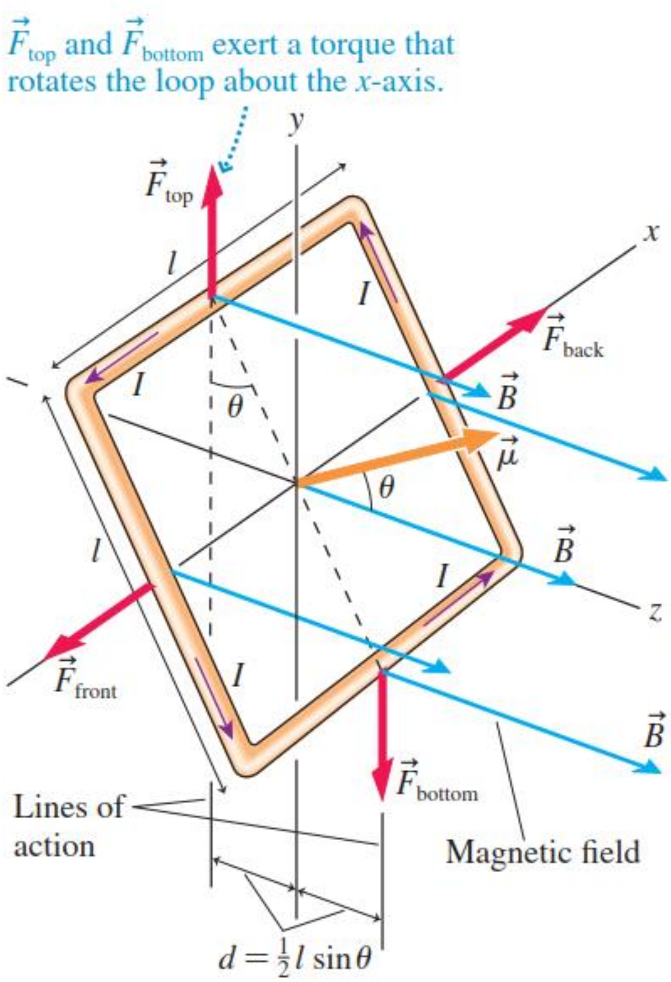
Rotating a loop

Here the loop is rotated by the -𝕆D kinetic torque from the magnetic field. $\vec{\mu}$ would be the e𝕪 kinetic vector, the -𝕆D kinetic torque comes from the current moving around the loop. This has an angle with the e𝕪 kinetic vector from the magnetic field. In between there is then a kinetic torque, that turns the loops until both e𝕪 kinetic vectors are aligned. It is like electrons inside a magnet moving others in line with them using constructive interference. The loop as an electromagnet is aligned like a compass would be with the external magnetic field.

Here, at last, we have a real connection to the behavior of magnets that opened our discussion of magnetism—namely, that like poles repel and opposite poles attract. Now we have an *explanation* for this behavior, at least for electromagnets. **Magnetic poles attract or repel because the moving charges in one current exert attractive or repulsive magnetic forces on the moving charges in the other current.** Our tour through interacting moving charges is finally starting to show some practical results!

Now let's consider what happens to a current loop in a magnetic field. **FIGURE 29.48** shows a square current loop in a uniform magnetic field along the *z*-axis. As we've learned, the field exerts magnetic forces on the currents in each of the four sides of the loop. Their directions are given by the right-hand rule. Forces $\vec{F}_{\text{front}}$ and $\vec{F}_{\text{back}}$ are opposite to each other and cancel. Forces $\vec{F}_{\text{top}}$ and $\vec{F}_{\text{bottom}}$ also add to give no net force, but because $\vec{F}_{\text{top}}$ and $\vec{F}_{\text{bottom}}$ don't act along the same line they will *rotate* the loop by exerting a torque on it.

FIGURE 29.48 A uniform magnetic field exerts a torque on a current loop.



Here μ would be the e𝕪 kinetic vector, when multiplied by B this is -𝕆D×e𝕪 kinetic work, that changes with the angle to the loop according to sinθ. IA is the e𝕪/-𝕠d kinetic current times +𝕠d×e𝕒/+𝕆D which is the area A inside the loop. That contains the -𝕆D kinetic torque or probability as a square, it is like an electron orbital containing the -𝕆D kinetic torque in an atom.

The torque on a magnetic dipole

Here μ is referred to as the dipole moment, that would be the e𝕪 kinetic vector the -𝕆D kinetic torque spins around. That is like a pivot point where a force F as -𝕀D×e𝕧 inertial work would be measured in turning a nut with a wrench. In (29.29) the torque $\vec{\tau}$ is $\vec{\mu}$ as e𝕪 times $\vec{B}$ which here would be the -𝕆D kinetic torque.

Recall that torque is the magnitude of the force F multiplied by the moment arm d, the distance between the pivot point and the line of action. Both forces have the same moment arm $d = \frac{1}{2} l \sin\theta$, hence the torque on the loop—a torque exerted by the magnetic field—is

$$\tau = 2Fd = 2(IlB)\left(\tfrac{1}{2} l \sin\theta\right) = (Il^2)B\sin\theta = \mu B \sin\theta \qquad (29.28)$$

where $\mu = Il^2 = IA$ is the loop's magnetic dipole moment.

Although we derived Equation 29.28 for a square loop, the result is valid for a current loop of any shape. Notice that Equation 29.28 looks like another example of a cross product. We earlier defined the magnetic dipole moment vector $\vec{\mu}$ to be a vector perpendicular to the current loop in a direction given by the right-hand rule. Figure 29.48 shows that θ is the angle between $\vec{B}$ and $\vec{\mu}$, hence the torque on a magnetic dipole is

$$\vec{\tau} = \vec{\mu} \times \vec{B} \qquad (29.29)$$

The torque is zero when the magnetic dipole moment $\vec{\mu}$ is aligned parallel or antiparallel to the magnetic field, and is maximum when $\vec{\mu}$ is perpendicular to the field. It is this magnetic torque that causes a compass needle—a magnetic moment—to rotate until it is aligned with the magnetic field.

An electric motor

In an electric motor the -𝕆D kinetic torque of two magnets makes the loop turn.

An Electric Motor

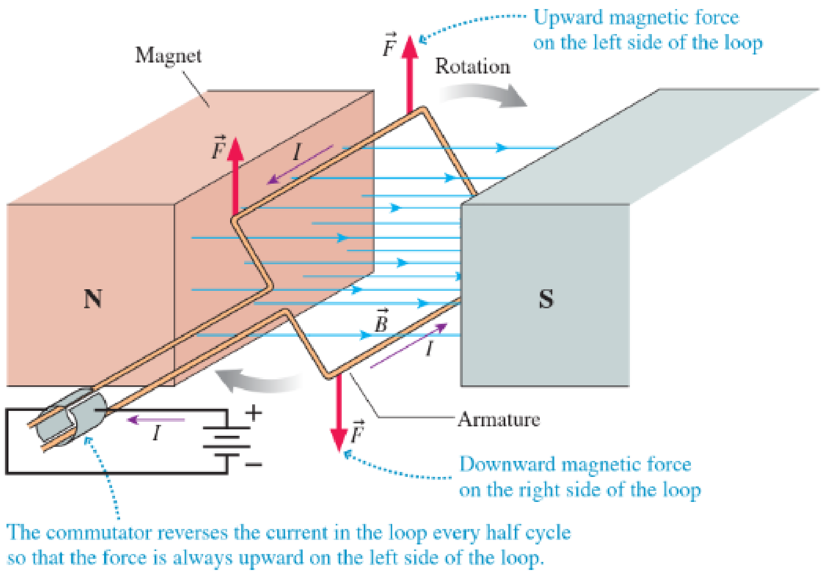
The torque on a current loop in a magnetic field is the basis for how an electric motor works. As FIGURE 29.49 on the next page shows, the *armature* of a motor is a coil of wire wound on an axle. When a current passes through the coil, the magnetic field exerts a torque on the armature and causes it to rotate. If the current were steady, the armature

The commutator

The motor continues to spin with the -𝕆D kinetic torque, the commutator reverses its direction.

would oscillate back and forth around the equilibrium position until (assuming there's some friction or damping) it stopped with the plane of the coil perpendicular to the field. To keep the motor turning, a device called a *commutator* reverses the current direction in the coils every 180°. (Notice that the commutator is split, so the positive terminal of the battery sends current into whichever wire touches the right half of the commutator.) The current reversal prevents the armature from ever reaching an equilibrium position, so the magnetic torque keeps the motor spinning as long as there is a current.

FIGURE 29.49 A simple electric motor.



Orthogonal spins

In this model $\vec{\mu}$ would be the e𝕒 altitude here from the nucleus, the +𝕠d potential magnetic field spins around this. An electron has its e𝕪 kinetic vector which is also referred to as $\vec{\mu}$ in conventional physics. Because these are inverses, the opposing spins and torques balance to give a stable orbital. e𝕒 can be regarded as pointing upwards, then the +𝕠d potential magnetic field spins around it like the equator of a planet.

A kinetic rolling wheel

The electron has its $\vec{\mu}$ as the e𝕪 kinetic vector, that is orthogonal to e𝕒 pointing along and tangent to the orbital path. It can also be regarded as a kinetic rolling wheel, the -𝕠d kinetic magnetic field spins like the axle of the wheel and the e𝕪 kinetic spoke rotates around it. While this is not always pointing in the direction of motion, the rolling wheel moves along this path. Here also the e𝕪 kinetic vector remains orthogonal to e𝕒.

Chaotic and probable orbitals

In practice the interactions of the +𝕆D×e𝕒 potential work and -𝕆D×e𝕪 kinetic work are more complex, the electron can move more chaotically as well with a E𝕐/-𝕠d kinetic impulse at times. When its e𝕪 kinetic vector is at an angle to e𝕒, then there is different amount of constructive interference with the proton. That means the electron is measured as a cloud of probabilities, these cancel out with destructive interference to give the quantized orbital value.

Magnetic monopoles

In this model the electron does not have a north and south pole, its spin moves forward in -𝕠d kinetic time like the hands of a kinetic clock gauge. There is no way to differentiate a north from a south pole, here it is a monopole with a single spin direction forward in time.

A clock gauge as spin in time

From the other side of the clock gauge it can appear to turn counterclockwise, a clockwise and counterclockwise spin would be destructive interference as repulsion. For example a north pole is turning clockwise by convention from the magnet's reference frame, a second magnet's north pole appears to be counterclockwise from the same reference frame. As destructive interference the magnets are less likely to be measured close to each other and so they repel.

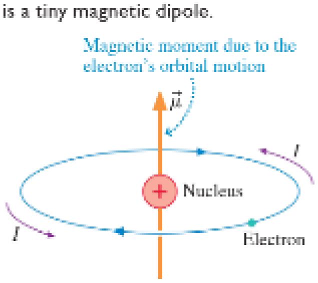
Electrons repelling each other

Two electrons when approaching each other have this same destructive interference, in this model that causes them to repel. They do not need north and south poles for this repulsion. If one electron has its spin flipped then it would attract the other like north to south poles. In this model they would form a boson pair.

29.10 Magnetic Properties of Matter

Our theory has focused mostly on the magnetic properties of currents, yet our everyday experience is mostly with permanent magnets. We have seen that current loops and solenoids have magnetic poles and exhibit behaviors like those of permanent magnets, but we still lack a specific connection between electromagnets and permanent magnets. The goal of this section is to complete our understanding by developing an atomic-level view of the magnetic properties of matter.

FIGURE 29.50 A classical orbiting electron is a tiny magnetic dipole.



Atomic Magnets

A plausible explanation for the magnetic properties of materials is the orbital motion of the atomic electrons. FIGURE 29.50 shows a simple, classical model of an atom in which a negative electron orbits a positive nucleus. In this picture of the atom, the electron's motion is that of a current loop! It is a microscopic current loop, to be sure, but a current loop nonetheless. Consequently, an orbiting electron acts as a tiny magnetic dipole, with a north pole and a south pole. You can think of the magnetic dipole as an atomic-size magnet.

Opposing electrons

This opposition of electrons is a boson pair, the e𝕪 kinetic vector would be in opposite directions to each other. That makes the -𝕠d kinetic magnetic field have a spin that is opposed, their -𝕆D kinetic torques now do constructive interference with each other. That makes them more likely to be measured close together as a boson. When they are regarded as having a e𝕪/-𝕠d kinetic velocity opposite each other, then the -𝕠d kinetic spin is also opposed.

However, the atoms of most elements contain many electrons. Unlike the solar system, where all of the planets orbit in the same direction, electron orbits are arranged to oppose each other: one electron moves counterclockwise for every electron that moves clockwise. Thus the magnetic moments of individual orbits tend to cancel each other and the *net* magnetic moment is either zero or very small.

The cancellation continues as the atoms are joined into molecules and the molecules into solids. When all is said and done, the net magnetic moment of any bulk matter due to the orbiting electrons is so small as to be negligible. There are various subtle magnetic effects that can be observed under laboratory conditions, but orbiting electrons cannot explain the very strong magnetic effects of a piece of iron.

Up and down is quantized

In this model e𝕪 as the kinetic vector can point in an up or down direction. These are opposite so vector subtraction between the two directions would be zero. The spins to be in opposing directions would be quantized in completely clockwise or counterclockwise, that makes the e𝕪 kinetic direction also completely opposed as up or down. The -𝕆D kinetic probability or torque is quantized and so cannot be a fractional angle, only 90°.

The electron spin

In this model the electron spins in -𝕠d kinetic time, its E𝕐/-𝕠d kinetic impulse is observed with its changes over time. With -𝕆D×e𝕪 kinetic work the spin becomes a torque as a probability of time. The spin does not occur in space, and so it does not appear to spin.

The Electron Spin

The key to understanding atomic magnetism was the 1922 discovery that electrons have an *inherent magnetic moment*. Perhaps this shouldn't be surprising. An electron has a *mass*, which allows it to interact with gravitational fields, and a *charge*, which allows it to interact with electric fields. There's no reason an electron shouldn't also interact with magnetic fields, and to do so it comes with a magnetic moment.

An electron's inherent magnetic moment, shown in **FIGURE 29.51**, is often called the electron *spin* because, in a classical picture, a spinning ball of charge would have a magnetic moment. This classical picture is not a realistic portrayal of how the electron really behaves, but its inherent magnetic moment makes it seem *as if* the electron were spinning. While it may not be spinning in a literal sense, an electron really is a microscopic magnet.

We must appeal to the results of quantum physics to find out what happens in an atom with many electrons. The spin magnetic moments, like the orbital magnetic moments, tend to oppose each other as the electrons are placed into their shells, causing the net magnetic moment of a *filled* shell to be zero. However, atoms containing an odd number of electrons must have at least one valence electron with an unpaired spin. These atoms have a net magnetic moment due to the electron's spin.

Electrons approaching each other

In the diagram the -𝕠d kinetic spin of the electron can be regarded as clockwise looking from the top here. If the e𝕪 kinetic vector pointed down it would appear to be counterclockwise. When electrons approach each other their e𝕪 kinetic vectors point towards each other as well. That comes from their e𝕪/-𝕠d kinetic velocities in opposing directions. With the spin around e𝕪 the same on each electron, each would measure the other's -𝕆D kinetic torque as opposite their own. That creates a destructive interference, they are then unlikely to be measured close to each other as repulsion.

Random magnetic moments

When the ey kinetic vectors point in random directions, then the -𝕆D×ey kinetic work and torque would cancel out with no net change of ey positions when measuring work. These are random because work comes from randomness and probability.

FIGURE 29.51 Magnetic moment of the electron.

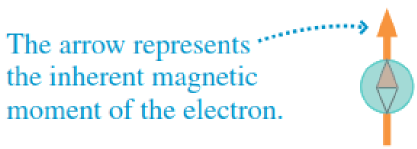
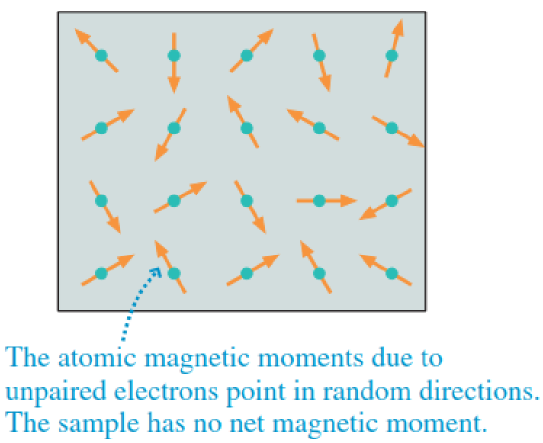


FIGURE 29.52 The random magnetic moments of the atoms in a typical solid.



Random electron motions

A solid can have its unpaired electrons pointing in random directions, also moving randomly in molecular bonds with other elements. A metal can have a sea of fermion unpaired electrons, these can so -𝕆D×ey kinetic work on many atoms as a random charge with no overall magnetism.

But atoms with magnetic moments don't necessarily form a solid with magnetic properties. For most elements, the magnetic moments of the atoms are randomly arranged when the atoms join together to form a solid. As **FIGURE 29.52** shows, this random arrangement produces a solid whose net magnetic moment is very close to zero. This agrees with our common experience that most materials are not magnetic.

Ferromagnetism

In this model each domain has a ey kinetic vector pointing in the same direction. When the iron is magnetized, all the domains are parallel to each other. The -ⓄD kinetic probability increases with a constructive interference.

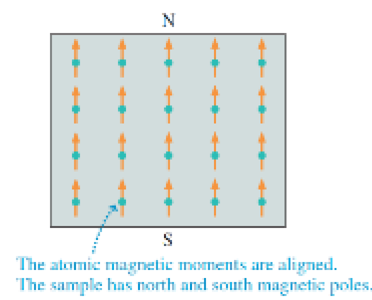
Ferromagnetism

It happens that in iron, and a few other substances, the spins interact with each other in such a way that atomic magnetic moments tend to all line up in the *same* direction, as shown in FIGURE 29.53. Materials that behave in this fashion are called **ferromagnetic,** with the prefix *ferro* meaning "iron-like."

In ferromagnetic materials, the individual magnetic moments add together to create a *macroscopic* magnetic dipole. The material has a north and a south magnetic pole, generates a magnetic field, and aligns parallel to an external magnetic field. In other words, it is a magnet!

Although iron is a magnetic material, a typical piece of iron is not a strong permanent magnet. You need not worry that a steel nail, which is mostly iron and is easily lifted with a magnet, will leap from your hands and pin itself against the hammer because of its own magnetism. It turns out, as shown in FIGURE 29.54 on the next page, that a piece of iron is divided into small regions, typically less than 100 μm in size, called **magnetic domains.** The magnetic moments of all the iron atoms within each domain are perfectly aligned, so each individual domain, like Figure 29.53, is a strong magnet.

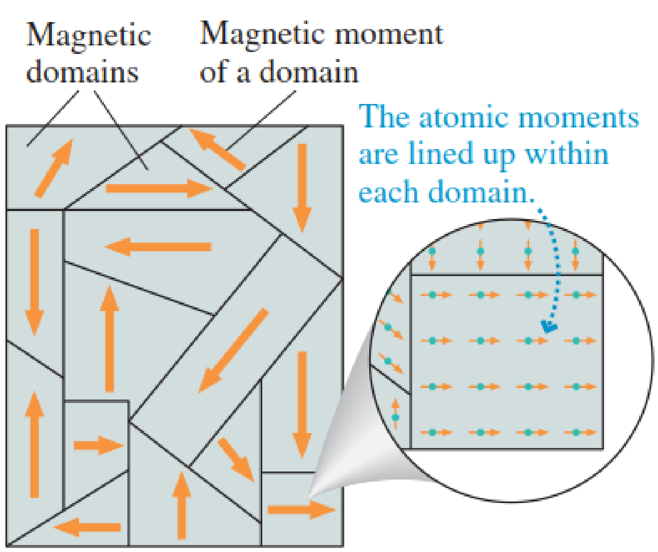
FIGURE 29.53 In a ferromagnetic material, the atomic magnetic moments are aligned.



Magnetic domains

Each domain tends to have the fermion electrons in their orbitals pointing in the same direction. Each electron does -ⓄD×ey kinetic work on their others, their -ⓄD kinetic torque tends to line them up in one direction.

FIGURE 29.54 Magnetic domains in a ferromagnetic material. The net magnetic dipole is nearly zero.



Induced magnetic dipoles

The bar or electromagnet does -𝕆D×e𝕪 kinetic work on the iron, that makes the domains turn in more of the same direction with the -𝕆D kinetic torque,

However, the various magnetic domains that form a larger solid, such as you might hold in your hand, are randomly arranged. Their magnetic dipoles largely cancel, much like the cancellation that occurs on the atomic scale for nonferromagnetic substances, so the solid as a whole has only a small magnetic moment. That is why the nail is not a strong permanent magnet.

Induced Magnetic Dipoles

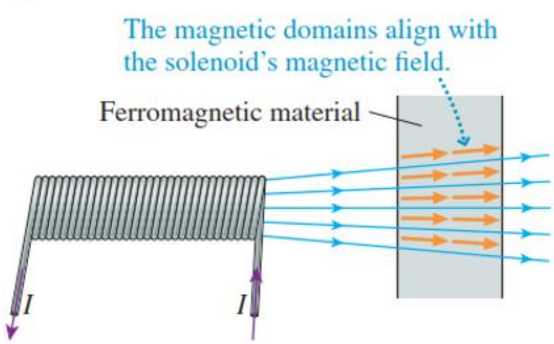
If a ferromagnetic substance is subjected to an *external* magnetic field, the external field exerts a torque on the magnetic dipole of each domain. The torque causes many of the domains to rotate and become aligned with the external field, just as a compass needle aligns with a magnetic field, although internal forces between the domains generally prevent the alignment from being perfect. In addition, atomic-level forces between the spins can cause the *domain boundaries* to move. Domains that are aligned along the external field become larger at the expense of domains that are opposed to the field. These changes in the size and orientation of the domains cause the material to develop a *net magnetic dipole* that is aligned with the external field. This magnetic dipole has been *induced* by the external field, so it is called an **induced magnetic dipole.**

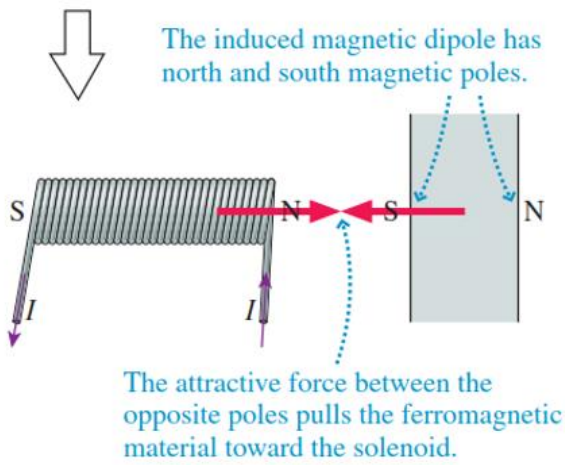
NOTE The induced magnetic dipole is analogous to the polarization forces and induced electric dipoles that you studied in Chapter 23.

Aligning the magnetic domains

In the diagram the -𝕆D kinetic torque of the electromagnet turns the magnetic domains in the iron. This is from constructive interference, then the iron has a like magnetic pole pointing to the electromagnet.

FIGURE 29.55 The magnetic field of the solenoid creates an induced magnetic dipole in the iron.





Constructive interference gives a magnetic attraction

Because the electrons in the iron are aligned with constructive interference, the iron is attracted to the electromagnet.

FIGURE 29.55 shows a ferromagnetic material near the end of a solenoid. The magnetic moments of the domains align with the solenoid's field, creating an induced magnetic dipole whose south pole faces the solenoid's north pole. Consequently, the magnetic force between the poles pulls the ferromagnetic object to the electromagnet.

The fact that a magnet attracts and picks up ferromagnetic objects was one of the basic observations about magnetism with which we started the chapter. Now we have an *explanation* of how it works, based on three ideas:

1. Electrons are microscopic magnets due to their spin.
2. A ferromagnetic material in which the spins are aligned is organized into magnetic domains.
3. The individual domains align with an external magnetic field to produce an induced magnetic dipole moment for the entire object.

The object's magnetic dipole may not return to zero when the external field is removed because some domains remain "frozen" in the alignment they had in the external field. Thus a ferromagnetic object that has been in an external field may be left with a net magnetic dipole moment after the field is removed. In other words, the object has become a **permanent magnet.** A permanent magnet is simply a ferromagnetic material in which a majority of the magnetic domains are aligned with each other to produce a net magnetic dipole moment.

Magnetism from domains

A magnet is formed by smaller domains all doing -𝕆D×e𝕪 kinetic work in the same direction, then with more aligned in this direction the magnet becomes stronger.

Whether or not a ferromagnetic material can be made into a permanent magnet depends on the internal crystalline structure of the material. *Steel* is an alloy of iron with other elements. An alloy of mostly iron with the right percentages of chromium and nickel produces *stainless steel,* which has virtually no magnetic properties at all because its particular crystalline structure is not conducive to the formation of domains. A very different steel alloy called Alnico V is made with 51% iron, 24% cobalt, 14% nickel, 8% aluminum, and 3% copper. It has extremely prominent magnetic properties and is used to make high-quality permanent magnets.

So we've come full circle. One of our initial observations about magnetism was that a permanent magnet can exert forces on some materials but not others. The *theory* of magnetism that we then proceeded to develop was about the interactions between moving charges. What moving charges had to do with permanent magnets was not obvious. But finally, by considering magnetic effects at the atomic level, we found that properties of permanent magnets and magnetic materials can be traced to the interactions of vast numbers of electron spins.