VACUUM EFFECTS

OF

GRAVITATIONAL

AND

ELECTROMAGNETIC

ATTRACTION

Bob Ticer

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PREFACE

I came up with an idea of how to explain gravity. To compare my idea with other theory I enrolled in a class at the University of Oregon to learn Einstein's theory of Special Relativity. I challenged it only to discover it is internally consistent. Shortly thereafter, however, I did not find General Relativity to be consistent with Special Relativity.

The inconsistency pertains to special relativity being a unification of mechanics with electrodynamics and Einstein's failure to include gravity as part of its unification. Constant light speed by special relativity is a limiting condition for matter to neither exceed nor even reach. To the contrary, a present interpretation of general relativity is that it includes black holes along with a singularity as the origin of our universe as finite and expanding. Even though Stephen Hawking redefined the black hole for it to emit Hawking radiation in order for it to be consistent with the thermodynamic principle of entropy and conservation of energy, the assumption of black holes and the singularity are generally accepted by the physics establishment.

Einstein assumed the universe is finite and static, but his equations did not comply as static according to Alexander Friedmann. Moreover, with the discovery of the redshift in more distant starlight, a cosmological principle was proposed for an expanding universe theory. An alternate interpretation of the redshift was also proposed as Tired Light theory, but it was discarded in favor of Big Bang in view of a Tolman Brightness Test. Because it takes light time to reach the observer, receding stars should appear closer than where they actually are. However, the most distant seeable stars appear as though they are now where they were when they emitted their light. Big Bang advocates now claim expansion of the universe has increased, as possibly caused by "dark-energy".

Other explanation is here given whereby Tired Light along with the Hubble Constant, as the rate of expansion, provides a long-range gravitational effect. The Hubble Constant at a distance equal to the diameter of the hydrogen atom interprets as a change in speed that per light speed equals the ratio of gravitational to electrostatic force of the hydrogen atom. There is by it a recycling process for maintaining the atomic structure of matter.

This explanation is different from Big Bang as now established, but Big Bang is not here discarded. If theory is proven, then it is fact instead of theory. As Hawking changed his mind in the 1990s in admitting there is viable evidence supporting the existence of black holes, I have similarly changed my mind about them and the singularity. I now propose complementing theory with other theory, such as combining Tired Light with Big Bang along with other theories that have or have not been dismissed.

As to how they can combine, it is because their observable effects are opposite and nullifying wherefrom the lost energy of Tired Light can be the dark energy now required of Big Bang.

Challenging theory is not merely to disprove it; it can also be a means of understanding it. Other means of understanding can result as a simplification of complex ideas, which are a mixture of simple ones, and by a step by step understanding of the historical development of theory.

Although the history of physics provides a means of understanding it as a step by step process, it generally contains a mathematical language that is too foreign for some of us to understand. There is a multitude of languages consisting of different units of measurement. They contain newtons, farads, amperes, coulombs, ergs and so forth. There are even systems of dimensionless units, such as plank units. Such language could be foreign to many of us. I have used more common language in this book. Units of centimeters, seconds and grams are used along with simple algebra.

Algebra is numerical math simplified. I believe it should be taught early in school along with arithmetic. Its simplicity is about such symbols as letters of the alphabet substituted for numbers. For instance, in place of adding numbers, say 156 and 44, in the manner 56 + 44 = 200, chosen letters are substituted in the manner A + B = C. Instead of multiplying such numbers as 3 and 4 in the manner 3 x 4 = 12, symbols are presented in the manner AB = C. And 3 x 3 x 3 = 3^3 = 27 can be represented as say C^3.

There is also a convenience of symbolic algebra for solving unknowns. For instance, if 5A + 4B = 6C and 5A – 4B = 2C, then the simple steps of addition, subtraction, multiplication, division and substitution are a means of obtaining numerical results. Adding the two equations obtains

$$\begin{array}{c} 5A + 4B = 6C \\ \underline{5A - 4B = 2C} \\ 10A + 0 = 8C \end{array}$$

Hence

$$10A = 8C$$

Dividing 10 by 8 and reversing order obtains

$$C = 1.25A$$

Substituting the value of C in the original equation obtains

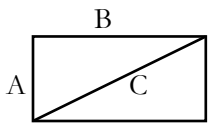
$$5A + 4B = 6C = 7.5A$$

$$4B = 7.5A - 5A = 2.5A$$

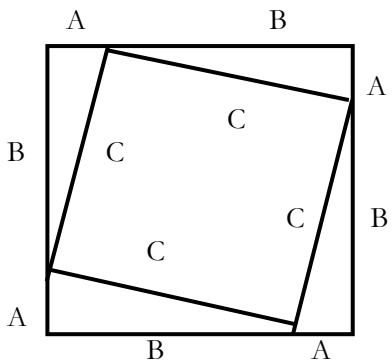
$$B = 0.625A$$

All numerical values are thus obtainable by obtaining a numerical value of either A, B or C.

Algebra interrelates with geometry for another way of understanding reality. Consider, for instance, the Pythagorean Theorem whereby the length of the hypotenuse of a right triangle equals the square root of each perpendicular length squared and then added in the manner $C^2 = A^2 + B^2$. To further illustrate, consider a larger square $(A + B)^2$ whereby its side lengths A plus B are four extensions of the lengths of perpendicular sides of four equal right triangles that, along with a square of the length C of the hypotenuse, are within the larger square. The geometry is illustrated in the manner of the area of a right triangle being one-half that of a rectangle.



$$AB = 2(AB/2)$$



As illustrated above, the side lengths C of the smaller square are the hypotenuses of the right triangles within the larger square of side lengths A + B whereby each corner of the inner square divides each side length of the outer square as lengths A plus B. The geometry is such that outside the smaller square are four right triangles of side lengths A and B

and a hypotenuse of length C, such that the total area is C^2 plus four one-half areas AB equate in the manner

$$(A + B)^2 - 4\left(\frac{1}{2}AB\right) = C^2$$

$$A^2 + 2AB + B^2 - 2AB = C^2$$

$$A^2 + B^2 = C^2$$

As illustrated, the hypotenuse C squared is viewable as part of a square of a rectangle of four equal sides. If the sides of the rectangle AB are extended to be A + B, then it becomes a square containing the square C^2 within it.

A particular significance of the Pythagorean Theorem is that it provides a mathematical condition of invariance. There are a number of values the perpendicular sides A and B can have as long as there values of their lengths squared added together equal the length squared of the hypotenuse. It then allows another way of measuring a distance blocked by some type of barrier.

Note: Simple steps of addition, subtraction, multiplication and substitution are here implied, as left for the reader to apply. However, the math is merely for verification instead of understanding of theory. It can be skipped over in this book.

1
INTRODUCTION

Rene Descartes philosophized, "I think, therefore I am. If I am deceived of my existence, then I must at least be the deceiver." He therefore confirmed his existence by way of his own awareness of himself.

Am I alone?

Resistance to thought and action is testimony to an extended existence of an objective world in which we live. I am not alone. We therefore exist.

I witness existence but do not seem to know how either it or a state of consciousness is possible. I merely assume we are parts of creation, as from either a supreme being or what merely exist.

Can there be existence without our awareness of it? No matter. Never mind. The mind-matter duality is of no concern, as this book is about the physical world inasmuch as material existence is comprised of a substance of some sort that varies in shape, size, density and so forth. Philosophers in this regard have attempted to explain everything existing in the world as part of a primary substance that became referred to as æther.

Suppose all physical reality is indeed comprised of æther. What, then, are its properties? How does it, for instance, separate from and recombine with itself in creating effects of reality? A substance being primary implies it has no internal mechanism to bond with other primary substance except for it interacting with its other parts. If such interaction is relative motion, then the action must somehow be elastic to maintain itself, as action between itself would otherwise result in a loss of relative motion.

Another likely condition for primary substance is that it needs to be of infinite content, even if only to partially fill infinite space instead of all of it, as for it to change direction by means of elastic collision instead of spreading apart without a means to reverse direction to again interact with itself. The question then comes to mind as to whether space is a plenum of æther or a partial vacuum and æther.

Descartes and other philosophers assumed space consists of a plenum. How, then, do various densities of matter exist if æther is everywhere identical in composition?

A plenum does not even have wiggle room for wave action to occur in the manner sound waves are compressed states of air molecules. The æther as a plenum is thus contrary to the air medium for sound.

It is no wonder that early Greeks deep in thought regarded our world as illusionary. As for the plenum, they considered only circular motion in it is possible. The sensation of free motion in various directions is allowed by the complexity of circular paths for our witness of effects.

Descartes also assumed all motion is circular as a complex system of vortices of diverse sizes and rotational speeds, and he further assumed total motion is conserved, as allowed by an exchange of motion between various actions of æther. As for the complexity of motion, endless possibilities exist by means of vortices moving inside other vortices for various relationships. A number of like vortices in one region of space can thus be relatively more or less dense than other vortices in another region of space. Our perception of the world thus comes about as an exchange of motion between vortices even though primary substance remains everywhere in space the same.

The source of all creation is thus already created out of what already exists ad infinitum. However, whatever existence we are aware of could be only part of many realities. Other parts of existence could, in effect, be invisible to us.

The æther is not presently accepted as scientific, as for being invisible if it does exist, but modern quantum mechanics is somewhat similar to it. In place of the æther there is vacuum space that is not empty, as consisting of a virtual field of virtual particles detectable according to probability, as to be mathematically predictable and thus indirectly confirmable by observation. However, indirect perception of the atomic world is different from that of the natural world of direct observation. The main difference is with regard to change. Change from Interaction within the atomic world is of discrete units of energy whereas change of particle interaction by either relative motion or gravity appears to be of a continuous nature.

Theory proven is fact instead of theory, but testing theory is a means of discovering truth, as by experiment. Alternative ideas can be helpful in this regard whether true or false.

This book does not prove any particular theory false. It unites them. For one example, it provides explanation of relative motion and gravitational effects consistent with quantum effects. Another example is it combines Big Bang theory with Tired Light theory. By the latter, gravity

is explained as a long-range vacuum effect whereby Tired Light recycles back to maintain the atomic structure of matter at a rate equal to the Hubble Constant. The ratio of the average density of mass in the universe per nuclear density of the hydrogen atom and the value of the Hubble Constant at a distance equal to the nuclear diameter of the hydrogen atom per light speed both equal the ratio of gravitational to electromagnetic force between the electron and proton.

As to how Tired Light and Big Bang can unite, they could combine as a nullifying effect, which could also be a possible explanation of how it is that dark energy exists. The dark energy could be the reduced energy of tired light due to a slight frictional resistance of the space through which light propagates.

Such explanations are a step by step process in view of the historical development of theory for there to be no contradiction of quantum mechanics and relativity theory. Regarding Big Bang theory, for instance, Einstein had proposed a Cosmological Constant as a force countering gravity for our universe to be both finite and static, as not to collapse by the force of gravity. However, a Hubble Constant of reduced starlight energy indicated either an expanding universe or one of tiring light. The Cosmological Constant was not originally included with Big Bang theory, but it is now reconsidered to explain how it is that the rate of expansion appears to have increased according to Big Bang. The frictional force of Tired Light as the expansion force is also consistent with the Cosmological Constant.

In the following chapter, Æther and Laws of Motion, the early history of Aristotelian physics led a step by step process to the discovery of laws of nature. Light, according to the early physics, provided earthly substance with the energy needed to maintain motion. In response, an impetus theory evolved whereby matter maintains an innate ability to sustain motion until impeded by some obstacle as other matter. It was one step to developing theory to be followed by such others philosophers as Copernicus, Kepler and so on.

In the next chapter, Newtonian Mechanics, it is explained according to Kepler's laws of planetary motion and Galilean relative motion, but not as a complete theory by itself. Newton, himself, was dissatisfied that he was only able to explain gravity according to an action at a distance principle. He also assumed ideal conditions of absolute space and absolute time that were later modified by Einstein. His mechanics also lacked a definition of energy that was later theorized according to the laws of thermodynamics. Nonetheless, even though Newtonian Mechanics was to be modified by Einstein for it to comply with the relativity of spacetime, it is still an integral part of theory as needed for a more complete understanding of it.

In the next chapter, Kinematics Atoms and Electrodynamics, they are explained in the historical context of Boyle's Law discovered with the aid of several inventions that led to explaining heat and temperature in view of the kinematics of relative motion, which eventually led to atomic theory and the laws of thermodynamics. The second law is known as entropy. It is significant in describing a dormant and potential energy source whereby it was later used to verify the Fourth Power Law of Black Body radiation, and to become part of the development of quantum theory.

The next chapter, From Wave Theory to Relativity, is about a wave theory of light in contradistinction to the partial vacuum of space. The theory developed around 1900 to explain such properties as diffraction, but its requirement of light waves being transverse waves required explanation itself as to how transverse waves can exist in a three-dimensional medium in contrast to surface waves or waves along a rope. A solution was provided by Maxwell's electromagnetic theory, as light waves being a continuation of magnetic fields induced by electric currents in free space. The speed of light was included in the theory as a constant. Constant speed through the æther was assumed, but the state of the æther remained questionable as whether it was dragged along with mass or was an absolute state not influenced by the presence of mass. Experiment indicated that light speed measures the same regardless of the relative motion of the system by which it is measured. An explanation was given by Lorentz whereby contraction of material length in the direction of relative motion and clocks being slowed by their motion in the æther contributed to the measure of light speed as constant. However, Lorentz did not conclude a variable æther state is undeterminable. He left that conclusion to Einstein.

In the next chapter, Simple Spacetime Relativity, the relativity of space, time and motion is shown to be internally consistent according to the postulates of covariance and constant light speed. Consistency of theory includes the principle of simultaneity, the addition of velocities theorem, the clock paradox, and constant speed change.

In the next chapter, Mass-Energy Dynamics, special relativity is shown consistent with such conservation laws of momentum and energy. The only questionable issue is about perception of the universe at large regarding a change in velocity of the observer. Although conservation laws apply to any systems interacting with each other, they do not apply with regard to how non-interacting systems are perceived anew from a changed state of the observer. For slower clocks and shorter rods, the universe at large could appear relatively larger, more massive and energetic unless perception of the observable part of the universe is relative as well, as is proposed as another alternate explanation.

The next chapter, The Relativity of Gravity, is more complex. Einstein attempted to generalize the principle of covariance to include gravity, but it is complicated by the acceleration aspect of gravity, such that gravity is described according to spacetime curvature due to the presence of mass. An energy-momentum tensor is used to describe spacetime curvature, but there are nonetheless conditions of relativistic effects of general relativity that are analogous to those of special relativity. Relativistic effects relating to gravity compare with those of relative motion as acceleration, whereas homogeneous conditions of gravity, such as distance and time increments, are analogous to inertial motion.

In the next chapter, Quantum Origins, a Planck Constant is explained in the historical context of theorizing the natures of heat and light. Included is the Stefan-Boltzmann fourth power law that further relates to the nature of the atom. Thermodynamic laws apply, particularly that of entropy regarding how temperature varies with force, as with further regard to Boyle's Law. Further experiment and development of theory led to the quantum condition first proposed by Plank.

The next chapter, Particle and Wave Quantum Physics, summarizes how quantum physics developed from particle and wave interpretation of theory. Henrik David Bohr provided the particle theory. Wave Mechanics was developed by Erwin Schrodinger. The waves became reinterpreted as probability conditions of particle effects.

As explained in the next chapter, Renormalizing Quantum Physics, more infinity problems of theory are revisited. Renormalization became the solution, as to dismiss the infinity part of the equation and only retain how a particle is normally perceived empirically according to experiment. The strong nuclear force and the weak force of electromagnetism became united.

A summary of Harold Aspden's theory is given in the next chapter: Æther Cosmology. It is a further development of æther theory unifying gravity with the atomic structure of matter.

The next chapter, The Relativity of Hubble Cosmology, is an analysis of Big Bang and Tired Light theories. Explanations are given as to how light energy received from longer distance appears to be weaker according to the Hubble Constant. According to Big Bang, the universe is expanding for light sources at longer distance to be receding at a faster rate. According to Tired Light, part of light energy is absorbed by the medium of space through which light propagates.

The final chapter, Gravity Cause Explained, does provide an explanation of the cause of gravity consistent with electromagnetism and the atomic structure. Matter is explained as wave-packets of light energy. The light as wave action superimposes on other light energy and wave pack-

ets to the extent it can occupy the same space that particles cannot, and to be invisible to the extent that relative motion and gravity occur.

Gravitational and electromagnetic attractions are explained in similar manner. They and quantum physics are united according to a ratio of the Hubble Constant to the Compton Frequency of the electron in the hydrogen atom. The Hubble Constant is a change in frequency per distance of light source from observation. The Compton Frequency relates to the Planck Constant and the internal energy of the electron. Their ratio appears to be a significant factor for the formulation of a unified field theory.

A unified field theory is not here proposed. There have been many proposals of it without general recognition of acceptance. The reason for such lack of recognition appears to be vagueness of the concept of field theory itself. The laws of motion, for instance, are well established as a particular action between two or more particles, but a field of such action is more complex because of it entailing average results of more complex entanglements. If the field theory is unable to predict certain entanglements, then it fails the test.

As previously stated, this book does not disprove established theories. It combines them instead. However, instead of proposing a unified field theory, the aim is only to maintain consistency of interpretation. Constant light speed of special relativity, for instance, is consistent with the parameters of the Planck constant in that a relativistic decreased of particle length in the direction of relative motion along with a relativistic increase in mass correlates with the constancy of the multiplication of parameters mass, velocity and radius of the Planck Constant whereby the Plank velocity is itself a constant in proportion to light speed.

Throughout the historical development of theory there has been a debate as to whether the underlying action of our physical world is primary of particles or waves. The primary difference itself is that waves can superimpose to occupy the same space whereas particles cannot. Einstein explained the emission of electrons of a metal according to frequency of light instead of its intensity, as by photons being of a particle-like action, but frequency is also a wave property. In general, waves can explain particle effects, but particles are not able to explain all wave effects. For instance, it cannot be explained how a single particle can result in an interference pattern if two holes are present instead of only one.

A graviton as a particle of gravity is also difficult to explain. How is it possible for a particle to reverse direction and momentum of another particle and continue with the same negative momentum of attraction? Newton, himself, was dissatisfied of not being able to explain gravity as an action at a distance principle. Einstein reverted to explaining gravity as the presence of mass resulting in space-time curvature, but he did not

explain how the presence of mass itself exists. To the contrary, both gravity and the presence of mass are more consistently explainable according to wave theory. Waves themselves can either have momentum or be invisible. According to the latter, they are undetectable in a state of equilibrium whereby they completely superimpose on each other for no change in momentum. By a contrary condition of interference they produce observable changes in effect in analogy to particle interaction. As to how relative motion occurs as material effects, it is analogous to a drift velocity within an electromagnetic field. As to how gravity and electromagnetic attraction both occur, it is according to different vacuum effects regarding frequency of a recycling process. Instead of gravitons being continually created to escape to infinite distance, they are gradually absorbed by the space medium in analogy to tired light for their energies to partially maintain the atomic structure and the vacuum effect from the emission of gravitons along with electromagnetic waves of light energy. The electromagnetic attraction is similar to gravity but much more energetic because of the annihilation and recreation of positive and negative fields of interaction being more frequent.

2
ÆTHER AND LAWS OF MOTION

Circular motion was conceived in ancient times as divine, as evident of stars orbiting in the heavenly sky above earthly chaos. Earthly substance was considered the center of the universe below heavenly stars.

As to explain the primary source of motion itself, Aristotle (384-322 BC) proposed an Unmoved Mover is its provider. What evolved from this proposal was a theory of emanation. Later, for instance, Robert Grosseteste (1168-1253) and Saint Bonaventure (1217-1274) proposed God first created lux, a corporeal form of substance that duplicates itself indefinitely. Motion consists as the duplication of form moving as energy waves in all directions. Lux constitutes the material form of substance by reflecting lumen, which is light. Light is also how God mediates between souls and bodies. As nature takes its course, it is not alienated from God, as He intervenes by emanating light from within.

Light, as according to Aristotelian physics, is thus the essential source of motion, as is distinguished from earthly substance having no inclination whatsoever to move without assistance. This theory was challenged by John Philoponus (about 490-570 AD) in asserting material substance is inclined to remain in motion without assistance. This idea identifies with inertia whereby a state of non-acceleration, as mass in relative motion or at rest, maintains unless it is changed by means of an external force, such as gravity or the collision from other mass in relative motion. However, even though it was an insightful idea for advancing theory, it was instead rejected by theologians with more influence in favor of the Aristotelian doctrine.

Light, in modern physics, is still an essential part of mass. The internal energy of mass is $E = mc^2$. The difference of it from Aristotelian physics is the inert aspect of mass allows relative motion to continue, but light is still an internal source of change, and there is further distinction of matter and light to consider. Matter varies in speed from interacting with light or other matter whereas light only varies in speed if moving through material media, such as water or air, or in a gravitational field. If matter changes speed by its interaction with light, both momentum and

energy are conserved according to either classical mechanics or relativity theory.

Impetus and Inertia

A modification of Aristotelian physics did not fall on deaf ears outside of Europe. As during the golden age of Muslim academic culture in Persia, Avicenna (980–1037) concluded motion is an inclination transferred from the thrower that does not cease if it occurs within a vacuum. He obviously realized a decrease in motion requires a resistance to it, such as the presence of air. This reiteration of the Philoponus position identifies with a modern concept of inertia and momentum in view of empty space, but the plenum was still embedded in general thought. Philoponus and Avicenna, for instance, both conceded that the power of motion given to an object to move through a medium would eventually be used up. Does, then, the light moving through the gravitational fields of the universe surrender its energy to them? It is assumed in this book that it does, as tired light.

Saint Thomas Aquinas (1223-1274) and Francis de Marchia (b. around 1285-d. after 1344) also accepted the idea of motion of matter maintaining until it is impeded by the presence of another object, or by gravity, but the idea of matter having innate ability to propel itself forward indefinitely with no additional assistance was proposed by Jean Buridan (1295-1358).

Buridan proposed that motion given to an object from another object is sustained by the object until passed onto another object. He named this inherent property of motion impetus. He did not identify impetus with the energy of light, but he did offer a biblical justification for it in interpreting Genesis as stating God rested on the Sabbath after He created the world in six days. Because God rests, He allows His creation to sustain motion such that no longer is there any need for Him to replenish it.

Impetus theory is identical to the modern concept of relative motion except that Buridan referred to rest as distinct from motion, as to allow for an underlying medium such as the æther for a state of absolute rest, as for it to be distinguishable from the relative motion of all matter moving through it. His theory remains consistent with the modern mechanical interpretation of motion insofar as Buridan even stated impetus is proportional to weight times speed. A heavier object or a faster one thus has more impetus, which compares with more momentum in view of modern terminology. Since gravity provides impetus to increase motion towards earthly mass, and earthly mass gives up impetus to escape from earthly mass, a cannonball falling through a hole through Earth is increased in impetus on the way down to the center of Earth the same as

the cannonball gives up impetus to move up an equal distance to the surface at the other end. Such analysis later exemplified such periodic motion as the free swing of a pendulum, and of oscillatory motion in general. The latter was to be theoretically developed in the seventeenth century, but the concept of impetus was interpreted differently by other thinkers in the fourteenth century.

Nicole Oresme (1320-1382) maintained impetus is the temporal quality used up in motion by the inertness of earthly substance tending toward its natural place of rest, the Earth, as Aristotle had contended, and as evident of objects losing motion by falling to the ground. He further distinguished between an impetus given to the motion of the heavenly stars and impetus given to the violent and accidental motion of earthly events. However, he argued, contrary to Aristotle, that it cannot cause an object to accelerate to an infinite speed even in the vacuum of space because the impetus is spent during motion, which would be correct if impetus were to be identified as acceleration.

Oresme further considered Archimedes' principle of the lever whereby the position of a heavier object is placed nearer to the fulcrum for balance. In interpreting this principle as applying to the cosmos, Oresme referred to the Aristotelian idea that earthly substance tends toward the center of the world where Earth rests. However, the moon, sun and other celestial bodies moving about indicated to Oresme the center of gravity could shift. It thus is possible Earth can slightly shift in position as well. He further reasoned, however, that Earth's movement is not proven one way or the other. He further proposed the criteria two equal hypotheses should be the merit of simplicity, as Copernicus later advocated, but Oresme accepted a stationary earth in support of the common interpretation of the Bible at the time.

The Copernican Revolution

While impetus theory developed at Paris, France, more eloquent ways of describing nature developed at Merton College in Oxford, England. Such scholars as John Dumbleton, Richard Swinehead and Thomas Bradwardine proposed an abstract system of degrees and latitudes for analyzing qualities of nature, such as hot and cold, and various forms of motion according to quantity.

The intent of these Oxford scholars was for providing a mathematical description of processes rather than to claim their abstract calculations were actual laws of nature. They nonetheless provided the quantitative means for mathematically analyzing results of experiment in arriving at such concepts as constant acceleration and instantaneous velocity. This is particularly true with Domingo DeSoto (1494-1460) applying the calculating technique of the impetus theories developed at Paris to refine

the earlier calculations of Oresme for uniform acceleration of falling objects due to constant increase in impetus.

After this development, Nicholas Copernicus (1473-1543) proposed a heliocentric scheme wherefrom the planets, including Earth, revolve around the sun. His scheme was rejected by authoritative rule, but it was later to be advanced by Johannes Kepler (1571-1630).

Aristarchus of Samos (b. around 310 BC–d. about 230 BC) advocated a heliocentric system of planets, including Earth, revolving around the sun. However, his scheme was overcome by the greater influence of Aristotle, who did not recognize the relatively great distance of stars whereby there is a condition of parallax.

Parallax is the apparent change in position of an object caused by the observer moving here and there. The positional change appears greater for closer objects. Nearby scenery, for instance, changes rapidly for passengers looking out the window while inside a moving automobile, whereas a more gradual change in relative position occurs of more distant mountains. The change in the relative position of the sun appears not to change except for Earth rotating for day and night to occur. Earth revolves around the sun, as well, for a change of seasons. Such slight change can either be interpreted as parallax of Earth's motion or the sun's motion. Description of the latter is sometimes more complicated. A complex system of epicycles, for instance, was used for describing circular paths of planets and sun revolving around Earth.

Copernicus did not consider parallax. Apart from it, observations of astronomers provided more and more data on the relatively closer positions of planets in our own solar system, such that the scheme of circles within circles for planets moving around Earth was more complicated. Copernicus thus proposed the much simpler scheme of Earth circling the sun. He also asserted no internal effects of Earth moving through space are detectable since all relative parts move uniformly, which implies a principle of relative motion.

Publication of Copernicus's book *De Revolutionbus* occurred the same year of his death, but the book was outlawed along with later works by any of its defenders, including Galileo. Giordino Bruno (1548-1600) advocated, for instance, an entire world full of solar systems, and he further speculated stars move relative to each other, but that they are too distant from us for detection of their relative motion. However, he was burned at the stake for his outspokenness, whereas Galileo was merely sentenced to confinement for his defiance of the order.

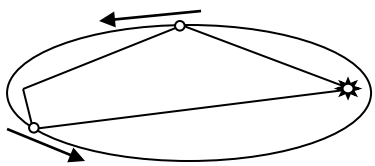
Copernicus had nonetheless set forth a revolution in thought. Readers in Italy and elsewhere accepted *De Revolutionbus*. Simon Steven (1548-1620) of the Netherlands supported the heliocentric system with his book *De Hemelop* published as early as 1608. However, the Copernican

system was not faultless, as celestial data compiled by astronomers indicated planetary motion was not of true circles. As Copernicus revered the circle as a divine principle, his scheme included thirty-four epicycles. This weakened his argument of simplicity. A Copernican revolution had nonetheless begun. Ironically, Johannes Kepler, a so-called mystic who claimed to listen with a sensitive ear to the musical harmony of planets in motion, including Earth, was to defend it.

Kepler's Celestial Scheme

Kepler (1571-1630) was proficient in mathematics. Such skill enabled him to become an assistant to Tycho Brahe's (1546-1601) in plotting data of celestial movement. Brahe had rejected the heliocentric system in favor of the stationary Earth mainly because he could not detect parallax of the stars. He regarded Earth material as an inert condition of nature. However, he did accept a heliocentric system as applying for all the planets other than Earth revolving around the sun. As he maintained the sun and moon only revolve about Earth, it would only be another step to include Earth as also revolving around the sun.

Kepler studied the data compiled by Brahe and in 1609 proposed three empirical laws to describe it: 1. Planets move in elliptical paths. 2. An equal area in equal time is swept between the sun and a planet. 3. Orbital periods squared in ratio to the cube of the planet's average distance from the sun are the same for every planet.



In view of the first law, an ellipse differs from a circle in that it has two foci in place of a center. A property of an ellipse is a total distance between any two straight lines connecting the two foci to anywhere on the perimeter of the ellipse is always the same. As illustrated above, consider a pencil maintains a taut string between two locations for drawing an ellipse. The length between the two loci determines the eccentricity of the ellipse. The total length of the two upper lines in the above illustration also equals the total length of the two lower lines, and the average of length between either of the two respective lines is also the same as the radius of a circle. If two foci separate from the center to the edge of the circle, for instance, the circle itself becomes its diameter. A semi-major axis of the ellipse, as the average length of two foci lines, thus equals the radius of the otherwise circle.

The second law refers to the distance between the sun and a planet sweeping the same area per time. The focus position of the sun is more massive than focus positions of planets for the planets to orbit around the sun. The second law states the area swept per time between the sun and planet by the planet is the product of the distance of the planet from the sun and the speed of the planet at its distance from the sun. The planets thus move faster when closer to the sun for them to maintain the same amount of area per time.

Note: An ellipse with both its two foci in the center is a circle. In any case, the average length of the two foci equals the radius of a circle, and orbital speed of a circle is the average orbital speed of the ellipse. Because twice as much radius has four times more area for a perimeter of twice distance, a twice speed increase at half radius takes one-fourth as long to sweep four times more area, being the same area swept per time.

The ellipses are not the same for each planet, but Kepler determined a common property as his third law. By it, a planet's orbital-period-squared in ratio to the cube of the planet's semi-major-axis as its average distance from the sun is the same for all planets. For simplicity of calculation, consider an Earth's orbital period to be one year. If its average distance from the sun is also determined as one unit, chosen as such, its orbital-period-squared in ratio to its semi-major-axis-cubed is one-numerical-unit, which allows for a simpler means of comparing the ratios of the other planets with Earth's.

The average orbital distance is that of the semi-major-axis. The orbital period is orbital distance per orbital speed. Both distance and speed of orbit determine the orbital period. A planet with a semi-major-axis that is twice that of Earth's has twice the orbital distance while moving at a slower rate. If slower by the square root of 2, its orbital period is 2 (as according to the longer distance) multiplied by the square root of 2 (according to the slower speed). A period squared is the square of 2 multiplied by the square of the square root of 2: $(2\sqrt{2})^2 = 8$. The twice more distance of a semi-major-axis cubed calculates as $2^3 = 8$, and 8 divided by 8 is also unity, the same ratio of Earth's period squared, and semi-major-axis cubed as unity.

It is possible Kepler could have had insight of the laws of nature, but they were developed in a progressive manner by other legends of history as Galileo and Newton. According to Newton's inverse square law of gravity, for instance, the average orbital speed v relates average orbital distance r as centripetal acceleration: v^2/r. Orbital speed around the same mass at twice distance decreases by the square root of ½, such that its period per distance increases by the square-root of 2. Twice orbital-period-squared multiplied by twice an orbital distance is similarly 8 times greater, as is twice the orbital-radius-cubed. Newton's inverse

square law thus equates the same as does Kepler's third law and explains the square root condition of speed.

Terrestrial Mechanics

Physics refers to the laws of motion as mechanics. Complementing the celestial mechanics of the planets is terrestrial mechanics. Its development also connects with gravity, as with determining the nature of bodies falling to Earth.

An experiment on gravity was done in the third century BC by Strato in determining sounds of falling bodies hitting the ground differ at different heights of fall. He thus surmised an increase in speed occurs during fall due to the louder sound of impact of an object's fall from a greater height.

An experiment in the thirteenth century was an attempt by Jordanus de Nemore (1225-1260) to distinguish weights of objects according to their angles of decent while they slide along planes. His theory of positional gravity and component forces considered work as in relation to the position of a level apart from where it balances in a state of equilibrium.

Leonardo da Vinci (1452-1519), whose work did not all survive except for his notes, attempted to determine if the gravitational fall of an object is directly towards the center of Earth. He dropped two heavy objects from a tower in a failed attempt to find a decreased distance of separation.

Da Vinci failed to determine the direction of fall because the change in distance is too minute to detect with the instruments he had available, but he discovered instead a pyramidal increased speed of fall in equal intervals of time in analogy to counting stairs. However, from his notes, which might not necessarily reflect what he actually concluded, he incorrectly stated the distance of fall is proportional to time instead of time-squared.

Oresme, Galileo and others correctly determined the distance of fall is proportional to its time squared, but da Vinci might have only erred in his taking notes of his findings. To his credit, da Vinci seems to have been wise to the ways of nature. For instance, in anticipation of Newton's third law of motion, whereby force and the resistance to force are mutually the same, he suggested air and water counteract with the same amount of force.

Demonstratio, published in 1552 by Giovani Battista Benedetti (1530-1590), was a book that attempted to determine the nature of falling bodies analytically. Benedetti first assumed bodies of different weight fall at the same rate if they are equal in density, as composed of the same material. His proposal was contrary to Aristotle's doctrine that a heavier body falls faster than does a lighter one, but in a revised edition published in

1554 he changed his position to that of bodies of the same material but of different size do not fall at the same rate.

Perhaps critics influenced Benedetti to change his position, or perhaps geometrical considerations were apparent. If an object divides into two or more parts, for instance, more inside becomes part of the outside, which is also more exposed to atmospheric conditions. Since only the surface area changes instead of total volume of all its parts, this means the mathematical ratio of volume to its surface area is relatively according to its size. Smaller objects thus encounter more friction per surface area to volume or weight, which causes them to move more slowly through the atmosphere.

All bodies of mass falling at the same rate could indicate empty space apart from the atmosphere. However, there could still be a medium of space with which mass adjusts for it to move freely through. It would be similar to how an impulse of momentum moves a solid material as wave action. However, as it were, for supposedly not knowing the true nature of mass, Galileo Galilei (1564-1642) theorized instead that all bodies regardless of their size, weight or material they are comprised of fall, in vacuum, at the same rate.

Note: Magnetic permissibility and electric permittivity are measurable effects in relation to space free of mass whereby light speed is according to conditions of permittivity and permissibility.

The abstract analysis of motion at Merton College likely guided Galileo rather than the works of Benedetti. In any case, the hypothesis Galileo put forth provided a means of testing whether the laws of motion typify objects as moving through empty space, as would seem necessary for the planets in the Copernican system to move unopposed by a medium. Galileo therefore experimented with objects moving along planes and took notice of the free swing of pendulums to discover an appreciable amount of reduced friction tends to allow motion to maintain. He thus postulated the first two laws of motion that Newton would later formulate in his system of mechanics with regard to the inertia of continual motion and its acceleration as a change in either speed or direction, or both.

In order to test the equality of fall between masses, it is likely Galileo performed experiments, as is alleged of him dropping objects off the leaning tower of Pisa, but such a claim is uncertain. Nicole Cabeo (1585-1650) had conducted experiments in 1641 to confirm his claim that objects do not fall at the same rate. When informed of the experimental results, Galileo replied how difficult it is to attain accurate results from such experiments.

Galileo seemed to take other results of experiment for granted as well. For instance, Pierre Gassendi (1592-1665) had directed an experi-

ment to be performed on a moving ship at sea to find out if an object follows a straight course of the ship while falling to the foot of the mast. His own experiments having already verified his laws of motion, Galileo confidently asserted the object would fall the same as if the ship did not move.

Still, to his credit, Galileo truly deserves the acclaim of pioneering the modern approach of establishing laws of nature according to observational facts rather than by ontology or abstract concepts of intuition.

Weighing the Debate

The idea all of space is filled with an undetectable medium is contrary to the empirical approach, but the new discoveries do not prove there is an empty space to move; it only affirms objects move as though empty space is before them instead of that it actually exists before them. Moreover, the new mechanics is not a complete explanation of reality. It does not explain, for instance, how it is possible for corporeal matter to attain and maintain a form in the manner it does. How, for instance, are elastic collisions possible without an internal force to maintain material form?

Such questions were still being pondered. Francis Bacon (1561-1626), for instance, questioned such concepts as a vacuum state with regard to the nature of matter. If matter consists of individual atoms, then how are they kept intact? He concluded atoms need to somehow possess inner qualities by means of some intangible spirits arising from a medium of some sort to provide cohesion and form. He also advocated a primary role of science is to describe nature according to how it is observed.

Another philosopher who did uphold the atomic theory as an internal mechanism was Gassendi. He offered an atomic theory in view of primary and secondary effects. Secondary effects are of inertia and motion. Inertia is necessary to resist penetration and to change the motion of other atoms by means of direct contact. The atoms sometimes combine to produce various effects, such as for our observable world to be comprised of the secondary effects arising from a primary source that produces the form and cohesion of the secondary effects. The primary source is visibly indeterminable by us even though it gives rise to the secondary effects that actually constitute the natural world of observation.

A philosopher who went so far as to advocate a plenum in view of the concepts of relative motion and inertia was Rene Descartes (1596-1650). He was well aware of the implications of these new concepts, but he opposed the vacuum state. He thus undertook the task of explaining relative motion and such effects as gravity in view of a plenum.

Since motion through a plenum is by reason necessarily circular, the Cartesian universe contains vortexes that differ in size and rotational speed. Exchanges occur by smaller vortexes accelerating to greater speeds in determining the weight of heavier ones, and the visibility of the world is determined by the size of our nerves extending from our brains. Our seeing as humans is, in fact, dependent on how our brains can comprehend all the many images our eyes allow it to focus on.

Descartes further postulated conservation of motion, which is similar to conservation of momentum in that in a collision between two masses the change in speed of the greater mass is less than the change in speed of the lesser mass. Twice an increase in speed of one half as much mass nullifies a half decrease in speed of the twice mass to thus conserve total motion.

As with regard to inelastic collision, motion can be conserved with the creation of heat either as the internal motion of molecules or as radiation, as is light. Kinetic energy does not appear conserved by inelastic collision except for it being internalized in some other form, such as heat.

What continual motion in particular directions indicates is separation of an isolated system of finite size unless there is something beyond it to reverse its internal motion. Interaction within a finite universe must thus extend beyond it to infinity.

Descartes also proposed an explanation of gravity whereby smaller particles accelerating to higher speeds tend to escape from slower, more massive particles, as to infer gravitational vacuum effect.

3
NEWTONIAN MECHANICS

Although Isaac Newton (1642-1727) is considered the founder of Classical Newtonian Mechanics, there is nearly no part of it, if any, that had not been thought of by someone else. His first two laws of motion, as with regard to momentum and force, are attributable to the works of Buridan and Galileo. John Wallis (1616-1703) stated the second law in 1603 and the third law of motion, with regard to mutual action and reaction, was similarity offered by Leonardo da Vinci (1457-1515) in pointing out that air and water are equally resistant to each other. Robert Hooke (1635-1703) claimed he had suggested to Newton the inverse-square-law of gravity, which Newton then formulated according to Kepler's planetary laws of motion.

Newton stands out nonetheless as outstanding for his contribution in advancing theory. It was a comprehensive formulation of ideas that resulted in a unification of Kepler's heliocentric scheme of the solar system in which relative motion and gravity equate as forces of nature. Even though it was to be modified by the relativity of space and time, his assumptions of absolute space and time along with conservation of mass were contributable to the formulation of theory.

Laws of Motion

In addition to the concepts of absolute space and absolute time as the means to determine events according to standard units of measure, Newton believed the material content of the universe always stays the same. It does not change by being in relative motion, under the influence of gravity, or by any means whatsoever. From this conservation of mass and assuming space and time are absolutes, he postulated three laws of motion:

1. Law of inertia: objects in a non-accelerating state of relative motion or at rest remain as such until they are acted on by an external force, such as by either gravity or collision with other mass.

2. Force is the product of a mass m and its acceleration **a** per time t with regard to acceleration.
3. An equal and opposite reaction occurs with every action.

The law of inertia is expressed as the product of a mass m and its velocity v as momentum P. Hence, the first law is according to the equation P = mv. By this law, momentum remains unchanged until acted on by another mass or external force.

With regard to the second law, the amount of force F used to change momentum is the product of mass m and acceleration **a**, as according to the equation F = m**a**. Acceleration itself is either a change in velocity, as either of speed or direction, or of both, per time. In ratio to mass it is possible that a quick enough fly exerts more force from changing speed than someone throwing a brick. However, since the brick has far more mass than the fly, it generally has more force than does the fly. More definitively, force is per time and per mass. The same change in a speed of twice as much mass in twice the time is the same amount of force, as the lesser mass changes at twice the rate:

$$F_1 = \frac{m(\Delta v)}{\Delta t} = F_2 = \frac{2m(\Delta v)}{2\Delta t}$$

The Greek delta letter Δ denotes change, as change in velocity from $v_0 = 0$ to v_1, and as change in time from say $t_0 = 0$ to t_1 as one second.

Since velocity includes both direction and speed, the change in velocity can either be a change in speed or a change in direction, or a change in both direction and speed. A rocket moving in a circle, for instance, constantly accelerates by means of constant force. The rocket can also constantly increase in speed by more force increasing the rate of circular acceleration.

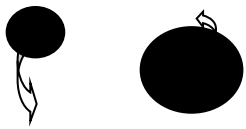
Galileo had previously established these first two laws. Newton added the third one: the law of mutual force. Hence, if a force acts on a mass, the mass reacts with an equal and opposite force for a change in momentum of the rocket caused by the rocket fuel to result in an equal amount of change in momentum of the rocket fuel in the opposite direction, as the rocket fuel would otherwise be inexhaustible.

From mutual action and reaction between masses is conservation of momentum. Conservation means staying the same, and conservation of momentum means total momentum of all mass in any particular direction never changes by the action of one mass on another. The action can either be a collision of two or more masses or a force such as gravity. If a greater mass collides with a lesser mass, conservation of total momentum of the action is maintained by the change in velocity of the greater mass

in one direction being relatively small and the change in velocity of the lesser mass in the opposite direction being relatively large. The mutual changes in each of the momentums is according to the equation

$$M(\Delta v) = m(\Delta V)$$

Change in velocity of the greater mass is thus less than the smaller mass.



Consider our moon orbiting Earth, as depicted above, as an example of equal changes in momentums of masses caused by their gravitational influence on each other as mutual. In this case, a relatively slower moving Earth being more massive than the moon results in a change in direction of the moon being a greater change in velocity at a greater speed. The moon's orbit around Earth is thus a relatively large circular path while Earth orbits within a small circular path of the larger one. As to why the Earth's path does not circle the moon, it is because Earth is too slow changing its direction at each new position of the moon.

Centripetal Acceleration

Centripetal acceleration is constant change in direction resulting in a circular path. Newton formulated it mathematically, but he delayed the publication of his work until 1974. Christian Huygens formulated it independently for his publication of it in 1673, but it was Newton who used it for the unification of celestial and terrestrial mechanics.

Consider, as by Newton's first two laws of motion, a particle tends to move in a straight path, but it actually moves peripherally instead around a fixed point because of a centripetal force constantly acting on the particle in changing its direction. The centripetal force is any agent, such as gravity or whatever, preventing the particle from escaping its orbit. The mathematical expression is

$$a = \frac{v^2}{r}$$

Respectively, the letters ***a***, r and v represent the rate of acceleration, orbital radius and orbital speed.

Centripetal acceleration is a particular form of acceleration equating to any form of acceleration generally expressed by the equation

$$a = \frac{\Delta v}{\Delta t}$$

As to how it interrelates is explainable according to the equation

$$\frac{v^2}{r} = \frac{vr}{rt} = \frac{v}{t}$$

Accordingly, magnitudes v and t of v/t relate to centripetal acceleration as changes in v and t. Twice v results in one-half t at one-fourth the distance of acceleration, being that the later half of constant speed change is twice as fast. As according to v^2/r, a constant rate of change in direction around a circle of radius r is such that twice orbital speed results in twice as much orbital distance, but a constant decrease in one direction is countered by a constant increase in the perpendicular direction. Similar to the general equation of acceleration, a change in direction at half distance r results in twice as much change in speed of a particular direction per time t, such that twice speed v results in four times as much acceleration at the same radius r. Twice change in speed during half time t simply results in the same twice as much acceleration as does the half distance of acceleration from one-half radius.

Gravity from Kepler's Scheme

Since force is defined as F = m*a*, centripetal force similarly equates as

$$\mathrm{F_c} = \frac{\mathrm{mv^2}}{\mathrm{r}}$$

Note: F_c increases for smaller r, as for faster change in direction at the same speed around a smaller circle.

Another force is gravitational, which is also partly centripetal with regard to it maintaining orbital motion. This connection was the means that enabled Newton to unify Kepler's celestial scheme with the forces of nature for formulating a theory of gravity.

Using Kepler's planetary laws of motion, Newton derived an inverse-square-law for gravity. Kepler's third law, in particular, relates the planetary orbits in our solar system. Accordingly, the period squared of any elliptical orbit equals the cube of the mean distance of the planet from the sun. The ratio of the time-squared of Earth's revolution around the sun to a cube of its distance from the sun (as from Earth's center of mass to the sun's center of mass) is thus the same as that of any other planet in the solar system.

Kepler's third law in mathematical terms is

$$A^2 = kr^3$$

The letter k represents a constant of proportionality for the proportionality between the period of revolution squared and mean radius r-cubed of the semi-major-axis of an elliptical orbit.

If the ellipse is a circle, which it can be, then r is the radius of a circle. As for simplicity, let the distance of orbit be that along the circumference of a circle such that the orbital distance is the number π (pi) multiplied by twice the radius r of the circle. (An average length of the two foci of an ellipse equate as a radius of a circle, such that a circle is truly representative of the average distance of an ellipse, whereby the two foci have converged to the same position.)

The time or period of revolution of the planet can also be expressed in terms of distance divided by orbital speed v in the manner

$$A = \frac{2\pi r}{v}$$

Squaring and combining equations gives

$$A^2 = \frac{4\pi^2 r^2}{v^2} = kr^3$$

Multiplying the last two sides of the previous equation by v^4, and by dividing it by k and r^4, gives

$$\frac{v^2}{r} = \frac{4\pi^2}{kr^3}$$

Centripetal acceleration according to Kepler's scheme is thus proportional to $4\pi^2/kr^3$.

Multiplying both sides by m relates to centripetal force in the manner

$$F_c = \frac{mv^2}{r} = \frac{4\pi^2 m}{kr}$$

Since r is a common distance separating the combined forces of masses m_1 and m_2, they combine by multiplication for the total force to equate in the manner

$$F_g = \frac{4\pi^2 m_1}{kr} \cdot \frac{4\pi^2 m_2}{kr} = \frac{16\pi^4 m_1 m_2}{k^2 r^2} = \frac{G m_1 m_2}{r^2}$$

This equation expresses Newton's general form of the inverse-square-law of gravity, with G as a constant of proportionality in place of $16\pi^4/k^2$. Its determined value is 6.67428(27) x 10^{-8} cubic centimeters per grams and per seconds squared.

Explaining Gravity

Newton was not content with his inverse-square-law for gravity being only capable of explaining action of one mass on another as occurring at a distance. He considered such action at a distance as casually absurd, as he attempted to explain gravity more completely in the manner of a contiguous action of masses affecting the space between them, as for action between masses to somehow result in their mutual attractions.

Although Newton attempted to explain gravity according to an agent acting between mass for contiguous action to occur, he was still reluctant to recognize an æther filled space as the medium for wave action. He regarded its presence as an obstacle to the free movement of planets and the natural motion of mass in general unless it could be rare in content. He considered an æther comprised of extremely rapid moving particles of minute mass for internal elasticity of containment. In theory, a particle of less mass can have a greater speed while it moves with the same momentum as does a more massive but slower moving particle. An internal containment of the former interacting equally in all directions with an external mix of the same Æther particles can allow ordinary particles to move in a path relatively free of content before them because of both æther and matter separately maintaining conservation of momentum.

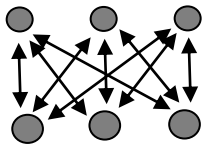
Newton's æther has merit and possible truth inasmuch as gravity could very well be the result of a vacuum effect from the interaction of æther with mass. Since mass accelerates speeds of lesser inert æther particles, the faster particles are more inclined to escape, as for leaving a vacuum effect in their wake. However, escaping particles need to somehow be replaced in order for the process to maintain continuance. A recycling process is thus required.

Descartes had proposed an explanation of gravity whereby smaller, less massive particles would be accelerated to higher speeds for them to escape the presence of more massive particles. In any case, Newton's laws of motion do not allow the collision of one mass on another to pull the other backwards. A more complex interaction is required. The one proposed in this book is similar to what Descartes had proposed; it is somewhat more complex inasmuch as it further complies with the more modern concepts of relativity and Quantum Wave Mechanics. Einstein proposed a stress condition of spacetime curvature due to the presence

of mass, and a reinterpretation of the wave aspect of Schrodinger's Quantum Wave Mechanics is a condition of probability whereby there is less probability of detecting more energetic virtual particles in the so-called vacuum space of a virtual energy field.

A Galilean Interpretation

Another explanation of Newton's law of gravity is according to Galileo's principle all bodies of mass fall through the vacuum of space towards Earth at the same rate. It indicates gravity for each part of mass is proportional to the amount of mass gravitating. However, the numerical calculation depends on a chosen unit of mass, as illustrated below of two masses each divided into three equal parts.



The total interaction of gravity between masses is thus simply a number of parts of one mass multiplied by a number of parts of another mass of equal magnitude. It relates to Newton's inverse-square-law of gravity in the manner

$$\frac{GM_1m_2}{r^2} = \frac{M_1v_1^2}{r} = \frac{m_2v_2^2}{r}$$

$$\frac{G(3M_1)(3m_2)}{r^2} = \frac{(3M_1)(3v_1^2)}{r} = \frac{(3m_2)(3v_2^2)}{r}$$

Three mass parts multiplied by three other mass parts thus equates to nine times centripetal force even though their speeds of centripetal acceleration only increase by the square root of 3.

Note: the increased speed is the same for any two triple mass quantities. What does change to maintain the same amount of actual energy is the numerical value of the gravitational constant G. It is three times less for a chosen unit of one-third gram instead of a gram, such that

$$\frac{\frac{1}{3}G(3m)}{r} = v^2 \qquad \frac{\frac{1}{3}G(3m)(3m)}{r} = 3mv^2$$

The significance of this analysis is regarding a later analysis of electromagnetic charge that is more intricately complex.

As for the additional mass and force themselves regarding conservation, it is maintained by constancy of the relative distribution of mass at large, as for an increase in mass density to be compensated for by a decrease in mass density somewhere else. To the contrary, the conservation of gravitational force also depends on the nature of the universe. If the universe is finite and expanding, then gravitational force would be decreasing along with its decrease in density for it decreasing with increasing distance between mass.

Newton assumed the amount of mass in the universe is constant. Gravity would be constant as well if the average density of the universe is also constant. Eight times more volume of mass countered elsewhere by eight times less volume of mass results in half and twice distances between particles for four times more and less gravitational force, and for twice and half as much gravitational potential. However, electromagnetic and atomic interaction within matter is more complex. Mass can convert to another form of energy, such as light. If converted as such, mass then would need to be created elsewhere.

Kinematics

An escape velocity v_e derives from kinetic energy in the manner

$$\frac{1}{2}mv_e^2 = \frac{GMm}{r} = mv_o^2$$

$$v_e = \sqrt{\frac{2GM}{r}} = v_o\sqrt{2}$$

The mass m can thus overcome the gravitational binding energy of relative motion if the speed v_e of escape is at least the square root of 2 times more than the orbital speed v_o at radius r from the center of mass M.

Although force is energy, in Newtonian Mechanics it more specifically applies to change in speeds of mass, whereas energy itself is more generally of various forms converting from one to another. For instance, energy of light can become internal mass-energy of matter, and vice versa.

Kinetic derives from the Greek word kinesis that means motion, but it was not applied until a much later time, as about 1850 by Lord Kelvin.

Gottfried Leibniz (1646-1716) called the energy of motion "Vis viva", meaning the living force. Willem's Jacob Gravesande (1688-1742) found the penetration of clay by equal weights that are dropped from different heights is in proportion to the difference in speeds squared of each weight. Emilie du Chatelet (1706-1749) explained this result as work

energy of the change in speed of mass used to move a mass quantity the distance proportional to the inertial resistance causing the change in speed.

With calculus, Joseph Lagrange (1736-1813) found in 1811 there is an additional difference of Vis viva mv^2 and a potential energy of momentum mv by a factor of 2. A factor ½ for kinetic energy $K = (½)mv^2$ came from Gustave Coriolis (1782-1843) in 1829, even though a kinetic theory of gases was developed earlier by Johann Bernoulli (1667-1748) in accordance with Newton's laws of motion.

Consider a moveable partition separating two gases into equal volumes of cubic space. Each gas has the same number of molecules, but molecules of one gas have only one fourth the mass moving at twice the speed on the average than does the more massive molecules of the other gas. Since $(½)m(2v)^2 = (½)(4m)v^2$, the gases have the same kinetic energy, and since one-fourth mass at twice speed strikes the partition twice as often, the momentum of action on both sides of the partition per time of action is the same, such that the partition does not move.

Conservation of kinetic energy of elastic collision is proven with three equations according to Newton's laws of motion:

(1a) $$(nm)v_1 + mv_2 = (mn)v_3 + mv_4$$

(2a) $$\frac{1}{2}(nm)v_1^2 + \frac{1}{2}mv_2^2 = \frac{1}{2}(nm)v_3^2 + \frac{1}{2}mv_4^2$$

(3a) $$v_1 - v_2 = v_4 - v_3$$

Accordingly, n denotes any positive real number such that the product nm denotes any mass quantity as proportional to m. The left sides of equations (1a) and (2a) represent the momentums and kinetic energies of the masses before collision. The right sides of these equations represent the same after collision: the velocities v_1 and v_2 are before elastic collision, and velocities v_3 and v_4 are after collision. Equation (3a) defines elastic collision such that the difference in relative speed between masses remains the same after collision as before collision, but they have been reversed in their original directions.

Equations (1a) and (2a) are divided by m, and both sides of equation (2a) are multiplied by 2 for simplification, obtaining

(1b) $$nv_1 + v_2 = nv_3 + v_4$$

(2b) $$nv_1^2 + v_2^2 = nv_3^2 + v_4^2$$

(3b) $$v_1 - v_2 = v_4 - v_3$$

To prove kinetic energy is conserved in elastic collision the task is to derive equation (2a) from equations (1b) and (3b).

Equation (1b) rearranges by subtracting v_2 and nv_3 from both sides of it to obtain

$$nv_1 - nv_3 = v_4 - v_2$$

$$n(v_1 - v_3) = v_4 - v_2$$

By dividing both sides of the resulting equation by $(v_1 - v_3)$ a solution of n is obtained as

$$n = \frac{v_4 - v_2}{v_1 - v_3}$$

Rearranging equation (3b) by adding v_2 and v_3 to both sides of it obtains

$$v_1 + v_3 = v_4 + v_2$$

Dividing both sides of it by $(v_1 + v_3)$ obtains

$$1 = \frac{v_4 + v_2}{v_1 + v_3}$$

The product of the two solutions n and (1) gives

$$(1)n = \left[\frac{v_4 - v_2}{v_1 - v_3}\right] \cdot \left[\frac{v_4 + v_2}{v_1 + v_3}\right] = \frac{v_4^2 - v_2^2}{v_1^2 - v_3^2}$$

Multiplying the first and last equalities of this equation by $(v_1^2 - v_3^2)$ obtains

$$n(v_1^2 - v_3^2) = v_4^2 - v_2^2$$

$$nv_1^2 - nv_3^2 = v_4^2 - v_2^2$$

Adding $nv_3^2 + v_2^2$ to both sides of this result obtains

$$nv_1^2 + v_2^2 = nv_3^2 + v_4^2$$

Multiplying both sides by m/2 obtains

$$\frac{1}{2}(nm)v_1^2 + \frac{1}{2}mv_2^2 = \frac{1}{2}(nm)v_3^2 + \frac{1}{2}mv_4^2$$

(2a) is thereby derived from (1a) and (3a) in proving conservation of kinetic energy in elastic collision from the conservation law of momentum and the difference in relative speeds after collision.

Conservation of kinetic energy is maintained by elastic collision in manner of also conserving relative motion. Twice mass changes the relative speed of the other mass twice as much by decreasing its relative speed half as much. The total increase in speed of mass is thus the same as the total decrease in speed of mass.

Contrary to this analysis is inelastic collision whereby relative motion between mass appears to decrease. However, an inelastic collision is merely more complex, involving such internal motion as the creation of heat or the emission of electromagnetic radiation for more complex analyses.

There are also conditions of relativity theory to consider regarding the difference between mass and energy. According to special relativity there is an exchange of mass between one mass as part of the exchange of momentum for less increase in speed. The exchange is thus partly inelastic whereby conservation of kinetic energy is even more complex. Moreover, there is an increase in mass per increase in speed such that a mass needs to increase to infinity to obtain light speed.

Mass is thus a particular form of energy that converts to or from another form of energy such as light. Newton did theorize mass converts to light and vice versa. It becomes relevant with regard to comparing gravity with electromagnetism. Light is electromagnetic energy. Gravitational energy is similar but also conditional to an equivalence principle of gravitational and inertial mass according to both Newtonian Mechanics and relativity theory.

The relativity of mass, space and time are also more consistent with the Plank Constant of Quantum Theory. By relativity, the relativistic increase in mass equal to the relativistic decrease in mass length in the direction of relative motion compares more favorably to the mass and radius parameters of the Plank Constant remaining constant along with the other parameter of velocity being a constant by itself.

4
KINEMATICS ATOMS AND THERMODYNAMICS

Sometime in the thirteenth century Giles of Rome (b. before 1247-d. 1316) proposed an atomic theory according to a condition that no form of matter exists smaller than a minimal quantity of substance. He tried to support his theory with the investigation of a vacuum state. He was unable to verify his theory, but investigations of the vacuum state continued, eventually leading to Boyle's Law, the kinetic theory of gasses, development of chemistry, laws of thermodynamics, and the classical theory of the atom.

The Kinetic Theory of Gases

Giovanni Batiste Beliani (1582-1666) debated with Galileo on how to explain vacuum effects. In the year 1620 the debate focused on air weight. It was known water could flow higher up from a vessel through a tube lying over a hill. However, if the top of the vessel was sealed, partial vacuum occurred at the top of the vessel from leaked water at the bottom, as to restrict the water from flowing through the tube. It was suggested by Galileo there are attractive forces between the water and the vessel, whereas Beliani believed the cause was outside air pressure on the water attempting to come out of the tube at its other end. Beliani was correct, as further investigation of vacuum states led to such new inventions as the mercury barometer by Evangelista Torricelli (1600-1647) and the air pump by Otto von Gueriche (1602-1686).

Torricelli used the barometer to compare air pressure at sea level to its pressure higher up in the mountains. He not only found a difference, he further discovered the pressure changes with a change in the weather. With mercury thirteen times denser than air, it is able to create a vacuum in a tube that varies according to present pressure of the atmosphere.

Gueriche invented the air pump to produce more vacuum in order to measure more work capacity of outside air pressure. The outcome was him using the barometer in 1660 for forecasting the weather. He also

published books, which Boyle read, defending the vacuum state proposed by Galileo and Newton and opposed by Aristotle and Descartes.

More experiments occurred in England, as Henry Power (1623-1670) and Richard Townely (1629-1707) examined air below atmospheric pressure in discovering the product of pressure and volume stayed constant. Robert Hooke (1625-1703) experimented with air above atmospheric pressure to determine the same result. He and Robert Boyle (1627-1691) confirmed the nature of gas pressures more in general. Boyle then proposed, in 1662, the law that the product of volume V and pressure p of gas is constant at a fixed temperature T, as expressed by the equation $pV = k$. (Also, in France, this law was proposed in 1676 by Edme Mariotte (d. 1684).)

A constancy of volume-pressure relates to Newton's laws of motion in that a sphere with twice the radius of another has eight times more volume, four times more surface area and twice the average distance for a particle to reach the surface for it to collide half as often. The intensity of collisions in the larger sphere in relation to twice distance and four times more surface area is thus one-eighth as much pressure. Since the decrease in pressure is the same as the increase in volume, their product is the same for all spheres.

What followed from Boyle's law is ways of relating heat and temperature. Although the motion of atoms or molecules causes them, all that physicists essentially knew about them is heat is a quantity contained of mass and temperature is a qualitative measure of how much a particular substance such as mercury expands in relation to heat absorbed, but Boyle's law indicated a way of understanding them in mechanical terms of relative motion and mass.

To understand the relation in terms of kinematics consider pressure p as force per area, as pounds per square inch, where weight is synonymous with the centripetal force of gravity, mv^2/r, and pressure as force per area is mv^2/r^3 per volume. As with the internal action, it is such that a particle moving twice r with the same speed collides with the surface one-eighth as often, such that the product of one-eighth pressure with a volume eight times larger is constant. Indicative also is twice temperature T resulting in twice as much pressure since eight times more volume is the same as eight times more heat and temperature is eight times more kinetic energy per volume. However, there are other factors that figure into the equation.

Daniel Bernoulli (1700-1782) initiated the kinetic theory of gases along with his study of hydrostatics. Bernoulli advocated a mechanical theory in analyzing the kinematics of molecules in view of particle collisions, despite a general regard at the time that such a process is too simple to resolve the more complex nature of reality.

Although the pressure-volume product was determined as constant for a particular temperature, it was still questionable as to whether the constant k is the same for different temperatures. Guillaume Amontons (1663-1705) foresaw the ideal gas law $pV = nkT$ before it became established, as stating in a 1702 paper that a product of pressure p and volume V equals a product of temperature T for the same constant k, such that either pressure, volume or both increase with the increase in temperature. He further considered the zero temperature in relation to zero pressure, which anticipated an absolute temperature scale established about a century and a half later.

Another form of the law, as Charles' law, became the law of volumes whereby the volume of the gas container increases with temperature instead of an increase in pressure. The law was proposed by Jacques A. C. Charles (1746-1823) in 1787. It along with Archimedes' principle of buoyancy, led to the invention of the hot-air balloon. It was also established quantitatively by Joseph Louis Guy-Lussac (1779-1850), in an 1802 publication, whereby one-degree centigrade change in temperature corresponds to a change in volume of the same pressure occurring as one part in 273 parts of the gas volume.

An ideal gas law was hinted at by Amontons in 1702. It was explicitly stated, in 1834, by Paul Emile Claypeyon in relation to Boyle's and Charle's laws. August Karl Kronig (1822-1879) derived it in 1856 in accordance with the kinetic theory of gases, as Rudolf Clausius did as well in 1857. However, Johannes van der Waals (1837-1923) disclosed, in 1873, the law is not ideal because of internal effects influencing the results. For instance, the number of molecules can be influential by them reversing their directions from colliding with each other. Even with more complex formula predictions of it are generally only reasonably accurate with gases of higher temperature and lower pressure.

Another criticism of the kinetic theory of gases itself was that internal motion of matter would likely cause it to explode every which way. It would not be until the middle of the nineteenth century until a counter argument would come forth with Clausius explaining that collisions between minute particles great in number obstruct their mean free path of escape. Constant collisions keep reversing directions for the total distance moved to be longer than the direct outward distance itself. The kinetic theory of gases was thus not to be accepted until revived in a statistical form by Clausius, Maxwell, Boltzmann and others in a later part of the nineteenth century.

The Substance of Heat

Heat as molecular motion had many proponents, including Boyle and Hooke, but until the later part of the nineteenth century a theory of

heat as a substance was more accepted. The criticism pertaining to an inner, violent molecular motion causing matter to explode in all directions was influential. For this reason and others the idea heat is a particular substance absorbed and emitted by matter instead of only an internal movement of the internal components of matter remained popular. However, debate on the nature of mass and heat continued its advance.

Both Boyle and Newton proposed fire consists of material substance, as the residue caused to burn and produce heat. Boyle experimented to find substances that did not decompose, which he defined to be an element. The concept of the element eventually led to the discovery of the atom.

Etienne Francois Geoffrey (1672-1731) advanced in 1718 the idea that a particular substance of a compound (such as carbon of carbon monoxide) is replaceable by another substance (as by hydrogen to convert the oxygen of carbon monoxide into water molecules). He then contrived a table of 16 columns in demonstrating an order of replacements of known substances. This effort evolved into a table of affinities wherefrom element A instead of element B combine with element C because of elements A and C having more of an attraction for each other than do elements B and C.

The table of affinities was utilized by Joseph Black (1728-1799), Henry Cavendish (1731-1812) and Joseph Priestley (1731-1810) to discover nearly all elements of permanent gases. Their discoveries led to an explanation of a weight oddity from combustion and calcinations of dissimilar materials that result from a combination of different elements further resulting in various combinations of exchange.

Newton had considered an inert matter contained by elastic forces of some kind of æther, and he offered explanation of heat as a repulsive force decreasing in inverse proportion to distance between molecules. He argued light particles excite æther, which then conveys the excitement onto matter to produce heat along with other effect. He even supported the connection of æther with heat and light by experimentation on the bases a vacuum did not prevent a transfer of heat (as radiant heat requires no material medium to move through space).

Attraction and Repulsion

Newton was also influential to future theory for advocating a dualistic principle of both attractive and repulsive forces of nature: one being gravity and the other as heat. Stephen Hales (1677-1761) developed an idea of both attractive and repulsive forces consisting of two kinds of matter tending to become balanced in a state of equilibrium. His idea was to have a profound influence on Benjamin Franklin (1706-1790) and others with regard to two fluid theories of electricity and magnetism.

Theorists were generally inclined to relate all forces as substances of a particular kind determining the internal natures of matter. In the 1740s, for instance, Franklin proposed that electrical phenomenon is an elastic fluid of mutually repulsive particles. Matter is electrically neutral for containing the right amount of a particle fluid, repulsive if it contains an excessive amount, and attractive if deficient of it. Gowin Knight (1703–1772) also proposed a fluid for magnetism with the propagation of light as the vibrant motion set up in the fluid.

William Cullen (1710-1790) advanced the idea natural forces result as various modifications of æther. He proposed electricity, light, heat, gravity, magnetism and so forth emanate as various æther forms that are themselves gravitationally weightless and distinct from matter, thus allowing additional effects deviating from an equilibrium state of gravity. Such a proposal was in line with the beliefs of Gassendi and the public in general.

Latent Heat

Cullen's student Joseph Black (1728-1799) also considered heat, light and so forth as modifications of æther. In support of his consideration, he systematically studied combustion and calcination of different elements in pioneering the science of calorimetry.

Black's study pertained to temperature and heat. Newton had defined a quantity of heat as the amount of time taken to lower a substance to room temperature. Black took this definition to mean that heat can be measured as a time required for either dropping or raising its temperature to a certain degree. He measured a certain quantity of water according to the amount of time it takes to raise its temperature one degree. The temperature, however, did not change in such cases as involving change from water to ice, or vice versa, and from this find Black proposed the concept of latent heat.

Latent heat had previously been noticed by Daniel Gabriel Fahrenheit (1686-1736). He discovered water remained in the liquid state while cooling at the freezing point (as now 32 degrees Fahrenheit), but it congealed into a solid state above this temperature by means of shaking the container. This find that Black verified on his own in 1761 suggested heat can be stored as a latent form of energy without a rise in temperature. A mixture of ice and water, for instance, need not change in temperature with change in heat if a change in heat is relatively slight.

From Phlogiston to Caloric

In an effort to disprove a theory that phlogiston is a primary substance of fire, Antoine-Laurent Lavoisier (1743-1794) probably introduced caloric in naming the main substance of heat. George Ernst Stahl

(1660-1724) had proposed phlogiston is a substance of violent motion producing flame and heat when entering into the air from the dispersing of matter. Plants absorb and then recycle it. There is truth to this idea if we identify phlogiston with carbon, which Stahl did, but he also claimed phlogiston is the only element existing not as a compound but as a primary substance and a catalyst for all processes of combustion.

Stahl's generalization was open to dispute since some substances lose weight during calcinations whereas others gain weight. Thus, in some cases phlogiston needs to be of positive weight; in other cases it needs to be of negative weight.

A resolution to this quandary was the table of affinities first presented by Geoffrey wherefore came many chemical discoveries. One of particular pertinence was the discovery of oxygen. Because of it, physicists no longer needed phlogiston to explain changed states of matter. Calx plus phlogiston producing metal, for instance, could more easily be explained as calx giving up oxygen to become metal. Conversely, metal absorbing oxygen becomes calx. Furthermore, experiments by Lavoisier indicated conversion of sulfur, phosphorus and arsenic into oxides results in a gain in their weight and the decrease in the weight of air.

In disclosing the inadequacy of phlogiston theory, Lavoisier held onto the general belief of Cullen and others that æther acts as a weightless elastic fluid that is not influenced by gravity, and it is primary responsible for such effects as light, heat, electrostatic repulsion and so on. He followed up on experimental results of Cullen on cooling effects of such volatile liquids as alcohol by vaporization to discover, independently of Black and Fahrenheit, the temperature of ice did not increase while changing into the liquid state. Along with replacing phlogiston with caloric he proposed an element such as oxygen has more affinity for absorbing caloric than does another, which could also allow ice to change to water while maintaining a slight portion of its coolness, as by a base material. The caloric thus seemed to provide more consistent explanation of how change occurs of substance, but it was to be overcome with the development of atomic theory and the laws of thermodynamics.

From Caloric to Atomic Theory

It was evident substances combine in definite proportions, as a precise amount of oxygen combines with a precise amount of hydrogen. This find was named by Joseph Proust (1754-1826) the Law of Definite Proportions. It and a similar law led the way to the modern theory of the atom.

The similar law is the Law of Multiple Proportions proposed by John Dalton (1746-1844). According to it, the chemical elements consist of tiny particles called atoms. Atoms of a particular element are all of the

same size, weight, mass, etc. that differ from those of other elements, but the different elements combine in ratio of whole numbers to form chemical compounds. Dalton proposed a numerical list of atomic weights of six known elements: hydrogen, oxygen, nitrogen, carbon, sulfur and phosphorous. Hydrogen, as the lightest of these elements, was assigned the number one.

Another similar law, proposed by Gay-Lussac, is the law of combining proportions. He and Alexander von Humboldt (1769-1859) discovered that two volumes of hydrogen combine with one volume of oxygen to become two volumes of vaporized water having the same temperature and pressure. Gay-Lussac further studied data collected by Humphrey Davy (1778-1829) with regard to volume ratios obtained by combining nitrogen with oxygen. He experimented to further discover a half gaseous volume of nitrous oxide is obtained by combining a volume of nitrogen and a half volume of oxygen of the same temperature and pressure.

Similar finds encouraged Gay-Lussac to conclude that gases combine in whole numbers ratios, as they also do according to weight. However, he did not explain why some whole number ratios differ from others. Why, for instance, does water vapor squeeze one volume of oxygen and two volumes of hydrogen into two volumes total?

Amedeo Avogadro (1776-1856) explained the ratios of whole number combos according to a hypothesis a gas with the same volume, pressure and temperature of another contains the same number of molecules. As to why two volumes of water vapor is the result of two volumes of hydrogen gas and one volume of oxygen gas, he assumed molecules are formed from "solitary elementary molecules", or atoms. Since hydrogen gas contains two atoms for every molecule, two hydrogen atoms combine with an oxygen molecule, as a single atom, to form into water consisting of two different molecules. The number of molecules per volume thus stays the same.

Avogadro's hypotenuse was at odds with Dalton's atomic theory that assumed the compounds of elements are the result of like atoms repelling each other and not allowing other kinds of atoms to occupy the space instead. Thus, Dalton and his followers were not to accept the concept that identical atoms combine in becoming a molecule. As it were, Avogadro's law failed acceptance until a fellow Italian, Stanislao Cannizzaro (1826-1920), pointed out in 1861 that the law could be used for a convenient table of atoms in simple ratios of whole numbers.

Rudolf Clausius (1822-1888) later helped promote the kinetic theory of gasses in explaining the vibrant motion of atoms is stable by being great in number, as each encounter between numerous atoms acts to slow the mean free path of escape by means of it constantly reversing

directions, which is consistent with an interpretation of gravity by Newton according to vibrant cells or vortices of æther having a zero total momentum internally for each cell, but which implies that space is indeed filled with an enormous number of miniature cells as a medium of interaction.

The Fate of the Caloric

The role of caloric in developing theory was to replace the phlogiston of fire as an explanation of latent heat. Properties ascribed to caloric were it consists of weightless particles repelling each other, as flowing from hot to cold matter. Because caloric was also assumed to be conserved, an engineer named Nicolas Leonard Sadi Carnot (1796-1832) used the caloric theory for the derivation of theorems to explain how a steam engine is able to operate more efficiently.

Postulating conservation of heat in view of caloric, Carnot theorized it flows from hottest to coldest parts of the mechanism performing work, as caused by the viscous flow of caloric. Since caloric is conserved, the process compares to a waterwheel turning by the flow of water that forever recycles. Similarly, because systems of the same temperature are unable to exchange caloric to perform work, recycling of caloric is required. Adding more fuel, for instance, allows a hot steam engine to continually release caloric for it to perform work.

Carnot's condition for efficiency was correct for the most part, but the conservation aspect of caloric is inconsistent with conservation of energy in that energy merely converts from one form to another. Caloric was thus to become discarded in favor of energy conservation.

Neither physicists nor chemists had yet established the modern law of conservation of energy, but Count Rumford (1753-1814) had demonstrated an enormous quantity of heat results from boring cannon holes. Humphrey Davy (1778-1829) rubbed ice plates against each other to demonstrate heat is producible below freezing temperature even though no caloric should be available from it. Moreover, no appreciable amount of change in mass or of its weight occurred in either of these experiments. Rumford thus proposed vibrant motion causes heat instead, whereas Davy considered heat occurs as resulting from the absorbing of light. Davy also suggested a novel idea: that light combines with oxygen to become "*phosoxygen*", as a process whereby mass increases by absorbing light, which it does, in fact, in accordance with relativity theory.

Conserving Energy

The main difference between conservation of caloric and conservation of energy is caloric does not convert into other forms of energy whereas all energy does, as according to its modern concept. This mod-

ern concept was stated in 1841 by Julius Robert Mayer (1814-1878) as a force (then regarded as a varying form of energy) that merely changes from one form to another. It is thus neither created nor destroyed. He argued the loss of kinetic energy during inelastic collision between masses transforms into heat as an internal form of continuous motion.

James Prescott Joule (1818-1889) verified Mayer's argument in relation to friction. Heat that results from stopping motion by friction was common knowledge. Joule measured it quantitatively in relation to the magnitudes of heat from work used to overcome friction. It was also known that the flow of electricity through a highly resistant wire heats the wire. Joule established this effect quantitatively in 1841 in confirming current transforms into heat in mechanical units of work.

In 1847, Hermann von Helmholtz (1821-1894) addressed the scientific community in stating there is no such thing as a perpetual motion machine performing work without compensation for it in return. Explanation refers to an isolated system in that the internal energy of the system comprises, as stated in modern terms, a total amount of kinetic and potential energies of the molecules remaining constant until acted on by some external influence. Whenever interaction occurs, a change in internal energy is according to the quantity of heat absorbed as the amount of work performed on the system, as according to the equation

$$\Delta E = H + W$$

H denotes quantity of heat, W denotes the amount of work performed, and E proceeded by the Greek delta letter Δ denotes the change in energy.

Note that one form of energy is related in terms of its potential. A ball at some height, for instance, has a gravitational potential, as weight that can be converted to kinetic energy. If it falls from the table, then kinetic energy further encounters friction of the ball falling through air and colliding with the floor, converting further into heat energy. Potential energy thus links to force regarding storage of energy. Moreover, there is also entropy as stored energy to consider as lost for useful work unless allowed by some change in its surrounding environment, as by another energy source.

Entropy

Clausius, in 1850, reformulated the theorem put forth by Carnot for it to comply with conservation of energy. It was also reformulated in 1851 by William Thompson (1824-1907), renamed Lord Kelvin. In result, a concept of entropy was established as the second law of thermodynamics.

In view of energy conservation in contrast to the caloric, adding fuel is to sustain a difference in temperature for doing work, but there are various forms of energy, and there is further distinction between useful energy and non-useful energy. Useful energy is that which can be used to create change; non-useful energy is energy in a state of equilibrium not changing unless by outside influence. For instance, two bricks in thermal equilibrium, as being of the same temperature, are incapable of doing thermal work by way of an exchange of heat from one brick to the other, but if one brick encounters a cooler environment, then potential heat energies become active.

It is therefore possible to have a certain amount of energy in the form of heat at absolute temperature, say T_1. In theory, we can only harness all of the energy of a system if its temperature is reduced to absolute zero. Generally, however, systems are somewhere between absolute zero whereby the energy can only be harnessed by lowering it from T_1 to T_2 according to the relation

$$1 - \frac{T_2}{T_1}$$

Applicable to this condition is an absolute temperature scale, which Kelvin introduced after Joule suggested in a letter to Kelvin that it was possible to measure the difference from absolute zero. All heat energy is thus available if $T_2 = 0$; none is available if $T_2 = T_1$.

There are such other forms of latent or stored energy as that of atomic energy. Clausius, who had already considered the thermal aspect of it, went a step further to generalize the process in the form of a thermodynamic law he named entropy. Its general conditions are: Entropy is the measure of the energy of an isolated system not able to do work; it does not decrease other than by it increasing the entropy of another system. It has also been further assumed to be a measure of disorder. As to how the definitions interrelate, such an orderly system of thermal equilibrium has the potential to convert into useful work, whereas disorderly energy tends to be more destructive. Since the law states that the total entropy of an isolated system does not decrease, and entropy is constant only by reversible processes, the observable part of the universe to maintain as such it itself somehow needs to be reversible.

Does a gram of sugar have more energy than a gram of some other food? According to the mass-energy equation derived by Einstein they have the same amount of energy. It is how they interrelate whereby the concept of entropy is significant in the analysis.

For an example of increasing entropy consider an enclosure having no outside influence except for gravity. Inside it a string holds a rubber

ball to prevent it from falling. Eventually the string breaks to allow the ball to fall in converting potential energy to kinetic energy. Assuming the ball and floor to be nearly elastic, two forms of energy (potential and kinetic) alternate as the ball bounces, but the ball also encounters the friction, or viscosity, of air while in motion, and the process tends to be inelastic. Even if there were no air, it is still inelastic because of heat generated by the ball's impact with the floor. With the kinetic energy converting to heat energy, the ball eventually comes to rest on the floor, as given for increasing the relative speed of the floor molecules passing on added motion to the outside matter they heat up in turn. Being in a state of equilibrium that is irreversible except for outside influence, entropy is thus increased to a maximum until another part of the universe intervenes.

Heat quantity Q in ratio to absolute temperatures is thus a determining factor of entropy of internal bodies of an isolated system whereby difference in temperature determines the amount of heat available for useful work. A body at temperature T_1 thus surrenders its heat Q to another body at temperature T_2 for a change in entropy, ΔS, of the two bodies to be

$$\Delta S = \frac{Q_2}{T_2} + \frac{Q_1}{T_1}$$

If a system performs work, then the amount of heat Q_1 lost at temperature T_1 will generally differ from an amount of heat Q_2 gained at temperature T_2, but if the positive amount given up is the same as the negative amount received, such that $\Delta S = 0$, then entropy is conserved as an adiabatic process.

Entropy as the second law of thermodynamics interrelates with conservation of energy as the first law of thermodynamics. An isolated system doing work gives up energy. The energy decrease is sometimes referred to as the quantitative measure of disorder. By kinematics, temperature is the random motion of molecules. Faster molecules of higher temperature cause more destruction, as for irreversible disorder. However, the result also depends on what constitutes an isolated system of the universe at large. A loss of kinetic energy violates conservation of energy unless it is created anew in some other form.

One conditional result of entropy of an isolated system losing temperature by inelastic collision is for it to spread out. Stephan Hawking, for instance, challenged black hole theory as violating entropy because of it having an event horizon that does not increase in distance from the center of mass. Theoretically the black hole cannot decrease in mass-energy; it only increases instead. However, if it does increase in mass-

energy, then the event horizon from which nothing escapes increases in distance. Still, to comply with the second law of thermodynamics, Hawking proposed the black hole emits Hawking radiation whereby it is not truly a black hole as originally defined. (However, he conceded in the 1990s that they do exist.)

A similar condition is a singularity whereby the increase of mass by gravity decreases the distance of the event horizon for the mass to become contained within an infinitesimal volume of space. However, if it is somehow able to expand, as to be consistent with entropy, it would also be consistent with Big Bang theory whereby the universe is assumed to be finite and expanding from the prior existence of a singularity representing the beginning of the universe.

The singularity condition assumes the universe is finite. However, if the size and mass-energy of the universe are both infinite instead, then there can only be expansion of isolated systems within it. Moreover, they need not be completely isolated. By emitting radiation to interact, they obtain states of equilibrium whereby entropy is conserved as an adiabatic process. An oven, for instance, maintains the same temperature by means of receiving the same amount of energy expanding from it. Similarly, gravitational radiation could be released from mass to either maintain or even increase pressure for an increase in temperature. Only an isolated system apart from an infinite universe would be, in theory, able to expand and thereby decrease in temperature and destruct in a way of becoming more disorderly.

Another possibility could be that mass is both expanding to allow more of its creation, as from previous mass converted into other forms of energy for a recycling process of a vacuum effect.

5
FROM WAVE THEORY TO RELATIVITY

Theories of nature evolved from opposing views pertaining to how space is filled. By one, the internal nature of matter comprises indestructible atoms moving by way of a partial vacuum. By another, a primary substance fills all space as a plenum.

A belief in the plenum was popular from the time of Aristotle until the development of fundamental laws of motion. After the establishment of the Copernicus heliocentric view of the solar system, and Galileo and Newton establishing their mechanics, it became more acceptable Earth moves freely as though the space before it is empty except for it only being partially filled with tiny indestructible atoms. Nonetheless, such philosophers as Descartes proposed, to the contrary, atoms are tiny vortices of swirling æther to merely appear as though they move as particles through empty space.

Nowadays the majority of physicists consider æther as non-existent, or invalid, since it is invisible in theory, and since physics confines itself to only what is observable, but it nonetheless has a long history in the development of theory from which wave action is an integral part of, as illustrated by the chain reaction below.

The illustration above depicts how momentum continues, as by either a medium or empty space before it. Through the medium the momentum is transferred to and from each iron ball by means of impulse. There is thus a momentum of impulse moving from one end of the row to the other when the former is struck by another ball. The momentum of the ball, in this case, continues to reemerge as relative motion of another particle.

The particle description is simpler, but the wave action is also helpful for understanding the true complexity of nature. Newton, for instance, was unable to explain the cause of gravity by way of contiguous action. He thus described it according to an "action at a distance princi-

ple". Although other attempts have been offered to explain the direct cause of gravity, none have been successful for centuries to come. Wave theory, on the other hand, can be more extensive in its approach. Waves, for instance, can superimpose to negate their relative effects, as to explain gravitational action at a distance as wave action through an undetectable medium.

Wave action, however, is extremely complex with regard to the many ways it can occur, depending on the nature of the wave producing medium. Sound waves, for instance, propagate longitudinal action whereas transverse action is more typical of the wave property of light. Most waves are periodic in nature, such that periodic motion of a particle in general can be described in accordance with a wave equation, but surface waves of the ocean vary in their periodicity with regard to a change in water depth.

Wave action can be insightful for anyone able to grasp its complexity, but such complexity is here avoided in favor of restricting it to a history of light.

Light and Wave Theory

Waves are noticeable events, such as surface ripples on a pond that are created by some sort of disturbance. In relating their wave action, Aristotle proposed light occurs from a wave-like disturbance of air. However, as far as is known, there was no constructive wave theory of light until 1678 when Christian Huygens (1629-1695) proposed his theory.

Huygens offered a principle of wave-envelopes being created anew at every point in space a wave impinges on. Their creation spreads in all directions, but supposedly (without any known explanation by Huygens) waves that are created back towards the center where the original disturbance occurred are obliterated by overlapping of continual creation, as to restore a state of equilibrium. Only the outer envelopes continue to spread from the center.

The theory has been criticized for its lack of explaining the obliteration effect, but Huygens likely had in mind that the wave action complies with the laws of motion. His understanding of them is evident with regard to his publication of centripetal force. He could have perceived the obliteration of wave action as mutual cancellation of momenta, whereas advancing waves merely carry momenta forward. In analogy to the impulse action of the iron balls in a row, elastic action of space can allow an excess amount of momentum to move forward while the obliteration of waves is a recycling process for maintaining a state of equilibrium for creation of more waves.

Huygens was able to explain double refraction in accordance with his theory. However, reflection and refraction were more simply explained in a manner consistent with a particle theory of light.

The law of refraction was accurately explained in a manuscript by Ibn Sahl (940-1040) of Bagdad as early as 984. In 1021, it became promoted in a treatise on optics by Alhazen (965-1014), who viewed light as consisting of rays of particles. It was first formulated by Willebrord Snellius (1560-1626) in Europe to become known as Snell's Law.

Descartes later introduced the sine function for the ratio of angles.

The direction of a stick submerging into water appears to change, but the change is an optical illusion. Instead of the stick changing direction, the light from it has changed directions twice by entering into and leaving from a denser medium, as refracted. Whereas reflection is simpler in that it equals the angle of incidence, refraction entails change in speed of waves entering into a different medium from which the ratio of angles of incidence θ_1 and refraction θ_2 equate with the ratio of speeds v_1 and v_2, and with the inverse ratio of refractive indexes n_1 and n_2 of the two mediums:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

Huygens used his wave theory to explain double refraction of light, as discovered by Rasmus Bartholin (1625-1698) in 1669 to occur in the calcite crystal called Iceland Spur. In double refraction, the light rays split into two directions, one ordinary and the other extraordinary. The ordinary direction complies with the law of refraction whereas the extraordinary direction is a non-compliance of the law. An explanation of this non-compliance is given by Huygens' theory as ripples of the medium spreading waves in all directions. Even more complete explanation was to be given with the development of wave theory to include properties of interference and transverse vibrations.

The corpuscular theory of light remained in favor until Thomas Young (1773-1829) proposed a principle of interference. Leonardo da Vinci (1452-1529) had observed water waves are able to cross paths without obstructing each other's movements. Young applied this wave effect to light waves, and he included such additional interference effects of waves moving through other waves. He surmised waves superimposing combine to either increase or decrease their effect depending on the degree they are either in or out of phase. If waves overlap in phase, then they combine their effect. If waves overlap in opposite phase, then their effect is canceled for a dark spot to appear.

Young explained light and dark fringes in diffraction patterns of waves according to his principle of interference. Francesco Maria Grimaldi (1618-1663) had discovered sunlight spreads abnormally when it passes through a small hole. Young drilled two holes for an experiment from which he found light and dark fringes occurred when they otherwise would not if only one hole was drilled. The fringe pattern is explainable as the diffraction patterns of two rays of light overlapping in and out of phase. Where they overlap in phase, light amplitudes combine effect; if they overlap in opposite phase, no light appears. (The amplitude in this classical sense means the height of the wave from crest to trough.)

Some experiments produce no interference, which is now explained as light emitted from the source as relatively incoherent. Since light waves are extremely rapid, and since trains of them are relatively short, it is possible to detect two or more rays superimposing only in particular circumstances. It occurs in Young's experiment by drilling holes close together. Another method is to split a light ray into two components, as for partial reflection. The split parts move through different paths of slightly different distances for them not to rejoin in their original state; they then superimpose instead into a slightly different state than their original one.

Transverse Waves

Young was able to explain nearly all light effects except polarization, a condition of opposites whereby particular direction up-and-down or sideways-back-and-forth is perpendicular to the direction that the waves move forward. To the contrary, longitudinal sound waves are density compressions that move forward with no noticeable transverse effect. In 1808, Etienne Louis Malus (1775-1812) discovered that either reflection or refraction can produce polarization. Young had not explained it because his medium for light waves compared to the propagation of sound through air as longitudinal waves of rarefaction and condensation of the air medium.

Young did suggest in 1817 that the waves needed to contain transverse components in order to explain the polarization effects. Augustin Fresnel (1788-1827), who was unaware of this suggestion, formulated his theory of optics in 1818 that did explain polarization as transverse waves. His theory includes Young's principle of interference and also the principle set forth by Huygens of continuous waves spreading from all the points of contact with space. However, the transverse wave led to another enigma inasmuch as it does not normally occur in a three-dimensional solid state. A rigid medium for three-dimensional space seemed to be too much of an obstacle to explain how planets and other objects move as freely through it as they appear to do.

The Elastic Medium

In investigating properties of the elastic medium, Claude Louis Navier (1785-1836) assumed objects are of extremely minute and compact particles whereby attractive and repulsive forces maintain in a state of equilibrium. The restoring force is analogous to a liquid reacting according to the motion of the particles. The solid state is conditional to the distance of separation between particles.

Navier's theory was elaborated on by Augustive-Louis Cauchy (1789-1857) with a law of elasticity that Robert Hook (1635-1703) had proposed. According to it the stretching of an elastic body is proportional to the force applied for the stretching.

Cauchy interpreted Navier's theory as setting up a condition of strain. Physicists name the mathematical formulation of this condition a tensor in relation to a more complex vector quantity in applying to variable forces of higher order. A vector refers to a quantity having both particular magnitude and direction. A current, for instance, displaces the path of a boat crossing a river at a given speed. A vector is speed of the boat moving in one direction and the current moving in another direction. The tensor could include an increase in the speed of the current, say, due to it nearing a waterfall.

Cauchy's results were mathematically consistent with those of Navier's homogeneous media, but more than one elastic constant of proportionality is needed for isotropic media. Whereas a homogeneous medium is the same everywhere, an isotropic one is the same only in directions, as it can vary in distance and other aspects. The media is necessarily isotropic in the case of Cauchy's results in allowing more than one kind of wave (as transverse and longitudinal) to propagate through it.

The equations of elastic solids were incompatible with optics insofar as they allowed for a longitudinal vibration as well as a transverse one. Cauchy overcame this incompatibility by considering a labile æther, as also capable of changing to a negative compressibility. This negative compression allows the æther to react differently to various kinds of waves, and even to allow the longitudinal velocity to be zero, as for standing waves.

George Green (1793-1841) investigated Cauchy's results, and he found them to be inconsistent with conservation of kinetic energy. They were then criticized by Simeon Denis Poisson (1781-1840) and Franz Ernst Neumann (1798-1893) as being inconsistent with a wave theory that was developed more completely by Green.

Electromagnetic Rotation

As to how the planets and other objects move so easily through æther of such solidity, ideas came forth. Gabriel Stokes (1819-1903) suggested the effect is relative. The æther relates to the slow-moving planets as a rarefied fluid, or jelly, but to the extremely rapid vibrations of light as a solid. James Mac Cullagh (1809-1847) proposed ethereal vortices or atoms do not resist a displacement resulting in distortion of the medium; they change instead in their state of rotation. This process is of a transverse nature allowing atoms to move freely through æther with rotations subject to luminous effect.

With these two ideas combined, matter moves through æther without resistance, as if sinking into jelly, whereas light occurs as the changes in the rotational states of atomic-like vortices. As rotation allows movement in the plenum, complex variation of rotation allows unlimited effects of light, electricity and magnetism from different types of wave action. Transverse wave polarization, for instance, could be a splitting of electric charge into positive and negative components.

Such speculative ideas were followed by empirical discoveries. In 1820, Han Christian Oersted (1777-1851) tested the effects of a magnetic needle near an electric current induced in a wire from a battery. He discovered the wire deflected the needle, as to reveal a connection between electricity and magnetism. Francois Arago (1786-1853) then discovered an electric current magnetizes iron. Andre-Marie Ampere (1775-1836) then demonstrated that electric currents affect each other similar to the attraction and repulsion of magnetic poles. Electric currents repel each other when flowing in opposite directions; they attract each other when flowing in the same direction, which is explained later in this book by a right-hand rule as to why opposite poles align close together.

In 1831, Michael Faraday (1791-1867) discovered change in a magnetic field induces an electric current in a wire. It is thus only necessary to apply a force, such as wind or whatever to move poles of a magnet for producing an electric current in a coiled wire that further produces additional magnetic effect. As an electric current produces an electromagnet, the electromagnet, in turn, produces more current. Alternating poles of the electromagnet near to the wire thus results as electromagnetic induction, as to how a generator is able to transform mechanical work into electricity.

A law to equate an electrical current to a magnetic field was developed by Jean-Baptiste Biot (1774-1862) and Felix Savart (1791-1841), and also by Pierre Simon Laplace (1749-1827). A significant part of the law is a constant of proportionality c, as equating a unit of electric charge e per time t passing through a unit length d of a section of a wire in proportion to the magnetic pole strength p, as $cp/e = d/t$. The pole strength p of the magnetic field is of the same dimensions as a unit of charge e of

an electric field. They cancel each other out in the equation for c to be identified as speed c = d/t.

Wilhelm Eduard Weber (1804-1891) and Rudolph Kohlrausch (1809-1858) ascertained in 1836 a value of c being the same as light speed, namely about 3 x 10^{10} centimeters per second.

The constant of proportionality c having the dimensions of a velocity was significant for the formulation of electromagnetic theory. Ampere had believed magnets are particular parts of electromagnets induced by electric currents within molecules of matter instead of within wires. However, Faraday believed magnetic currents, or "lines of force" in his way of thinking, exist in virtually quasi empty space whereby changes occurring in electromagnetic fields take time, whereby the propagation of their effect is the propagation of light.

Faraday did not formulate a mathematical theory. His ideas along with others were included in a theory of electromagnetism formulated by James Clerk Maxwell (1831-1879). According to it, material wires are not needed to conduct electricity, as it is able to propagate in the continuum of space as provided by the presence of an electromagnetic field alone. A displacement of electric current simply produces an electric field that induces a magnetic field that, in turn, induces another electric field, etc. An open field creation thus progresses at light speed as the electromagnetic spectrum.

Included in Maxwell's formulation of electromagnetism are Coulomb's Law and the Biot-Savart Law. An inverse-square law for electrical force had been proposed by Joseph Priestley (1733-1804) and others. It was published first by Charles Augustin de Coulomb (1736-1806). Similarly, in relation to a current of charge, is the Biot-Savart Law proposed by Felix Savart (1791-1862) and Jean Baptiste Biot (1774-1862) whereby the magnetic intensity between any two points along two different parallel wires is proportional to the distance squared between them and the amount of current flow and their speeds. If the currents flow in the same direction, they attract; if they flow in opposite directions, they repel.

The two laws are united by Maxwell's theory of electromagnetism by a relationship of magnetic permissibility and electric permittivity. Constants of magnetic permissibility and electrical permittivity are denoted as μ and ε, respectively. Along with light speed c they are c_0, μ_0 and ε_0 in vacuum space, as absent of matter, equating in the manner

$$c_0 = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$$c_0^2 \mu_0 \varepsilon_0 = 1$$

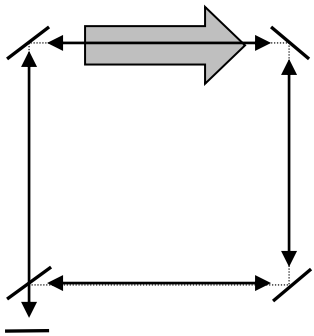
It is with the presence of mass whereby the above constants have empirical effect. For either μ or ε or both greater than μ_o or ε_o light speed c needs to be less than c_o in order to maintain unity.

Advancing Theory

A verification of Maxwell's theory of electromagnetism came in 1888 when Henrock Rudolf Hertz (1857-1894) produced electromagnetic waves in showing that they interfere with themselves, and he even measured their wavelengths as fringes produced on a screen.

The next task became to determine the state of the æther in relation to matter. For instance, if light speed c is constant through the æther, it is also consequential whether æther itself is in a state of motion that can or cannot influence the presence of matter.

Three possibilities were considered: 1) matter carries no æther; 2) matter partly carries it; and 3) matter carries all of it. Hertz adopted the third possibility, which had already been presented in 1845 by Stokes, but it was also inconsistent with experimental results. More consistent with experiment was a partial drag hypothesis, which had been proposed by Fresnel. A theory even more consistent with experimental results in general was one offered by Hendrick Antoon Lorentz (1853-1928), which assumes æther, as a state independent of matter, is a particular state of absolute rest. Although the assumption was not verified, further explanation led to the special relativity principle, which can explain all experimental results by assuming the properties of matter are altered to move through an æther as invisible. Clocks, for instance, become slower and length of matter in the direction of motion becomes shorter.



A particular experiment of significance at the time, as illustrated above, was one suggested by Francis Arago (1786-1856) indicating matter drags the æther. As light rays are split by a partially coated silver mirror, other mirrors direct the split parts for them to pass in opposite directions through a glass tube of running water. Rays moving in the same direction the water moves arrive back sooner than the rays moving in an

opposite direction. However, the increased speed of some light and the decreased speed of other light are only equal to a fraction of the water's speed, as in agreement with Fresnel's partial drag hypothesis.

This experiment supported Fresnel's partial drag hypothesis, but it was not able to explain another experiment by Edward Williams Morley (1838-1923) and Albert Abraham Michelson (1852-1931) in 1881, as not including running water. If æther is dragged by matter, then a slight shift in fringes of the wave pattern on a screen should indicate a change in direction of Earth as it rotates on its axis and revolves around the sun. To the contrary, no appreciable change was observed to occur.

Explaining Experiment

The result of one experiment was consistent with Fresnel's partial drag hypothesis. Another experiment favored Stokes' complete drag hypothesis. A more complete theory was needed in order for explanation of experimental results to be consistent. A near candidate at the time was Lorentz's electron theory.

Lorentz had theorized electromagnetic fields contain minute particles that bond together by their mutual attraction from having opposite charge. They are thus a mutual state of vibrant equilibrium. Such a state affects light propagating through it. Because an electromagnetic field produces light, the state of the field itself is also changed. As the electromagnetic waves of light interfere with the equilibrium state of charged particles, the field reacts to a changed vibrant state of charged particles. The resulting effect is an increase in inertia of matter as it moves through the æther.

Matter replaces æther as its medium for light propagation, but light propagating through material mediums differ from that of æther. A material medium varies in its relation to light whereas æther is the same for all light. Light moving in the same direction water does, for instance, is faster than if moving contrary to it. Matter being a medium of light propagation instead of it dragging æther as the medium explains the result of the Arago experiment. However, it failed to explain the Michelson-Morley null results.

To explain the null results of experiment, Lorentz assumed that matter moving through æther is squashed in the direction of relative motion. The contracted length of the apparatus in the relative direction of motion results in light moving the same distance it would if at rest in the æther.

Although contraction of length is sufficient by itself to explain the null results of the Michelson-Morley experiment, Lorentz went a step further in defining a "local time" in assuming clocks are similarly affected by moving through æther. Hence, a time of propagation is the same as if

the apparatus is at absolute rest with the æther, suggesting the state of absolute rest in the æther is not ascertainable by means of the Michelson-Morley experiment.

Jules Henri Poincare (1854-1912) urged Lorentz in 1900 to generalize his theory to comply with the principle of relativity wherefore all motion of mass is merely relative, being no observable state of absolute rest. Lorentz did provide transformation equations to this effect, but he maintained there might still be possible means of detecting a state of absolute rest. Meanwhile, Einstein independently derived the same Lorentz transformations in a manner that is free of all preconceived notions pertaining to the æther.

Lorentz and Einstein's Explanations

Woldemar Voight (1850-1919) had derived these same transformation equations in 1887 to describe a rigid medium of light as a non-compressible fluid. Voight considered the theories of Cauchy, Neumann and others in view of a Doppler effect propounded by Christian Doppler (1803-1853). By it, sound waves or light waves are either stretched or contracted depending on the relative direction of motion between the observer and the source of emission. However, neither Lorentz nor Voight applied the transformation equations more generally to the laws of mechanics. Einstein did as such. As a consequence of it and the development of quantum physics, the æther as a methodological part of scientific theory became discarded.

In reformulating the principle of relative motion, Einstein emphasized the æther is unnecessary for formulating theory. He demonstrated this claim in 1905 with his formulation of special relativity theory for a unification of electrodynamics and mechanics, as it only postulated the constant speed of light as an empirical fact of nature with no reference to the æther.

Einstein did suggest the æther could be used for understanding theory, as just not being needed for its formulation, but other physicists did not agree it should be retained. After physicists discovered both light and matter have dualistic particle-like and wave-like properties, leading physicists at the time, such as Bohr, Born and Heisenberg reinterpreted so-called wave equations as probability equations instead, as for determining probable location, time, energy and momentum for a particle effect to occur.

Leading into the twentieth century was these two revolutionary ideas of relativistic and quantum natures of light and mass. They did not conflict for the most part with each other. For instance, a photoelectric effect explained by Einstein as light particles to be named photons became part of quantum theory. A similar effect to the photoelectric one is

the Compton Effect that Compton formulated as quantum effects consistent with relativity theory. A discovery, in 1924 by Louis de Broglie, indicated both matter and light can be described as either duel wave-like or particle-like, and he theorized them in accordance with both quantum and relativity theories.

Initially the quantum could be formulated along with relativity theory, but it also developed as a contrary means of explaining nature. Whereas the relativity theory is deterministic with regard to cause and effect, quantum mechanics became interpreted as indeterminate according to probability.

This condition of probability pertains to wave effects of nature. Erwin Schrodinger provided a quantum wave equation for de Broglie theory to be formulated as a wave mechanics whereby it is assumed an electron consists of clouds of standing waves producing a quantum-particle effect. However, subsequent development led to the Heisenberg principle of uncertainty by which the world on the atomic scale became considered indeterminate with regard to knowing cause and effect.

In 1927, top physicists of the time convened in Copenhagen, Germany in concluding a yearlong debate ending with the Copenhagen Doctrine. As it were, Schrodinger's wave equations had been shown to be successful for predicting events, but Born and Heisenberg argued for an impossibility of determining both exact position and exact momentum of a particle because the means of determining them (as by light) influences the outcome. Even though the Schrodinger's wave equations predicted outcomes, they were to be reinterpreted as probability waves.

Along with indeterminism was the demise of the æther as the means of explaining nature. Since the primary aim of science is to describe nature in accordance with observation, and because experiment indicates the æther is invisible if it does exist, it is thus non-existent as far as science is concerned. However, subsequent development has been shown to be illusive. A virtual field of virtual particles is needed to more accurately predict results.

A double standard also seems to exist with regarding explanation as to why no explanation is required to explain how virtual particles can cause attraction but, to the contrary, tired light theory is dismissed for not explaining how distant stars move through the medium of space, lose energy and are still as visible as they are. Explanation of the latter is to be offered later on in this book.

6
SIMPLE SPACETIME RELATIVITY

Einstein formulated special relativity (SRT) according to two postulates: 1) light speed is constant in a vacuum relative to the observer regardless of what the velocity of the observer is relative to any other; 2) physics laws are the same in all inertial reference frames. The second postulate is referred to as covariance. Light speed is not only covariant; it is particularly unique because of its speed in gravitational free space is the same in contrast to variable speeds of matter.

How these postulates modify Galilean relativity and Newton's absolute space and absolute time according to constant light speed and the relativity of spacetime is explained here in accordance with the null result of the Michelson-Morley experiment. It continues with derivations of Lorentz Transformations and so forth explained in view of modification of Galilean relativity and how observation of absolute rest is nullified.

The Michelson-Morley Experiment

The Michelson-Morley experiment was an attempted determination of light speed in relation to æther. If the æther represents absolute rest, and if light waves propagate at the same speed through it, then light speed should vary with Earth's motion varying through æther in various orbital directions around the sun. However, no significant variation of light speed was found convincing enough by this experiment or any other. Null results were thus explained according to relative spacetime instead of absolute time and absolute space.

The experimental measure of light speed was according to a to-there-and-back event. A silver-coated lens is positioned at a 45-degree angle to the incident light to split it into separate rays. One ray continues on through the lens in the same direction while the other ray reflects at a right angle. Other lenses reflect the rays back to the silver coated lens for them to pass through it and superimpose onto a screen.

What physicists expected from this arrangement is the total distance of each split ray differs because of perpendicular lengths of the apparatus not being precisely equal. What actually appears on the screen is an inter-

ference pattern of light and dark fringes (as predicted of superimposed waves). An appreciable amount of change in the interference pattern to verify change in light speed per perpendicular distance extended due to relative motion is what was not observed.

To explain the null results Lorentz assumed length s_x of the apparatus contracts in the direction of relative motion by the factor

$$\alpha = \sqrt{1 - \beta^2}$$

β represents v/c as the direction and speed of matter in ratio to light speed. Perpendicular lengths s_x and s_y are considered equal:

$$s_x = s_y = s$$

Each arm of the apparatus compares as equal to a proper length denoted as s such that, if the apparatus is theoretically at absolute rest, then respective times for light to move respective distances to-there-and-back are according to the equations

$$2t_x = t_{x1} + t_{x2} = \frac{s}{c} + \frac{s}{c} = \frac{2s}{c}$$

$$2t_y = t_{y1} + t_{y2} = \frac{s}{c} + \frac{s}{c} = \frac{2s}{c}$$

In these equations, t_{x1} and t_{y1} are the respective times to there and t_{x2} and t_{y2} are the respective times back from there.

What if the apparatus moves at velocity v in the x direction relative to absolute rest?

According to Galilean relativity and the premise light speed is invariant relative to the æther the times for light to move respective distances s_x and s_y vary. The differences in light speed and the apparatus speed are thus c – v in the direction of motion and c + v in the opposite direction of motion. A total time of the to-and-from propagation along the x-axis should be

$$2t'_x = t'_{x1} + t'_{x2} = \frac{s}{c-v} + \frac{s}{c+v}$$

$$= \frac{s(c+v)}{(c-v)(c+v)} + \frac{s(c-v)}{(c+v)(c-v)} = \frac{sc+sv+sc-sv}{(c-v)(c+v)}$$

$$= \frac{2sc}{c^2-v^2} = \frac{2sc}{c^2\left(1-\frac{v^2}{c^2}\right)} = \frac{2s}{c(1-\beta^2)} = \frac{2s}{c\alpha^2}$$

This time differs from that of the apparatus being at absolute rest: $2t_x = 2s/c$. However, if the apparatus contracts in the direction of relative motion by the factor α, then the difference in time from that of absolute rest is only by the factor $1/\alpha$.

The total time it takes light to propagate in the perpendicular direction of motion, as during time $2t'_y$, is similarly determined. The actual path of light is according to two directions: 1) the direction along the arm of the apparatus perpendicular to the direction of motion; and 2) the direction of motion in keeping pace with the apparatus. The actual distance is along the hypotenuse of a right triangle with respect to distance moved of those two other perpendicular directions. By the Pythagorean Theorem

$$\left(ct'_y\right)^2 = s^2 + \left(vt'_y\right)^2$$

$$s^2 = \left(ct'_y\right)^2 - \left(vt'_y\right)^2$$

$$s^2 = \left(t'_y\right)^2 (c^2 - v^2)$$

$$\left(t'_y\right)^2 = \frac{s^2}{c^2 - v^2} = \frac{s^2}{c^2(1-\beta^2)}$$

$$t'_y = \frac{s}{c\alpha}$$

The time light moves to-and-from in the perpendicular directions is

$$2t'_y = \frac{2s}{c\alpha}$$

It is the same with respect to the direction of motion if the apparatus arms in the direction of motion contract by the factor α.

Because light moves at the same time, speed and distance along both arms of the apparatus, there are no differences observed of a shift in the pattern of fringes. Although this explains the null result of experiment, it only requires the apparatus to contract in the direction of relative motion; it does not require clocks to retard as well, and there remains the possibility of timing light from one place to another by synchronization of clocks by one being transported to the other location. Relative time is thus another step for determining spacetime relativity.

If clocks are slower by the factor $1/\alpha$, durations of events are shorter by the factor α. Hence

$$2t'_x\alpha = 2t'_y\alpha = \frac{2s}{c\alpha}\alpha = \frac{2s}{c} = 2t_x = 2\mathrm{t_y}$$

Absolute rest is thus invisible with regard to a there-and-back light speed. However, to be consistent, a direct measure of light speed as constant should be nullified as well.

Further analyses involve more intricate explanations in relating such principles as covariance and the relativity of simultaneity. The latter explains how constant light speed is still determined as such from the synchronization of clocks by one of them being transported to a distance for its direct one-way measure.

Covariance

Covariance means the laws of physics apply the same to all systems. In other words, the perceptions of observers **A** and **B** are the same with regard to **A** or **B** being relatively at rest and the other moving at speed v. Because motion affects lengths and clocks, it is not obvious the speeds of different observers are perceived the same relative to each other, but relative motion is easily verified mathematically as covariant.

Consider Observer **A** at absolute rest sees Observer **B** approaching at velocity v the distance from x_1 to x_0 during time $t_1 - t_0$. The event includes a time it takes light to move a distance between positions x_1 and $x_0 = 0$. The time t_a of Observer **A** seeing Observer **B** moving the distance $x_2 - x_1$ is

$$t_a = \frac{x_1 - x_0}{v} - \frac{x_1 - x_0}{c}$$

Since the clock of Observer **B** is slower by the factor $1/\alpha$, since Observer **B** approaches the oncoming light at velocity v, and since coordinate lengths of Observer **B** are relatively shorter by the factor α, the duration of Observer **B** seeing Observer **A** move along length $(x_1 - x_o)\alpha$, as according to observer **B**'s clock, is

$$t_b = \frac{(x_1 - x_o)\alpha^2}{v} - \frac{(x_1 - x_o)\alpha^2}{c+v}$$

The task is to show $t_a = t_b$:

$$\frac{x_1 - x_o}{v} - \frac{x_1 - x_o}{c} = \frac{(x_1 - x_o)\alpha^2}{v} - \frac{(x_1 - x_o)\alpha^2}{c+v}$$

$$\frac{1}{v} - \frac{1}{c} = \frac{\alpha^2}{v} - \frac{\alpha^2}{c+v}$$

$$c(c+v) - v(c+v) = c\alpha^2(c+v) - vc\alpha^2$$

$$c^2 + vc - vc - v^2 = c^2\alpha^2 + vc\alpha^2 - vc\alpha^2$$

$$c^2 - v^2 = c^2\alpha^2$$

$$c^2\left(1 - \frac{v^2}{c^2}\right) = c^2\alpha^2$$

Since $\alpha^2 = (1 - v^2/c^2)$, the equality $t_a = t_b$ is confirmed. Observers **A** and **B** thus perceive relative motion the same as if either A or B is at absolute rest.

Simultaneity

Even though Einstein postulated constant light speed as fact without explanation, his principle of simultaneity helps explain it. Because Observer **B**'s clock in relative motion is slow, it is not simultaneous with the clock of Observer **A** relatively at rest. However, by the principle of covariance **A** and **B** perceive events the same, such that **B** is also regarded as relatively at rest. Simultaneity of events should thus be the same for both observers.

Consider **B** moves away from **A** at velocity v to a distance x after time t according to **A**'s clock. The task is to confirm **B**'s perception of time is the same as **A**'s. At distance x, it takes time x/c for light from **B** to move to **A**. The time for **A** to see **B** move the distance x is thus x/v + x/c. Because the coordinate lengths of **B** contract in the direction of motion by the factor α, and since duration of events by **B's** slower clock are also shorter by the factor α, and because the difference in **B**'s velocity from that of light is c – v in relation to **A** being relatively at rest, a ratio of unity of respective times T_A and T_B of **A** and **B**'s clocks being synchronous in timing of the event is

$$\frac{T_B}{T_A} = \frac{\frac{x\alpha^2}{v} + \frac{x\alpha^2}{c-v}}{\frac{x}{v} + \frac{x}{c}} = \frac{\frac{\alpha^2}{v} + \frac{\alpha^2}{c-v}}{\frac{1}{v} + \frac{1}{c}} = \frac{\frac{\alpha^2(c-v) + \alpha^2 v}{v(c-v)}}{\frac{c+v}{vc}} =$$

$$\frac{\alpha^2 vc(c-v) + \alpha^2 v^2 c}{v(c-v)(c+v)} = \frac{\alpha^2 c(c-v) + \alpha^2 vc}{c^2 - v^2}$$

$$= \frac{\alpha^2 c(c-v) + \alpha^2 vc}{c^2\alpha^2} = \frac{c-v+v}{c} = 1$$

Relativity of simultaneity is thus covariant with respect to different speeds v and locations x for synchronization of transport of clocks and the direct measure of light speed.

Lorentz Transformations

Transformation equations transform distance and time coordinates of observers in relative motion to the coordinates of the other observer. Let x, y, z, t be the spacetime coordinates of Observer **A** relatively at rest, and let corresponding coordinates of Observer **B** relatively in motion be x', y', z', t'. Respective origins O and O' of the two coordinate systems overlap at time t = t' = 0, such that time and distance of the events in coordinate system **B**, as perceived by Observer **B**, transform in view of Observer **A**'s perception, and vice versa for perceptions of each other's coordinates to be the same.

First consider a Galilean transformation of coordinates with regard to system **B** moving at velocity v relative to system **A**. Let origins of respective observers **A** and **B** be at the same place during the instant $t_0 = 0$, such that the coordinate distance x system **B** moves at velocity v relative to **A** becomes shorter after time t by the amount vt. Hence

$$s = x - vt$$

The task is to show how observer **B** perceives the same rate of decrease in coordinate system s'.

The event could be in any direction of relative motion. To describe it according to Galilean relativity whereby clocks and distance coordinates do not appear affected by relative motion, three-dimensional-perpendicular coordinate systems are established. Coordinate system **B** has perpendicular coordinates from origin O at time t as x', y', z', t' in comparison to coordinates x, y, z, t for **A**, as designating **B** in relative motion and A relatively at rest.

Lengths y' and z' are perpendicular to the direction of motion and do not contract by it. Hence, y' = y and z' = z. In the manner of explaining null results of the Michelson-Morley experiment, the distance light actually moves perpendicular to the direction of relative motion increases by the same mathematical factor the time of a clock in relative motion increases. The extended time it takes light to propagate farther is thus negated by the slower clock.

In contrast, the x and x' directions of relative motion moving relative to each other in opposite directions are consequential to how distances are determined by each observer. Since Observer **B**'s clock is slow, **B** moves an extended duration and an extended distance for modi-

fication of a Galilean transformation by a relativistic factor to be of the form

$$x' = \frac{x - vt}{\sqrt{1-\beta^2}}$$

As for the transformation of time coordinate, distances coordinates convert into time coordinates and vice versa. With constant light speed as a measure of distance the respective times t and t' can be replaced with x/c and x'/c. Substituting ct' for x', ct for x, and x/c for t obtains

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1-\beta^2}}$$

This is the Lorentz transformation that transforms the coordinate time t' of system **B** in view of system **A**.

The transformations indicate changes in time and distance because of different time and distance for light to move from each position of relative motion. If the object of reference is approaching the observer, distance and time of light speed are subtracted from those of actual time and distance of movement of the object. For objects receding from the observer, time and distance of light speed are added, as v is then of a negative value.

Transformations generally apply to different perceptions of events instead of merely to relative motion between observers. Covariance still applies, but another observer or object in relative motion can be included in the analysis whereby its motion, time and distance are determined differently by two other observers even though the different transformation results still apply as though any inertial frame of motion can be considered as relatively at rest.

Adding Velocities

Since clocks in relative motion differ, it is not obvious how observers in relative motion determine other velocities, as their calculation requires a theorem for adding velocities. For deriving it, consider inertial systems **A**, **B** and **C**. Consider **A** as relatively at rest, **B** as moving at velocity v_1 relative to **A**, or **C** as moving at velocity $v_2 = x'/t'$ relative to **B**. The sum of velocities v_1 and v_2 is to be determined relative to **A** as velocity $v_{12} = x/t$.

In relating coordinates of **B** to those of **A**, velocity v_2 transforms as

$$v_2 = \frac{x\prime}{t\prime} = \frac{[x - v_1 t]\sqrt{1 - \frac{v_1^2}{c^2}}}{\left[t - \frac{v_1 x}{c^2}\right]\sqrt{1 - \frac{v_1^2}{c^2}}} = \frac{x - v_1 t}{t - \frac{v_1 x}{c^2}}$$

Multiplying the first and last sides of the equation by $t - v_1x/c^2$ obtains

$$v_2\left(t - \frac{v_1 x}{c^2}\right) = x - v_1 t$$

$$v_2 t - \frac{v_1 v_2 x}{c^2} = x - v_1 t$$

Adding v_1v_2x/c^2 and v_1t to both sides of the equation obtains

$$v_1 t + v_2 t = x + \frac{v_1 v_2 x}{c^2}$$

$$t(v_1 + v_2) = x\left(1 + \frac{v_1 v_2}{c^2}\right)$$

Finally, dividing both sides of the equation by t and $1 + v_1v_2/c^2$ obtains

$$\frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}} = \frac{x}{t} = v_{12}$$

This equality represents velocity of system C in relation to the coordinate system A.

The formula above is for comparing velocities in the same direction of motion. It is possible to derive a formula for systems moving perpendicular to each other as well, which is actually simpler because of no contraction of length in the perpendicular direction of relative motion. Consider an object rotating perpendicular to the forward direction of relative motion. Because the clock in relative motion is slow, the observer perceives a faster speed of rotation by a relativistic factor. However, the actual speed of rotation is the combined vector product of perpendicular and forward speeds according to the Pythagorean Theorem.

Consider **A** is relatively at rest, **B** as moving along the x-axis at velocity v_1, and **D** moving along the y'-axis at velocity v_3. In relating coordinates of **B** to those of **A**, velocity v_3 becomes

$$v_3 = \frac{y\prime}{t\prime} = \frac{y\sqrt{1 - \frac{v_1^2}{c^2}}}{t - \frac{v_1 x}{c^2}} = \frac{y\sqrt{1 - \frac{v_1^2}{c^2}}}{t\left(1 - \frac{v_1 x}{tc^2}\right)}$$

Multiplying by $(1 - v_1x/tc^2)$ and dividing by the square root of $(1 - v_1^2/c^2)$, the left and right sides of the equation become

$$\frac{v_3\left(1-\frac{v_1x}{tc^2}\right)}{\sqrt{1-\frac{v_1^2}{c^2}}} = \frac{y}{t}$$

Since $x/t = v_1$, y/t becomes

$$\frac{y}{t} = \frac{v_3\left(1-\frac{v_1x}{tc^2}\right)}{\sqrt{1-\frac{v_1^2}{c^2}}} = \frac{v_3\left(1-\frac{v_1^2}{c^2}\right)}{\sqrt{1-\frac{v_1^2}{c^2}}} = v_3\sqrt{1-\frac{v_1^2}{c^2}}$$

This result is only of **D** moving along the y-axis relative to **A**. The velocity of **D** in the actual direction of the xy-plane has not yet been determined. To determine it, the Pythagorean Theorem applies with regard to the speeds in perpendicular directions. The result is

$$v_{13} = \sqrt{\frac{y^2}{t^2} + v_1^2} = \sqrt{v_3^2\left(1-\frac{v_1^2}{c^2}\right) + v_1^2} = \sqrt{v_3^2\alpha_1^2 + v_1^2}$$

The velocity v_{13} is that of system **D** relative to system **A**.

The derivation assumes light speed is the same for all observers, and they are to be consistent in showing light speed added to light speed or any velocity is still light speed c:

$$c_{cc} = \frac{c+c}{1+\frac{cc}{c^2}} = \frac{2c}{1+1} = c$$

$$v_{12} = \frac{v_1+c}{1+\frac{v_1c}{c^2}} = \frac{v_1+c}{1+\frac{v_1}{c}} = \frac{c(v_1+c)}{c+v_1} = c$$

$$v_{12} = \frac{c+v_2}{1+\frac{cv_2}{c^2}} = \frac{c+v_2}{1+\frac{v_2}{c}} = \frac{c(c+v_2)}{c+v_2} = c$$

$$v_{13} = \sqrt{v_3^2\left(1-\frac{c^2}{c^2}\right) + c^2} = c$$

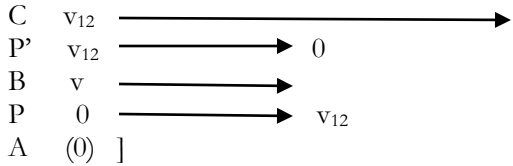
$$v_{13} = \sqrt{c^2\left(1-\frac{v_1^2}{c^2}\right) + v_1^2} = \sqrt{c^2 - v_1^2 + v_1^2} = c$$

Light speed is thus the same in all inertial systems according to the addition of velocities formulas.

Constant Speed Change

Acceleration as a change in speed, according to Newtonian Mechanics, increases without limit, but the addition of velocities theorem stipulates to the contrary that light speed is a limit for matter to neither exceed nor even reach. However, applying the theorem to a system that constantly changes speed is complex. A change in speed from two seconds of acceleration, for instance, is simply determined in accordance with the addition of velocities theorem, but because the rate of speed change decreases as speed itself increases, the total time of acceleration entails more entailed calculation.

Speed change itself is defined constant in a manner consistent with the principle of covariance. If system **P** is subsequently coincident with inertial systems **A**, **B**, **C**, etc., as if the change from one inertial system to another is of an equal time interval, and if the speed and direction of the motion of **B** relative to **A** is the same as **C** relative to **B**, and so forth, then the change in speed is constant. If the change in speed from **A** to **B** is from v_1 to v_{12} with regard to spacetime coordinates of **A**, then the speed change from **B** to **C** is also from v_1 to v_{12} with regard to the spacetime coordinates of **B**, but the speed change from **B** to **C** is from v_{12} to v_{13} with regard to the spacetime coordinates of **A**. There is thus simple progression of **P** changing speed from v_1 to v_{12} to v_{13} etc. However, this progression is not by the same relativistic factor relative to **A**, as due to **A** perceiving a decreased rate of speed change at greater speeds.



Symmetry and asymmetry of relative distance is illustrated according to the above illustration. Covariance applies with regard to **A**, **B**, **C**, **P** and **P'** simultaneously meeting wherefrom **B** relatively moves at velocity v away from **A** and at velocity –v away from **C**. Symmetry is with regard to **P** and **P'** being v relative to **B** at the time they catch up with **B**. However, there are also asymmetry conditions as well. **B** perceives accelerations of **P** and **P'** different than do **A** and **C**. **B** perceives a different change of speed of either **P** or **P'** as 2v, as from either –v to v or from v to –v, which is a greater change than from 0 to v_{12} as perceived by **A** and **C**.

Since v is the speed of **B** relative to **A,** it determines the distances separating **B**, **C**, **P** and **P'** from **A** at time t. Since the speed of **B** is v rela-

tive to either **A** or **C**, and the speed of either **A** or **C** is v relative to **B**, and since the initial and final speeds of **P** and **P'** are also v relative to **B**, **P** and **P'** initially move in opposite direction away from **B** at a speed v relative to **B** to slow to relatively at rest with **B** and then change direction to return to **B** at speed v, as required by covariance. The asymmetry is according to the difference of how distance and time of acceleration is determined by **B** instead of either **A** or **C**, but symmetry still applies of **P** and **P'** meeting with **B** whereby change in speed of both is a difference between zero and v_{12} relative to **A** and **C**.

By covariance, both time and distance are determined according to **A**'s clock and **B**'s speed relative to **A**. The distance d of acceleration per second is thus vt relative to either **A** or **C,** but it is shorter relative to **B** due to **B**'s clock being slower by a relativistic factor. In effect, the relativistic distance relative to **A** or **C** is simply vt with a slightly different interpretation. Consider, then, the following mathematical interpretation:

$$d = v_a t = \frac{2v_a t}{1+\frac{v_a^2}{c^2}+1-\frac{v_a^2}{c^2}} = \frac{2v_a t}{1+\frac{v_a^2}{c^2}\sqrt{\left[1-\frac{v_a^2}{c^2}\right]^2}}$$

$$= \frac{2v_a t}{1+\frac{v_a^2}{c^2}+\sqrt{1-\frac{2v_a^2}{c^2}+\frac{v_a^4}{c^4}}} = \frac{2v_a t}{1+\frac{v_a^2}{c^2}+\sqrt{1+\frac{2v_a^2}{c^2}+\frac{v_a^4}{c^4}-\frac{4v_a^2}{c^2}}}$$

$$= \frac{2v_a t}{\left[1+\frac{v_a^2}{c^2}\right]+\sqrt{\left[1+\frac{v_a^2}{c^2}\right]^2-\frac{4v_a^2}{c^2}}} = \frac{2v_a t}{\left[1+\frac{v_a^2}{c^2}\right]+\left[1+\frac{v_a^2}{c^2}\right]\sqrt{1-\frac{(2v)^2}{c^2\left[1+\frac{v_a^2}{c^2}\right]^2}}}$$

$$= \frac{v_{12} t}{1+\sqrt{1-\frac{v_{12}^2}{c^2}}}$$

The speed v_{12} approximates to $2v_a$. However, v_{12} generalizes for any speed v, as the general formula derived verifiably from the Lorentz transformation equations.

Significantly, if v_{12} is extremely small in comparison to light speed c, as for a negligible effect of the relativistic factor, such that it approximates as 1, then the above result equates as a Newtonian non-relativistic one:

$$d = v_a t = \frac{at^2}{2}$$

By Newtonian Mechanics, v_a is the average speed of P from 0 to 2v, but by the addition of velocities theorem the change in speed from v = 0 to v_{12} is slightly less than 2v because of the rate of speed change at relatively higher speeds decreasing. The difference is negligible except for greater changes in speed from 0 to nearly that of light.

What can further be explained is constant speed in analogy to a relativistic condition of gravity according to General Relativity, as both of them relating to a relativistic factor-squared.

$$\frac{v_{12}}{\sqrt{1-\frac{v_{12}^2}{c^2}}} = \frac{(2v)}{\left[1+\frac{v^2}{c^2}\right]\sqrt{1-\frac{v_{12}^2}{c^2}}} = \frac{2v}{\sqrt{\left[1+\frac{v^2}{c^2}\right]^2-\left[1+\frac{v^2}{c^2}\right]^2\left[\frac{(2v)}{\left[1+\frac{v^2}{c^2}\right]c}\right]^2}}$$

$$= \frac{2v}{\sqrt{1+\frac{2v^2}{c^2}+\frac{v^4}{c^4}-\frac{4v^2}{c^2}}} = \frac{2v}{\sqrt{1-\frac{2v^2}{c^2}+\frac{v^4}{c^4}}} = \frac{2v}{\sqrt{\left[1-\frac{v^2}{c^2}\right]^2}} = \frac{2v}{1-\frac{v^2}{c^2}} = \frac{2v}{\alpha^2}$$

The progression of v_0 to v_{12}, as for twice v, is thus in ratio to the relativistic factor squared.

The significance of the relativistic factor squared regarding constant speed change is that the relativistic factor for gravitational acceleration is also squared. It does not determine the value of the gravitational constant, but it is analogically consistent inasmuch as covariance of a clock increasing at constant speed equals that of a clock experiencing a constant increase in gravitational strength. However, the analogy is not merely that of centripetal acceleration and rotational acceleration; the increase in gravitational potential is analogous to increase in speed, as the relativistic effect includes both gravity and relative motion in the gravitational field.

Note: A mathematical solution to comparing **P**'s clock time to **A**'s is not here provided, as it entails a more complicated math than simple algebra. What has only been explained is the distinction of the calculation of time and distance between relativity theory and Newtonian Mechanics.

The Clock Paradox

Observers **A** and **B** in relative motion time each other's clock as slow, but not if **B** moves away from **A**, reverses direction and then returns to **A**. **B**'s clock is then determined as the slower one by direct comparison. This is the well-known clock paradox: both clocks being

perceived slower than the other by condition of covariance, but only one clock is slower by means of direct comparison.

The paradox is explainable because the event is not symmetrical. The traveling observer changes direction; the stay at home observer does not. In order to confirm the clock paradox does not contradict theory, it is only necessary to show how Observer **A**'s clock is slow if Observer **A** accelerates instead of Observer **B**. Instead of Observer **B** changing direction to return to Observer **A**, **A** merely accelerates to catch up with **B**. There is symmetry with regard to either **A** or **B** accelerating: **B** moving away from **A** at velocity v uses force to become relatively at rest with system **A** and uses more force to return to **A** at velocity –v; as to compare with **A** using the force to become relatively at rest with system **B** and using more force to move at velocity v_{12} in order to catch up with **B**.

To verify symmetry is conditional consider **B** moves along the x-axis relative to **A** at velocity v before changing direction along the x-axis at time T to move at velocity –v instead of v. With regard to **A** as relatively at rest, wherefrom **B** moves relative to **A**, the comparison of time recorded by **A**'s and **B**'s clocks during the trip is

$$2T' = \frac{2T}{\alpha}$$

This longer time results from **B** moving an extended distance at speed v because of a slower clock.

The determination of time for the previous event is simple. However, for the event of **A** being relatively at rest and then moving to catch up with **B**, **A**'s clock keeps two different rates while **B**'s clock remains the same. By the addition of velocities theorem a change in velocity is not simply from v to 2v; instead, it is from v to v_{12}, which involves a corresponding change in rate of clocks. This condition is thus more complex than the previous one. However, the complexity was previously determined in the section Constant Speed Change whereby distance and time of acceleration equate the same as the average speed consistent with the Newtonian formula $d = vt = (½)at^2$.

The task is nonetheless to determine total time for **A** to catch up with **B** results the same as $2T/\alpha$. In perspective, what is to be determined is

$$T + T'' = \frac{2T}{a^2} = \frac{2T'}{a}$$

T" is **A**'s time while accelerating from speed zero to v_{12}. Since **B**'s clock is slow by the relativistic factor, **B** perceives T" as T', which is the same as the time **B** moves relative to A.

To reconfirm, **B** moves relative to **A** in time T the distance X at velocity v_1. In order to catch up with **B**, **A** accelerates from relatively at rest to velocity v_{12}. The time T" it takes **A** to catch up with **B** is according to difference in speeds: $v_{12} - (v_1 - 0)$. According to **A** the difference is v_2; according to **B** the difference is v_1. Hence

$$v_{12} = \frac{v_1+v_2}{1+\beta_1\beta_2} = \frac{2v}{1+\beta^2}$$

$$T" = \frac{X}{v_{12}-v} = \frac{X}{\frac{2v}{1+\beta^2}-v} = \frac{X(1+\beta^2)}{2v-v(1+\beta^2)}$$

$$= \frac{X(1+\beta^2)}{2v-v-v\beta^2} = \frac{X(1+\beta^2)}{v-v\beta^2} = \frac{X(1+\beta^2)}{v(1-\beta^2)}$$

$$= \frac{T(1+\beta^2)}{1-\beta^2} = \frac{T(1+\beta^2)}{\alpha^2}$$

The total time relative to **A** is

$$T + T" = T + \frac{T(1+\beta^2)}{\alpha^2} = \frac{T\alpha^2}{\alpha^2} + \frac{T(1+\beta^2)}{\alpha^2}$$

$$= \frac{T(1-\beta^2)}{\alpha^2} + \frac{T(1+\beta^2)}{\alpha^2} = \frac{T-T\beta^2+T+T\beta^2}{\alpha^2} = \frac{2T}{\alpha^2}$$

However, being T' is slower than T by the factor $1/\alpha$, the total time of the event according to **B** is

$$\frac{2T}{\alpha^2}\alpha = \frac{2T}{\alpha}$$

Determinations of slower times are thus the same for **A** and **B** with regard to symmetry of conditions.

7
MASS-ENERGY DYNAMICS

Kinetic energy is conserved of elastic collision according to Newtonian Mechanics. It is not conserved regarding inelastic collision, as energy is assumed to change in form in being conserved by converting it to either light or heat. Such conversion is indicative of Special Relativity. Conservation of momentum and mass-energy by it are both conserved of absorption and emission, or just of reflection, of such electromagnetic energy as light photons. There is a so-called Doppler Effect whereby the principle of covariance applies whether the reflection is either of a photon or a material particle, but conservation of total energy maintaining after an exchange of mass is still more complex. Although mass-energy as mc^2 is derived as constant according to conservation of momentum and mass, the exchange of mass from collision results in a more complex process regarding how total energy is conserved.

Einstein's mc^2, as pointed out by Harold Aspden (1927-2011) in his books, had previously been derived by Joseph John Thomson (1856-1940) in relation to the development of Maxwell's theory of electromagnetism. Thomson's derivation of it combines kinetic energy $(1/2)m_ev^2$ of the electron and its radius r_e with the electromagnetic formula of unit charge e in the manner

$$\frac{(ev/c)^2}{3r_e} = \frac{1}{2}m_ev^2$$

$$\frac{e^2v^2}{3c^2r_e} = \frac{1}{2}m_ev^2$$

$$\frac{2e^2}{3r_e} = m_ec^2$$

Einstein's derivation of mc^2 was different, as it includes an increase in mass-energy along with an increase in relative motion. There is conversion between light and matter, and there is a Doppler effect relating how both light and matter are observed. Along with nullifying effects of

space-time relativity there are nullifying energy effects to consider of kinetic energy as well whereby the internal motion aspect of its conservation is just a matter of interpretation.

Mass-Energy and Light

Conservation of energy is at issue regarding inelastic collision occurring between two masses for them to remain in the same state of relative motion as relatively at rest. For, if collision is inelastic in nature, then motion stops unless it continues as some other form of energy. Internal energy could be stored, for instance, as heat or molecular motion. By elastic collision the kinetic energy is maintained as relative motion of the masses. For a collision to remain inelastic whereby the same mass content of the system remains as it was before collision, the internal energy of motion caused by the collision is spent to maintain in a state of equilibrium with its environment. It could be spent either as the internal motion of molecules of matter or as radiant heat, as a means to maintain thermodynamic equilibrium.

Heat is viewed as a random motion of internal molecules of mass, but conservation of relative mass and momentum applies to molecular motion. The molecules are not able to directly surrender their motion to molecules when they are separated by empty space. However, there is still a possibility to consider of heat being absorbed and emitted as electromagnetic radiant, such as is light.

Since energy is conserved of masses in collision by them exchanging it, a kinetic energy of relative motion also maintains in some form or another. Einstein agreed. Mass and energy according to SRT are equivalent whereby the mass content of a body is only one of many possible forms of energy as convertible from one form to another.

Consider light as a particular form of energy. It being emitted, absorbed and reflected by matter constitutes pressure, as according to an electromagnetic theory that was derived by Maxwell in the middle of the nineteenth century, and as was verified by experiment in the year 1890 by Peter Lebedew (1866-1911). Reflection and absorption of light by two lightweight flags, for instance, can cause them to rotate around a tiny pole if they are attached opposite to each other, as by one side of each flag being colored white to reflect light and the other side of each flag being the color black to absorb it. The absorption of light by one flag while the other flag reflects it results in unequal momenta.

Einstein equated the internal energy of mass as a product of mass and light speed squared in the manner

$$E = \frac{E_0}{\sqrt{1-\frac{v^2}{c^2}}} = mc^2 = \frac{m_0c^2}{\sqrt{1-\frac{v^2}{c^2}}}$$

Mass m_0 is the rest mass of m moving at velocity v, and m_0c^2 is internal energy constitutive of rest mass. The increased relative mass m in relative motion minus the rest mass is identified as kinetic energy potential for relative motion in approximation to kinetic energy of Newtonian Mechanics.

Einstein explained internal mass-energy as work energy of a photon within a mass being emitted back and forth. The photon is equated to a potential energy of rest mass m_o as part of the total mass M relatively at rest. Two mass parts m_o, also described as two spheres, emit and receive a photon from within M described as a tube. When sphere A emits the photon to sphere B, M recoils during time t of emission and reception the distance x = vt while the photon moves the distance d = ct. Work is done to move M back and forth as such that equates to potential energy $E_o = dm_o$. The relations equate as total momentum in the manner

$$Mv = \frac{E_o}{t} \tag{1}$$

$$v = \frac{E_o t}{Mc} \tag{2}$$

Displacement x of M equates in the manner

$$x = vt = \frac{E_o t}{Mc} \tag{3}$$

$$xM = dm_o \tag{4}$$

$$x = \frac{dm_o}{M} = \frac{E_o t}{Mc} \tag{5}$$

Substituting x from (5) obtains

$$\frac{E_o t}{Mc} = \frac{dm_o}{M} \tag{6}$$

$$E_o = \frac{Mm_o cd}{Mt} = \frac{m_o cd}{t} = m_o c^2 \tag{7}$$

This derivation assumes m_o is a single part of M as representative of all of M. What remains to be derived is the relation of kinetic energy to internal energy, as there is a further condition of internal motion relating

to external motion in the manner m_oc^2 in relative motion increases by the relativistic factor of its speed v. Supposedly, by interpretation, the relative motion of mass increased by the relativistic factor relates directly to kinetic energy in a way that total energy is conserved. It is possible as such if m_oc^2 is interpreted as internal rest mass-energy when relatively at rest from inelastic collision and the relativistic increase in mass from relative motion is interpreted as the transformation of internal rest mass-energy as potential energy into kinetic energy, which implies an actual change in mass between different masses in elastic collision need not occur. The exchange only interprets as such because the result is the same as being a conversion of internal energy to external energy, as consistent with entropy, the second law of thermodynamics.

Relative Mass Increase

According to special relativity a mass m in relative motion at velocity v in ratio to light speed c is relatively greater than the same mass m_0 relatively at rest:

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}} \tag{1}$$

Mass-energy according to theory is conserved after collision. If the collision is inelastic, wherefrom relative motion between masses is terminated, the total mass-energy remains unchanged.

An increase in relative mass along with an increase in relative motion is mathematically verifiable according to the conservation principles of mass-energy and momentum. Constant light speed and covariance apply, as does the addition of velocities theorem, for the verification.

Relative mass is first distinguished from the rest mass. Let m_0 be mass relatively at rest with either Observer **A** or Observer **B**. Let m be the same quantity mass if moving with **B** at velocity v_1 relative to a positive direction towards **A**. Mass m and mass m_0 become one, say M, relative to **A** by means of inelastic collision. Conservation of mass along with conservation of total momentum applies according to equations

$$m + m_o = M \tag{2}$$

$$mv_1 + m_o(0) = mv_1 = Mv_2 \tag{3}$$

Equation (2) illustrates the total mass is the same before and after inelastic collision. Equation (3) is somewhat more complex due to $m_o(0)$ being at rest with **A** before collision. Total momentum relative to **A** before col-

lision is thus only mv_1, but because both masses move at velocity v_2 after inelastic collision, the total momentum relative to **A** is also Mv_2.

Substituting m and m_0 of equation (2) for M in equation (3) allows for a solution of m as

$$mv_1 = (m + m_0)v_2$$

$$mv_1 = mv_2 + m_0v_2$$

$$mv_1 - mv_2 = m_0v_2$$

$$m(v_1 - v_2) = m_0v_2$$

$$m = \frac{m_0v_2}{v_1 - v_2} \tag{4}$$

The objective is to verify equation (4) equals equation (1):

$$m = \frac{m_0v_2}{v_1 - v_2} = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{5}$$

$$\frac{m}{m_0} = \frac{v_2}{v_1 - v_2} = \frac{1}{\sqrt{1 - \frac{v_1^2}{c^2}}} \tag{6}$$

$$\frac{v_2}{v_1 - v_2} = \frac{1}{\sqrt{1 - \frac{v_1^2}{c^2}}} \tag{7}$$

$$\sqrt{1 - \frac{v_1^2}{c^2}} = \frac{v_1 - v_2}{v_2} = \frac{v_1}{v_2} - 1 \tag{8}$$

$$v_2\sqrt{1 - \frac{v_1^2}{c^2}} = v_1 - v_2 \tag{9}$$

$$v_2^2\left[1 - \frac{v_1^2}{c^2}\right] = v_1^2 - 2v_1v_2 + v_2^2 \tag{10}$$

$$v_2^2 - \frac{v_1^2v_2^2}{c^2} = v_1^2 - 2v_1v_2 + v_2^2 \tag{11}$$

$$-\frac{v_1^2v_2^2}{c^2} = v_1^2 - 2v_1v_2 \tag{12}$$

$$2v_1v_2 = v_1^2 + \frac{v_1^2 v_2^2}{c^2} = v_1^2\left[1 + \frac{v_2^2}{c^2}\right] \tag{13}$$

$$2v_2 = v_1\left[1 + \frac{v_2^2}{c^2}\right] \tag{14}$$

$$v_1 = \frac{2v_2}{1+\frac{v_2^2}{c^2}} \tag{15}$$

Equation (15) is of the form of the addition of velocities theorem.

Equation (15) relates to equation (1) in a manner of elastic collision being a reversal of inelastic collision. Consider v_1 is the initial velocity of m towards $m_o(0)$; v_2 is the velocity of m_x after inelastic collision. In relation to the addition of velocities theorem, v_1 further pertains to the result of elastic collision as a reversal of inelastic collision from changes in velocities of m_o and m_x. In view of covariance, velocities v_2 of $m_o(0)$ relative to m_x and $-v_2$ of m_x relative to $m_o(0)$ are the same speed. This covariant symmetry further applies to reversals of inelastic collision. The change in speed of $m_o(0)$ from v_2 to 0, with m_x relatively at rest, is from 0 to v_2, as reversing of inelastic collision. However, with respect to $m_o(0)$ as relatively at rest, it is according to the addition of velocities theorem for twice change of v_2 from 0 and from v_2.

The conservation of mass in inelastic collision indicates a paradox with regard to the same mass being relatively greater if in relative motion, but the paradox is resolved with regard to conservation of mass only applying as a momentary state of collision. If collisions are inelastic, mass is conserved by internal motion of the system, as heat or some other form of energy. If they are of internal motion, then conservation of mass is maintained, but mass is not conserved as mass if it converts to such electromagnetic energy as light. If the internal energy converts to light energy, then mass is only conserved if some other mass absorbs an equal amount of light energy.

The Doppler Effect

Although increase in mass-energy along with relative motion is complicated, it was previously indicated by a Doppler Effect proposed in 1842 by Christian Doppler (1803-1853). It explains why a whistle on a train is of a lower pitch, as when the train recedes from the observer, and of a higher pitch, as when approaching the observer. Explanation is according to the vibration of air molecules forming waves. Lower pitch sound is stretched out weaker waves and higher pitched sound is more compacted stronger waves. Stretching results from recession between the

source and observer. Compacting results from an observer and source approaching each other.

These effects are of the general dynamics of ordinary particles as well as for light. Bullets fired from a gun, for instance, are more energetic if the gun firing them is moving towards the target rather than away from it. They also apply to light whether light is either particle or wave in nature. Systems approaching each other naturally receive light signals more rapidly than do systems receding from each other. Such effects result from laws of motion according to either Newtonian or relativity theory.

The task is to illustrate general covariance of observers firing bullets at each other for comparison of results with a specific Doppler effect of light propagation. Accordingly, Observer **A** is relatively at rest at the origin from where Observer **B** moves away at velocity v_1. After time T and the distance X of their separation, as according to **A**, **A** fires a bullet at **B**. After time T' = T/α_1 of their separation, as according to **A**, **B** fires a bullet at **A**. Regarding covariance of same relative speed the task is to show the time for receiving a bullet is the same for **A** as it is for **B**.

First, consider a time T_b for **B** to receive a bullet from **A** is time T plus time T_x it takes the bullet moving at velocity v_2 to catch up with **B** moving away from X at velocity v_1. Hence

$$T_b = T + T_x = \frac{X}{v_1} + \frac{X}{v_2 - v_1} = \frac{x(v_2 - v_1)}{v_1(v_2 - v_1)} + \frac{v_1 X}{v_1(v_2 - v_1)}$$

$$= \frac{X(v_2 - v_1) + v_1 X}{v_1(v_2 - v_1)} = \frac{v_2 X - v_1 X + v_1 X}{v_1(v_2 - v_1)} = \frac{v_2 X}{v_1(v_2 - v_1)}$$

This time is according to the clock of **A**. Because **B**'s clock is slower by the factor $1/\alpha_1$, as to perceive less duration, **B** determines the total time as

$$T_b = \frac{X\alpha_1}{v_1}\left[\frac{v_2}{v_2 - v_1}\right]$$

The task now at hand is to determine the time for **A** to receive a bullet from **B**. Because **B**'s clock is slow by the factor $1/\alpha_1$, the time **B** decides to shoot a bullet at **A**, after **B** passes **A**, is T' = T/α_1 for moving distance X' = x/α_1 between **A** and **B**. The bullet's speed is calculated according to the addition of velocities theorem whereby v_{12} and v_2 are both negative values because of **B** receding from both **A** and the bullet:

$$-v_{12} = \frac{v_1 + (-v_2)}{1 + \beta_1(-\beta_2)} = \frac{v_1 - v_2}{1 - \beta_1\beta_2}$$

Although **A** receives the bullet as moving in the negative direction, as v_{12} to be a negative velocity, the time X'/v_{12} for **A** to receive the bullet from **B** is additional to the time X'/v_1. It is thus positive. Hence, the time **A** receives the bullet is

$$T_a = T' + T'_x = \frac{X'}{v_1} + \frac{X'}{v_{12}} = \frac{X}{v_1\alpha_1} + \frac{X}{v_{12}\alpha_1} = \frac{v_{12}X}{v_1 v_{12}\alpha_1} + \frac{v_1 X}{v_1 v_{12}\alpha_1}$$

$$= \frac{v_{12}X + v_1 X}{v_1 v_{12}\alpha_1} = \frac{X(v_{12}+v_1)(1-\beta_1\beta_2)}{v_1(v_2-v_1)\alpha_1} = \frac{X}{v_1\alpha_1}\left[\frac{v_{12}(1-\beta_1\beta_2)+v_1(1-\beta_1\beta_2)}{v_2-v_1}\right]$$

$$= \frac{X}{v_1\alpha_1}\left[\frac{(v_2-v_1)+v_1(1-\beta_1\beta_2)}{v_2-v_1}\right] = \frac{X}{v_1\alpha_1}\left[\frac{v_2-v_1+v_1-v_1\beta_1\beta_2}{v_2-v_1}\right]$$

$$= \frac{X}{v_1\alpha_1}\left[\frac{v_2-v_1\beta_1\beta_2}{v_2-v_1}\right] = \frac{X}{v_1\alpha_1}\left[\frac{v_2-v_2\beta_1^2}{v_2-v_1}\right] = \frac{Xv_2}{v_1\alpha_1}\left[\frac{1-\beta_1^2}{v_2-v_1}\right]$$

$$= \frac{X\alpha_1^2}{v_1\alpha_1}\left[\frac{v_2}{v_2-v_1}\right] = \frac{X\alpha_1}{v_1}\left[\frac{v_2}{v_2-v_1}\right]$$

This time being the same as T_b, as perceived by **B** is thus covariant.

A similar event for light signals is achieved by substituting c for v_2, and v for v_1, to obtain

$$\frac{X\alpha}{v}\left[\frac{c}{c-v}\right] = \frac{X\alpha}{v}\left[\frac{1}{1-\beta}\right] = \frac{X}{v}\left[\frac{\alpha}{1-\beta}\right] = \frac{X}{v}\left[\frac{\sqrt{1-\beta^2}}{1-\beta}\right]$$

$$= \frac{X}{v}\left[\frac{\sqrt{1-\beta}\sqrt{1+\beta}}{1-\beta}\right] = \frac{X}{v}\left[\frac{\sqrt{1+\beta}}{\sqrt{1-\beta}}\right] = \frac{X}{v}\left[\frac{1+\beta}{1-\beta}\right]^{\frac{1}{2}}$$

This is the time either Observer **A** or Observer **B** sees the other observer move the distance X.

The relation holds for any distance X or X', and for any time T_a or T_b. It is thus divisible into any number of distances and times. These times and distances relate to wave properties of light as wavelength λ and frequency *f* such that

$$f' = f\left|\frac{1-\beta}{1+\beta}\right|^{\frac{1}{2}} \qquad \lambda' = \lambda\left|\frac{1+\beta}{1-\beta}\right|^{\frac{1}{2}}$$

$$f' = f\left|\frac{1+\beta}{1-\beta}\right|^{\frac{1}{2}} \qquad \lambda' = \lambda\left|\frac{1-\beta}{1+\beta}\right|^{\frac{1}{2}}$$

The equations are relativistic Doppler formulae for comparing light sources and observers as relatively either approaching toward or receding from each other at constant velocity. The results are the same whether light is a wave or a particle.

Conserving Light Energy

Since light possesses momentum, its emission and absorption by mass is subject to the conservation laws of momentum and energy. Verification is with regard to mass $m_0 = 1$ and momentum $m_0(0) = 0$ relative to Observer **A** absorbing a photon of light having momentum $m_x c$ such that m_0 and the photon energy move with Observer **B** at velocity .6c relative to Observer **A**. Conservation of momentum with regard to the total mass of both light and matter with respect to **A** is according to the equations

$$m_x c + m_0(0) = (m_x + m_0)\,.6c$$

$$m_x c = .6m_x c + .6m_0 c$$

$$m_x = .6m_x + .6m_0$$

$$.4m_x = .6m_0$$

$$m_x = \frac{3}{2}m_0$$

The total mass with respect to A before and after absorption is thus

$$\frac{3}{2}m_0 + m_0 = \frac{5}{2}m_0$$

Total momentum before collision was (3/2)(1) = 3/2 light speed units. It is also (3/2 + 1)(3/5) = (5/2)(3/5) = 3/2 light speed units after collision. The total momentum is thus conserved with regard to absorption and emission of light by matter.

Note: Since total mass before and after collision is simply $m_x + m_0 = 2.5$ units with respect to **A**, it is also conserved, as in accordance with inelastic collision.

For a reverse process of inelastic collision as elastic collision a photon is emitted from total mass $m_x + m_o$ in the opposite direction at which it was absorbed. Although **B** perceives speed of emission the same as absorption, **A** perceives the emitted photon speed as

$$v_{12} = \frac{2v}{1+\frac{v^2}{c^2}} = \frac{2(.6c)}{1+.36} = \frac{15}{17}c$$

The relative mass becomes

$$\frac{m_0}{\sqrt{1-\left[\frac{15}{17}\right]^2}} = \frac{17}{8}m_0$$

Its momentum becomes

$$\frac{17}{8}m_0 \cdot \frac{15}{17}c = \frac{15}{8}m_0 c$$

The photon *mass-inertia* in the opposite direction is

$$m_{xb} = m_x \left|\frac{1-v_{12}}{1+v_{12}}\right|^{\frac{1}{2}} = \frac{3}{2}m_0 \left|\frac{c-\frac{15}{17}c}{c+\frac{15}{17}c}\right|^{\frac{1}{2}} = \frac{3}{8}m_0$$

Total mass and total momentum with respect to A are again

$$\frac{17}{8}m_0 + \frac{3}{8}m_0 = \frac{5}{2}m_0$$

$$\frac{17}{8}m_o\frac{15}{17}c - \frac{3}{8}m_0 c = \frac{3}{2}m_0 c$$

Both mass and momentum of light and matter are thus conserved of elastic collision between light and matter by means of a transfer of mass between light and matter.

Since the total energy of matter relatively at rest equals the product of mass and light speed squared, and since elastic collision between matter and light involves a transfer of mass for its conservation, implications are matter is essentially a collection of light energy in that it converts from a light form to a mass form by means of inertia.

Conserving Energy More Generally

Consider an example result whereby a mass m_x equal to three unit masses m_o moving at speed v_x collides with a unit mass m_o relatively at rest for them to move at velocity .6c. According to Newtonian Mechanics they combine as four unit masses moving at speed .6c to have a momentum of $4m_o(3/5)c = (12/5)m_oc$. For the total momentum to remain the same after its collision it need equate as $3m_o(v_x) = (12/3)m_oc$, such that $v_x = (4/5)c$.

According to SRT there is a relativistic increase in mass along with relative motion. Hence

$$\frac{(9/5)m_o}{\sqrt{1-(4/5)^2}}\left(4/5\right)c + m_o \neq \frac{[(9/5)m_x+m_o]}{\sqrt{1-(3/5)^2}}\left(3/5\right)c$$

$$3m_o\left(4/5\right)c + m_o \neq 6m_o\left(3/5\right)c$$

$$\frac{17}{5} \neq \frac{18}{5}$$

However, if the original rest mass m_x was $3m_0$ and the internal motion is slower by the same relativistic factors, then the relativistic increase in mass is nullified in effect for the result to calculate the same way Newtonian Mechanics determines it.

The nullification of increase in mass by slower time is perceivable as a relative increase in distance of internal interaction for less energy. The interaction energy is of electromagnetic radiation relatively moving back and forth at speeds (c + v) and (c – v). Even though there is a relativistic contraction of length in the direction of relative motion, the overall forward motion results in more travel distance.

Similarly, kinetic energy is affected by difference in relative speeds. In opposite directions of relative motion the collision between internal particles of mass relates as the difference in opposite directional speeds in the manner $(c + v)(c – v) = c^2 – v^2 = c^2[1 – (v^2/c^2)]$. Difference in potential or kinetic energy of relativity theory from that of Newtonian Mechanics is thus explainable.

General Implications

Is gun powder more energetic than sand? Is hot water more energetic than cold water? According to relativistic mass-energy it is the same for any gram of mass no matter the nature of its substance. It is just not observable as such. How energy interrelates is determined according to entropy. However, that implies internal effects can be invisible outcomes, such that observational effects need to be understood as such.

The equal mass-energy change among masses interacting is particularly significant regarding conservation of either potential or kinetic energy, as the mass-energy relation mc^2 was derived prior to Einstein's different derivation of it, as Thomson's derivation was according to electrostatic charge plus kinetic energy, which Aspden included in his theory with unifying aspects. The unifying aspects are of ghostly particles analo-

gous to virtual particles of quantum physics as an internal source determining the visible part of reality.

Conservation of either potential or kinetic energy not only relates to the previous proof of kinetic energy conservation according to Newtonian Mechanics, it could further relate to internal motion of mass regarding inelastic collision and to gravity in that light speed is slower in a gravitational field. Energy conservation still applies mathematically, but actual perception of reality varies according to how it interrelates.

Although energy is conserved of the interaction between systems, mass-energy apart from the interaction is, in theory, not necessarily conserved in view of observers whose time and distance units have changed from interaction. For a slower clock, the orbital radius and speed of a star in a distant galaxy could appear shorter and/or faster unless the view of the observable part of the universe is also relativistic as a consequence of its observation being a part of an infinite universe.

A relativistic point of view of the observable part of the universe is explained in this book. By it, observable radiation is dependent on how it allows relative motion of mass-energy. It relates to both Quantum Mechanics and General Relativity. By Quantum Mechanics, there is a probability condition whereby so-called vacuum space is a virtual field of energy wherefrom virtual particles are predicted to have indirect effect on the atomic structure of matter. General Relativity includes an equivalence principle of Newtonian Mechanics whereby gravitational mass is, in effect, the same as inertial mass.

In relation to the virtual field is a Higgs Mechanism for the creation of mass-energy. Higgs particles moving at light speed become mass as they become slower in a Higgs Field. As to speculate, conservation of energy is maintained by mass-energy somehow converting back to virtual radiation somewhere else, as in maintaining the atomic structure of matter. Its quick disappearance provides a strong vacuum effect in its wake for attractive forces to occur.

The Higgs Mechanism is part of a unification of three fundamental forces of nature: the strong nuclear force, the weak force of non-nuclear subatomic particles, and electromagnetism. Not included in the unification is gravity. To explain gravity in consistent manner, consider the gravitational field is sustained by the presence of mass. Light energy is slowed within it. Some of the radiation converts to mass and vice versa to create a vacuum effect in its wake. The recycling is much weaker and gradual than the Higgs Mechanism for it to be a long-range effect as the weak force of gravity in comparison to the other forces.

The recycling process is also dependent on the particular state of mass-energy. Light supposedly differs from matter in that different light can occupy the same space whereas different matter cannot. Light is thus

invisible to other light, but part of it somehow becomes matter that detects a particular range of radiation. Not only are time and distance units determined by the states of relative motion and gravity, the range of radiation detectable by matter is relative as well, as is also the observable view of the universe at large.

8
THE RELATIVITY OF GRAVITY

After modifying Galilean relativity for it to comply with relative spacetime instead of absolute space and absolute time, Einstein focused on Newton's theory of gravity for its compliance with relative spacetime as well. He considered gravity as analogous to relative motion in compliance with an equivalence principle fundamental to both Newtonian Mechanics and relativity theory, whereby gravitational mass and inertial mass are essentially the same. A change in motion of mass thus occurs either from a collision with another mass or by the gravity of the other mass. Twice as much mass changes velocity of another mass twice as much by either gravity or collision with the other mass.

Another principle Einstein used in relating gravity to relative motion is similar to one Copernicus previously proposed to explain our unawareness of Earth's orbital motion. Copernicus realized that we are not internally aware of Earth's motion around the sun because of us being uniform with Earth's motion around it. Einstein also reasoned we are internally unaware of falling freely by gravity because, as had been determined by Galileo, all mass falls at the same rate through a vacuum towards Earth's center. He also assumed light is gravitated along with mass for no internal awareness of change, which is consistent with describing spacetime according to constant light speed. However, gravity is inhomogeneous by nature, as to complicate the equivalence principle in that parts of a system gravitate towards a center of mass according to various distances and different directions of free fall.

Einstein equated free fall with inertial motion inasmuch as there is no internal awareness of either one, but free fall of Earth with its moon can be felt by way of ocean tides, as parts of Earth closer to the moon gravitating more towards it. There is also a tendency of mass to gravitate towards a common center instead of in parallel direction. Objects inside a container in free fall thus tend to converge towards a mass center. Furthermore, what is opposite to falling inward is a curvature of orbital speed. An increase in orbital speed at the same radial distance results in a straighter orbital path, as for moving farther contrary to falling at the

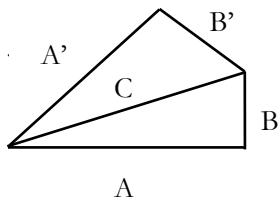
same rate. A ball moving faster also moves potentially farther before lowering to the ground. The greater speed of light perpendicular to the radial distance similarly moves straighter distances than does slower mass falling at the same rate towards the center of mass. There is thus a greater tendency of orbital escape by the speedier light.

Since constant light speed is the founding principle of SRT, and since light is assumed to gravitate toward matter, Einstein relegated the validity of SRT as a special case, applicable as far as tidal effects are negligible. They are negligible, for instance, inasmuch as particular parts of the gravitational field are perceivable as homogeneous whereby different distances are too short to determine their differences of gravitational effect. Einstein then opted for a geometrical description of gravity in accordance with spacetime curvature due to the presence of mass.

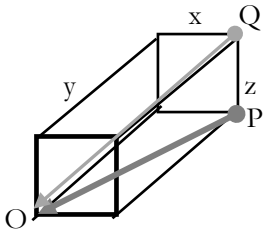
Even though Einstein opted to stipulate SRT is valid only as a special case, it can still be considered as an integral part of GRT inasmuch as the latter is a modification of the former whereby analogies of such relativistic effects as retardation of clocks and contraction of length occur according to both SRT and GRT. Moreover, even though GRT describes spacetime as curved, whereby light speed varies, SRT and GRT still interrelate by geometrical invariance, particularly in view of a Schwarzschild Metric derived by Karl Schwarzschild (1873-1916) and published in 1916.

Invariance

The Pythagorean Theorem is useful in surveying when the line of sight for a direct measure of distance is blocked by an obstacle. A right triangle hypotenuse provides an invariant for mapping an alternative direction as a detour, with the hypotenuse as determinable for distance. Because the two other legs can extend perpendicular to each other in any directions from opposite ends of the hypotenuse, their relation to the hypotenuse determines an invariant for all right triangles formed from it. As illustrated below, the invariant is of the form $C^2 = A^2 + B^2 = A'^2 + B'^2$. A^2 differs from A'^2 and B^2 differs from B'^2, but the total area is the same, as C^2, for both right triangles.



This invariance also applies to higher dimensions, as according to the rectangular box below. Length OP is the hypotenuse of a right triangle with its other sides as x and y. Length OQ is also a hypotenuse of a right triangle with its other sides as OP and z. Length OQ is thus according to the legs of two right triangles of sides x, y and z.



$$\overline{OP}^2 = x^2 + y^2$$

$$s^2 = \overline{OQ}^2 = \overline{OP}^2 + z^2 = x^2 + y^2 + z^2$$

Physics includes, among other things, time and motion, and with SRT as first formulated by Einstein and then given geometrical interpretation by Hermann Minkowski (1864-1909), time becomes a fourth-dimension of the spacetime interval s in the manner

$$s^2 = x^2 + y^2 + z^2 - c^2t^2 = x'^2 + y'^2 + z'^2 - c^2t'^2$$

The letter s denotes the interval, as to determine a value of a variable of one coordinate system if other values of two coordinate systems are known.

Invariance of the interval derives from the Lorentz transformations:

$$x' = \frac{x - vt}{\sqrt{1-\beta^2}} \quad , \quad y' = y \quad , \quad z' = z \quad , \quad t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1-\beta^2}}$$

For the derivation, time coordinates convert into distance coordinates in the manner

$$ct' = \frac{ct - \beta x}{\sqrt{1-\beta^2}}$$

The coordinates are then added and subtracted in the manner

$$ct' + x' = \frac{ct - \beta x}{\sqrt{1-\beta^2}} + \frac{x - vt}{\sqrt{1-\beta^2}} = \frac{ct - vt + x - \beta x}{\sqrt{1-\beta^2}} = \frac{ct(1-\beta) + x(1-\beta)}{\sqrt{1-\beta^2}}$$

$$ct' - x' = \frac{ct - \beta x}{\sqrt{1-\beta^2}} - \frac{x - vt}{\sqrt{1-\beta^2}} = \frac{ct + vt - x - \beta x}{\sqrt{1-\beta^2}} = \frac{ct(1+\beta) - x(1+\beta)}{\sqrt{1-\beta^2}}$$

The product (t' + x')(t' – x') gives

$$t'^2 - x'^2 = \left[\frac{ct(1-\beta)+x(1-\beta)}{\sqrt{1-\beta^2}}\right] \cdot \left[\frac{ct(1+\beta)-x(1+\beta)}{\sqrt{1-\beta^2}}\right]$$

$$= \frac{c^2t^2(1-\beta^2)-ctx(1-\beta^2)+cxt(1-\beta^2)-x^2(1-\beta^2)}{1-\beta^2} = c^2t^2 - x^2$$

Hence, invariance of the interval is of the form

$$s^2 = c^2t\square^2 - x\square^2 = c^2t^2 - x^2$$

$$\frac{s^2}{c^2} = t\square^2 - \frac{x\square^2}{c^2} = t^2 - \frac{x^2}{c^2}$$

$$\frac{s^2}{t^2} = c^2 - \frac{x^2}{t^2} = c^2 - v^2$$

$$\frac{s^2}{t\square^2} = c^2 - \frac{x\square^2}{t\square^2} = c^2 - v^2$$

Invariance of the interval is a means of relating different phenomena. In the same manner of relating spacetime coordinates, for instance, momentum and energy are invariant according to the equations

$$\frac{s^2}{c^2} = P_x^2 + P_y^2 + P_z^2 - \frac{E^2}{c^2} = P_{x'}^2 + P_{y'}^2 + P_{z'}^2 - \frac{E'^2}{c^2}$$

$$s^2 = P_x^2c^2 + P_y^2c^2 + P_z^2c^2 - E^2 = P_{x'}^2c^2 + P_{y'}^2c^2 + P_{z'}^2c^2 - E'^2$$

Total energy or momentum of systems thus calculates by knowing variables of energies or momenta of one system in comparison to another.

Relativity invariance is applied according to whatever information can be obtained by it. Its purpose in this book is to understand the difference and similarity of how it relates to both special and general relativity. According to special relativity, light speed is constant relative to someone relatively at rest in gravitational free space. If s = 0, then it relates in the manner.

$$0 = c^2t^2 - x^2$$

$$x^2 = c^2t^2$$

$$\frac{x^2}{t^2} = c^2$$

$$\frac{x}{t} = c$$

According to general relativity, however, light speed varies according to the field strength of a gravitation field. What is now to be explained is how it relates to variable light speed regarding invariance of general relativity.

Invariance of Spacetime Curvature

The conception of Newton's inverse-square-law of gravity as acting at a distance is contradistinctive to Einstein's explanation of it as spacetime curvature. Action at a distance is instantaneous, but transport of information faster than light speed is contrary to the condition of special relativity. Einstein thus generalized covariance of spacetime for it to comply with gravitational effect, as general covariance, which maintains invariance of the laws of physic in being the same for all reference frames.

A field theory refers to magnitudes in space and time differing according to temperature, gravitational effect and so forth. The convenient way of relating them is by a mathematical matrix, and the simplest form of Einstein's field equation is a tensor matrix for spacetime curvature as

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

The left side of the equation is Einstein's tensor matrix and the right side is a stress-energy tensor matrix in compliance with the Minkowski spacetime invariance for momentum and energy. The $8\pi G/c^4$ is an Einstein constant including Newton's constant G and light speed c. The $4\pi G$ is in relation to surface area of a sphere. The dimensionality (cubic centimeters per second squared and per gram) of 2G relates as a distance r multiplied by velocity v squared per mass m: v^2r/m. Divided by c^4 it becomes dimensionally as per centripetal force: r/mv^2. Multiplied by an energy potential mv^2 per volume, as proportional to r^3, its dimensionality is per area, r^{-2}. If r^{-2} is divided by c^2 to become t^{-2}, it then relates as energy instead of as momentum. Moreover, optional is an inverse of centripetal force coupled with the stress momentum-energy tensor $T_{\mu\nu}$ for determining the spacetime curvature of a gravitational field according to surface area of a volume space per pressure, as pounds per surface area and as the weight of gravitational force.

The subscripts $\mu\nu$ of the matrixes are similar to spacetime coordinates x, y, z, t of relative motion, but they apply more specifically to Riemannian curved space apart from Euclidian space-time coordinates,

and they are also more complex in describing positions in four dimensional spacetime instead of only coordinate directions for relative motion. The matrix thus allows for a more descriptive geometry according to the distribution of mass-energy.

Einstein used Riemann curvature tensor calculus to describe spacetime curvature of general relativity. A tensor of the first rank is a scalar, which is a magnitude of something such as temperature or mass quantity that can be described by a single number, as a magnitude. A tensor of the second rank is a vector, as for including a direction along with magnitude. Higher ranked tensors are more complex. The Riemann tensor, for instance, describes the shortest path along a curved surface according to a geodesic matrix $g_{\mu\nu}$.

The spacetime curvature in general relativity includes the $g_{\mu\nu}$, as to be determined by the stress energy tensor. By substitution, the Einstein tensor on the left side of the equations becomes

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

The Riemann Curvature Tensor matrix $R_{\mu\nu}$ along with the scalar magnitude R and geodesic curvature tensor matrix $g_{\mu\nu}$ are thus determined according to the value of the momentum-energy tensor matrix $T_{\mu\nu}$.

The Schwartzschild Metric

$T_{\mu\nu}$, as a stress momentum-energy tensor, is an invariant for describing the effects of all forms of energy. Its applications are complex and there are various solutions as to whether the field rotates and so on. The tensor itself is according to conservation of energy in being consistent with the Lorentz invariance previously derived by Minkowski spacetime in relating invariance of internal mass-energy and momentum.

The Schwartzschild Metric with a non-rotational condition in relation to special relativity and a homogeneous perception of the gravitational field is the simplest solution. It includes the Newtonian form of gravitational escape speed as part of its modification of SRT. It is of the form

$$ds^2 = \left[1 - \frac{2GM}{rc^2}\right] c^2 dt^2 - \left[1 - \frac{2GM}{rc^2}\right]^{-1} dr^2 - r^2 d\theta^2 - (sin^2\theta) d\varphi^2$$

The last two terms of the metric with trigonometric quantities θ and φ refer to polar coordinates in place of the perpendicular coordinates y and z of flat spacetime. Flat spacetime refers to gravitationally free space wherefrom the conditions of SRT apply. They apply to the coordinate lengths of time dt and distance dr as infinitesimal increments. Increments

dt and dr interrelate by the metric to equate in terms of an invariant as the interval ds.

The increments dt and dr relate to gravitational homogeneity. Gravity is more the same in effect at less difference in radial distance from a mass surface. Gravity thus converges to a state of homogeneity of infinitesimal differences between radial distance and time.

Note: The increments dt and dr, as relatively homogeneous gravitational increments of spacetime in analogy to relative motion, are conditional to both acceleration and non-acceleration. For instance, in free fall there is less internal awareness of acceleration in the sense the outside view of the world is more hidden, but an observer in free fall seeing the outside world does perceive a change in velocity in further view of the rest of the world. This outside view is analyzable similar to how the clock paradox is explainable according to an asymmetrical condition of a slower clock being the one that changes direction, as covariance also complies with gravity inasmuch as the laws of physics are perceived the same for all observers. The principle in general relativity is a condition of general covariance inasmuch as symmetry also applies.

Incremental differences allow Newtonian Mechanics to apply as an initial modified state according to the relativity of spacetime. The modification is according to equivalence of inertial and gravitational mass whereby either $(1 - v^2/c^2)$ or $(1 - 2GM/rc^2)$ can be a relativistic factor. Relative means comparable to. The relativistic factors thus compares effects as relatively at rest in gravitational free space.

Variable Light Speed

A distinction of the form of the Schwartzschild Metric from that of Lorentz Invariance is with regard to acceleration whereby the speed of light is derived as slower within the gravitational field. However, it is still possible to explain spacetime events according to either constant or variable light speed. The choice is arbitrary, but maintaining constancy of light speed is more consistent with spacetime of special relativity.

Events are seen in view of constant light speed according to the principle of simultaneity of special relativity. If the event is a particle of light emitted and absorbed, then its own difference is zero, such that the Schwartzschild Metric in the absence of polar coordinates becomes

$$0 = c^2 dt^2 \left[1 - \frac{2GM}{rc^2}\right] - dr^2 \left[1 - \frac{2GM}{rc^2}\right]^{-1}$$

$$dr^2 \left[1 - \frac{2GM}{rc^2}\right]^{-1} = c^2 dt^2 \left[1 - \frac{2GM}{rc^2}\right]$$

$$\frac{dr^2}{dt^2} = c^2\left[1 - \frac{2GM}{rc^2}\right]^2$$

$$\frac{dr}{dt} = c\left[1 - \frac{2GM}{rc^2}\right] = c'$$

The relative speed of light in a gravitational field is thus less than unity. If $2GM/r = c^2$, then $c' = 0$ for not even light to be able to escape from the field.

Although light speed is interpreted as variable in accordance with the Schwartzschild Metric, it still equates to Lorentz invariance, as by substituting c' for c in the manner

$$ds^2 = c^2dt^2\left[1 - \frac{2GM}{rc^2}\right] - dr^2\left[1 - \frac{2GM}{rc^2}\right]^{-1}$$

$$= c\square^2dt^2\left[1 - \frac{2GM}{rc^2}\right]\left[1 - \frac{2GM}{rc^2}\right]^{-2} - dr^2\left[1 - \frac{2GM}{rc^2}\right]^{-1}$$

$$= c\square^2dt^2\left[1 - \frac{2GM}{rc^2}\right]^{-1} - dr^2\left[1 - \frac{2GM}{rc^2}\right]^{-1}$$

Note: The value of c within the relativistic factor need not change because the changes in speed of the escape velocity of the field and light are both of the same ratio as determined by the same relativistic factor squared: $v'^2/c'^2 = v^2/c^2$.

Of further note, the slowing of light speed is related directly to escape speed instead of orbital speed. Of significance is the fraction ½ for the value of $2GM/rc^2$. It equates with the gravitational potential GM/r as the maximal limit of orbital speed as the square root of light speed as a maximal limit of escape speed. With clocks in a gravitational field being slower in relation to the escape speed, at one-half escape speed both light and time are slow by the same factor, and one-half escape speed equates as the gravitational potential as orbital speed squared.

Light speed within a gravitational field is actually perceived as constant by local observers in the field. Likewise is the moon's orbit, which represents a natural clock, not being perceived as slower because of it and Earth both being in the same gravitational field of the Sun. In effect, slowing of light and matter is partially nullified by the slowing of clocks. However, the Schwartzschild Metric indicates clocks are only slower by the relativistic factor whereas light speed and relative motion are slower by the relativistic factor squared.

Special and General Relativity Analogies

Spacetime described according to variable light speed is more complex than according to constant light speed, but gravitational analogies of relativistic effects are still explainable according to constant light speed. Instead of variable light speed in a gravitational field, consider spacetime as relatively expanded in analogy to observers in relative motion determining a longer relative distance because of their slower clocks.

Observers in relative motion determine each other's clock as slow. The coordinate distance each observer moves relative to the other is perceived longer than the other because of an extended time allowed by a relatively slower clock. An observer at rest in gravitational free space likewise determines the gravitational spacetime as relatively expanded according to constant light speed and clocks interpreted as slower in the field. However, a local observer in a field of gravity perceives the exact opposite effect of spacetime outside the field than what observers outside the field perceive of the field, as contrary to observers in relative motion both perceiving the other observer's clock as slow.

The opposite effect is analogous to the clock paradox explainable according to asymmetry. As the clock changing direction is the one determined as slow, clocks within gravitational fields are similarly determined as slow in comparison to clocks relatively at rest in gravitational free space due to asymmetry of gravitational acceleration. Local observers relatively at rest on Earth's surface thus determine the same local light speed as if in gravitational free space, but light from non-local sources outside the field of gravity is perceived differently. Earth observers with slower clocks perceive events in gravitational free space as occurring in less time.

Einstein, as early as 1906, had similarly considered effects of gravity as analogical to those of relative motion, as in regard to equivalence of inertial and gravitational mass. By 1911 he concluded the light spectrum blueshifts when entering the gravitational field and redshifts when leaving it. The shifts increase with time and distance in analogy to either increasing redshift or blueshift seen by an observer who increases speed while either receding from or approaching toward light. The Doppler Effect thus increases with time and distance of acceleration by either gravity or relative motion.

Slowing of relative motion according to the Schwartzschild Metric is by the relativistic factor squared because of time being slower by the relativistic factor and distance being longer by the relativistic factor. If a contraction of wavelength coincides with its slowing, then it applies to both light and matter for consistent nullification of effect.

Conservation of energy is also illustrated in considering a gravitational field as relatively expanded instead of light speed being slower in it. There is analogy of relativistic increase in mass and energy. Mass in rela-

tive motion is perceived as relatively greater than if relatively at rest, and spacetime of a gravitational field is relatively increased in place of decreased light speed and slower motion in the field. In view of Newtonian Mechanics, orbital speed is in ratio to mass and orbital distance. Twice the mass and twice the orbital distance render the same orbital speed. In effect, the orbital speed of the moon around Earth is seen by an observer relatively at rest in gravitational free space as either slower or of the same speed depending on whether spacetime is considered expanded or not. Although slower orbital speed is by a relativistic factor squared according light speed being slower by a relativistic factor squared, its interpretation as constant light speed of larger spacetime allows the orbital speed to be in accordance with an increase in orbital distance along with an increase in relative mass. Since mass is proportional to relative motion squared, whereby a relativistic increase in mass increases its gravitational potential by a relativistic factor squared, relative mass entering a gravitational field with a relativistic increase in mass and relativistic decrease in radius is then consistent with a greater relative mass in relative motion.

Although either choosing variable light speed or modified spacetime is arbitrary, the latter is consistent with Einstein's interpretation of gravity as spacetime curvature. An observer on a planet in free space with a slower clock seeing events occurring faster than light speed is contrary to the condition no information of events exceeds light speed. There is curvature of light approaching a gravitational field, but light emitted directly towards the center of the gravitational field does not curve. If it is received from two different observers in the field, their clocks can be synchronized with one of the same distance from both. Relativistic modification of spacetime is then only according to special relativity.

Relativistic analogies of general and special relativity thus comply in consistent manner. However, conditional to special relativity is an addition of velocities theory, but there is no addition of gravitational potentials theorem of general relativity as an analogy.

Adding Gravitational Potentials

Light speed according to SRT is a limiting condition that matter cannot exceed nor even reach. By GRT the limiting condition refers directly to escape speed instead of orbital speed. For an addition of gravitational potentials theorem in analogy to the addition of velocities theorem, the limiting condition of the rotational speed is the square root of one-half c instead of c. The analogy is thus slightly more complex.

How, then, can the analogy apply more completely regarding its inclusion with electromagnetism and Quantum Electrodynamics (QED)?

Suppose the gravitational potential instead of the gravitational escape speed is the primary condition of an upper limit. Unique is (½)c,

justified by the slow light condition of the Schwartzschild Metric in the manner

$$c\left(1-\frac{2GM}{rc^2}\right)=c\left(1-\frac{1}{2}\right)=\frac{1}{2}c=c$$

The difference between an escape speed and square root of the gravitational potential is that the former is greater than the latter by the square root of 2. One-half squared is one-fourth. One-half c for the gravitational potential in the relativistic factor thus relates in the manner

$$\sqrt{1-\frac{2GM}{rc^2}}=\sqrt{1-\frac{1}{2}}=\sqrt{\frac{1}{2}}$$

Since gravitational potential is rotational speed squared, an analogy condition of SRT and GRT maintains regarding c/2 as an observable-upper-limit of spacetime curvature.

The Cosmological Constant

Einstein assumed our universe is finite and static. A condition for it to be as such is that it needs a sufficient amount of mass to contain itself. Too much mass would cause it to contract and not enough mass would allow it to fly apart. The means to counter these two possibilities, he theorized, is a repulsive force counter to gravity, which could be represented as a Cosmological Constant inserted into his field equations for a modified form in the manner

$$R_{\mu\nu}-\frac{1}{2}Rg_{\mu\nu}-\Lambda_{\mu\nu}=\frac{8\pi G}{c^4}T_{\mu\nu}$$

The addition of constant Λ is a theoretical possibility inasmuch as the mathematical process of integration allows it. Integration is a reverse process of differentiation whereby exponent powers become reduced in the manner x^3 becomes $2x^2$, x^2 becomes $1x^1$, and x becomes $0x^0 = 0$. Since differentiation eliminates constants, they become unknowns with regard to integration.

Alexander Friedmann (1888-1925) examined Einstein's field equations and asserted they indicate the finite-static-universe is unstable even with the cosmological constant. The discovery of a redshift in more distant starlight further indicated the universe is expanding. Einstein concurred, referring to his insertion of the cosmological constant as his biggest blunder, but it has of late been reconsidered to explain dark energy as needed for an increased rate of expansion of the universe according to an expanding universe theory.

The cosmological constant of general relativity was generally dismissed by physicists, as equaling zero, until 1995 when astronomical observation of redshift data indicated the expansion of the universe has not been constant, as to have increased its rate of expansion. For a possible explanation of this increased expansion rate the cosmological constant has been reconsidered along with assuming the existence of dark energy as a repulsive force, but a repulsive force of general relativity has not been determined in accordance with empirical data and theory to be consistent with the needed energy for increasing the expansion rate. A dark energy of about 10^{122} times greater than what the cosmological constant provides has been claimed by some physicists to be needed.

Further consideration of the Cosmological Constant remains a complication to be resolved for how an expanding universe is explained in consistent manner. In this regard, its explanation could relate to further explanation of the nature of gravity itself. There is, for instance, an internal repulsive force of gravity as weight to consider as its own counter force.

Consider a spherical quantity of mass everywhere of the same density. At its center is zero gravity by nullification of equal amounts of force acting in opposite directions. However, a repulsive force of interaction between mass itself occurs as weight. At one-half radius distance of the sphere is one-fourth more gravitational force downward per mass, but there is only one-eighth as much volume and mass for one-half as much downward gravitational force. The less force indicates mass should increase nearer to its center for its density to increase to the fourth power.

In relation to internal gravitational interaction between particles of mass m the gravitational force relates to Newton's inverse square law in the manner

$$\frac{G\left(\frac{1}{2}m\right)^2}{\left(\frac{1}{8}r\right)^2} = \left(\frac{1}{16}\right)\frac{Gm^2}{r^2}$$

The internal gravitational force thus decreases to the fourth power as the mass density increases to the fourth power.

This result compares with that of quantum physics insofar as mass inside the nucleus of the hydrogen atom, as the proton, is to the fourth power of the electron mass. (The proton is about 1836 times more mass than the electron and nuclear radius is about 1836 times shorter than the radius of the atom.) There is thus a tendency of gravitational mass to be in compliance with a fourth power rule. However, the atomic nucleus is more massive with more energy whereas the gravitational analogy is of

less gravitational force, which is consistent with electromagnetic formula e^2/mr whereby electric charge decreases with greater mass.

Although gravity correlates as such with quantum physics and electromagnetism, results are obviously more intricately complex. The density of mass varies according to different forces in relation to electrodynamics and quantum physics. With gravity itself there are spiral conditions of centripetal force of rotation to consider, such that galaxies and planetary systems tend to plane out from being spheres.

Black Holes and Singularity

Along with the discovery of the redshift of starlight with distance an interpretation of the Schwartzschild radius is that it indicates existence of black holes and a singularity. Black holes exist if there is enough mass of a gravitational field to not allow either mass or electromagnetic radiation to escape from it. The singularity has become theorized as the origin of the universe from which it has continued to expand.

A mathematical singularity is defined as two terms of an equation with one term being of zero magnitude and the other term being of infinite magnitude. The singularity is indicative of the Schwartzschild Metric with the possibility of the relativistic factor being zero. If the gravitational field is massive enough for the escape speed to be c, then the ratio of escape speed to light speed is one. Since the relativistic factor is the number one divided by the ratio of an escape speed squared to light speed squared, whereby one minus one is zero, increment dr is divided by zero to indicate mathematical infinity, which is undefined in terms of the observable world. As for the other term of the singularity, increment t of c(dt) multiplied by the relativistic factor as zero is zero.

Similar to the singularity is a black hole as conditional to an escape speed being that of light speed whereby not even light is able to escape. The Schwartzschild radius for an escape velocity equal to light speed is called the event horizon of a black hole. Black holes are now considered to exist at the center of galaxies, including our Milky Way.

Black holes are also conditional to special relativity. Constant light speed according to it is an upper limit for matter to neither equal nor exceed. The gravitational analogy is merely with regard to the escape speed of the gravitational field. However, such interpretation has been controversial.

There is according to special relativity an increase in relative mass with an increase in relative motion. The increase in mass-energy is further shown to be conserved by an exchange of energy between systems. For an analogy, a relative increase in relative mass of a gravitational field, in addition to mass entering into the field, should constitute work energy spent for a lesser increase in gravitational force and lesser increase in rel-

ative mass density. If the field increases in mass, it should radiate energy. Moreover, the ratio of radiation to mass should increase for greater escape velocities, such that the radiation escaping should be in proportion to the additional mass. An addition to the gravitational potentials theorem is thus indicated as analogous to the addition of velocities theorem.

In the early 1970s the condition of the black hole was modified by Stephen Hawking for it to emit Hawking radiation. In explaining how black holes radiate, Hawking assumed a probability condition of quantum mechanics applies to allow the probability of a light particle inside a black hole to exist outside of it as well.

In 1972, Jacob Bekenstein (1947-2015) proposed black holes should radiate energy in order for them to increase their entropy. Hawking first rejected Bekenstein's claim, as assuming an increase of entropy need not apply to the entire universe as an isolated system not causing a change to another system, but in 1974 he considered black holes of higher temperature than the radiation they absorb do violate the second law of thermodynamics. However, he conceded about twenty years later that convincing evidence indicates black holes do exist.

How is it possible, then, for the presence of mass to warp space enough to disallow matter to escape? How is it possible for matter to condense into a space of zero volume? A conceivable answer relates to renormalization and a virtual field of energy in a so-called vacuum space being, in effect, part of a greater dimensional world.

Infinity is generally a mathematical problem in relating laws of physics to the observable world. It was a problem relating to thermal energy of light (as an ultraviolet catastrophe) until the quantum was established as a restrictive condition. It continued to be a problem with quantum physics until the principle of renormalization was applied as a more general condition.

Is renormalization conditional to relativity theory as well? It could be if $r/t \leq c$ is truly stipulating. If any part of collision masses is extended to any degree of continual contact, then an infinite speed of c is allowed, as in ratio to a zero value of t. However, with stipulation that collisions between masses are such that there is no simultaneous action beyond immediate contact, there is a quantum condition of probability allowing for virtual effect, as continual contact violates the probability condition. This condition also applies to relativity in the sense no information of events can exceed light speed is only conditional to perception. Virtual particles thus collide only in ways their immediate extensions of change are not perceivable as such. Since spacetime is relative, part of its inner volume could be non-detectable. Immediate contact is thus of zero extended distance. Electrons can collide with electrons, but

it takes a smaller particle for observational measure, as for size being relative as such.

A minimum amount of distance contact as an unobservable measure is similar to a virtual condition of quantum physics. The renormalization of infinities of quantum physics is thus a distinction whereby a virtual particle is a mathematical result of otherwise predictive failures of mathematical theory. However, renormalization of relativity theory has not been accepted because of its infinity implications interpreted as a singularity instead. However, indications are that the renormalization should apply to relativity theory as it does to quantum physics.

An interpretation of the singularity is somewhat arbitrary in the sense that a quantity divided by zero is undefined. According to theory that our universe is finite and expanding is that it could indicate it consists of infinite mass-energy density instead of infinite mass-energy itself. If the origin of the mass-energy of our universe is finite, then there is no violation of energy conservation in that it was finite in the beginning as it is finite now. However, a special relativity analogy indicates a different interpretation of the singularity.

Light speed, in accordance with the addition of velocities theorem of special relativity, is unattainable of matter by means of collision with either light or other matter. Accordingly, there is a decrease in length and increase in mass-energy with an increase in speed. At light speed, mass would thus become infinite mass-energy of an infinitesimal size, except for it being conserved and thereby requiring an infinite internal source of potential energy. In so doing, the mass absorbs mass-energy from whatever accelerates the mass. It thus takes an infinite amount of mass-energy to accelerate mass to light speed. To be consistent, there should be an infinite amount of virtual energy to create the mass of an expanding universe.

Regarding gravity along with assuming the universe is finite and expanding now at a faster rate than in the past, the existence of dark energy as its cause could further be regarded as the infinite source, as for its invisibility being conditional to entropy in relation to how the virtual field of energy interrelates to the observable world.

By another interpretation of entropy, as thermodynamic, energy becomes neutralized in a state of equilibrium to exist as potential energy. A mass cannot exchange heat with another mass of the same temperature. The virtual field of energy could be a state of equilibrium it interacts internally with atomic particles in creating a particular state of equilibrium with only them.

How, then, has the universe expanded from a singularity?

For space to be curved it needs to be more than simply empty space. A vacuum effect is indicated whereby matter is part of a more

general field of different energies. If matter produces waves of energy invisible to other matter, then a virtual hole in space is created. If matter tends to fill this hole faster than other virtual particles can, then it is conceivable that virtual energy elsewhere having mutual interaction with matter aids in the replacement at some other location.

Still, how can countless matter condense into a single point?

It is also conceivable that matter also converts into virtual energy. It could be the rate of conversion, as frequency, increasing. If true, it would then seem possible that matter is created elsewhere for the process to maintain itself with gravity and electric charge included as such.

Black holes and the singularity are neither proven nor disproven. Of more significance is interrelation of different theory in consistent manner. Indications are that general relativity can interrelate with quantum theory. Special relativity interrelates with electromagnetism and with general relativity. Another interrelation to consider is that between general relativity and electromagnetism. A significant difference is that electric charge is bipolar with positive and negative charge whereas gravity is only attractive in nature. Increase in mass thus results in an increase in gravitational energy but a decrease in electromagnetic energy.

An interrelation of gravity and electric charge is provided by a theory proposed by Harold Aspden. It relates electric charge with Coulomb's inverse-square-law of static electricity. The electromagnetic formula still differs, but it still interrelates as a different aspect of theory.

9
QUANTUM ORIGINS

An origin of the quantum is blackbody radiation. Formulae were derived to determine a relation between temperature and intensity of radiation that a body of mass can absorb and emit while in equilibrium with the forces of nature. Classical formulae for predicting results of experiment failed until a concept of the quantum was introduced. Understanding this development is with regard to particular relations between heat and light.

Heat and Light

In the year 1800, William Herchel (1738-1822) used a variety of eye glasses of different color lenses to peer through a telescope and observe the sun. By using these different glasses of various color he discovered light filtered through some of them felt warmer than if filtered through others. He followed up with the implications of this discovery by devising experiments consisting of prisms and thermometers to further discover heat tends to be greater towards the red end of the light spectrum and even beyond into the then unknown infrared part of it invisible to the eye.

A heat-light connection was thus established, but it would be another twenty years before Andre-Marie Ampere (1775-1836) suggested light and heat are only different aspects of the same process. A response to Ampere's suggestion came with Marcedonio Melloni (1798-1854) agreeing inasmuch as he believed both are waves propagating through media. He regarded light as the harmonious waves of æther, and he similarly regarded heat as radiant waves of caloric, but his experimental findings from 1833 to 1840 indicated no essential difference in wave properties of these two phenomena. To his credit, he did discover refractive properties of thermal radiation.

More development followed from experiments by Jean Bernard Leon Foucault (1819-1868) and Armond Hippolyte Louis Fizeau (1819-1896) in confirming wave properties of radiant heat. Their experiments split rays of infrared light for them to superimpose and produce alternating bands of hot and cold in analogy to the light and dark fringes of or-

dinary light. James David Forbes (1809-1861) then discovered heat polarizes similar to that of light, and he advanced the concept of a continuous radiation spectrum that later became essential to Maxwell's theory of electromagnetism. It followed that the unification of electromagnetism and thermodynamics was in order. It would have been routine except for the predominance of wave theory at the time. The relation between vibrant molecules of matter with the waves of light was not adequately understood as of yet.

There had been some attempts to unify theory as such. Leonard Euler (1707-1783) proposed the principle a particular substance of mass can absorb light of any frequency that its smallest particle is able to vibrate. He attempted to explain phenomena according to the æther from which matter forms. His theory was not successful, but his absorbing principle did not go unnoticed.

More essential to the development of theory were discoveries of how matter absorbs light. William Wollaston (1766-1825) discovered in 1802, for instance, that light spectra emitted from matter include dark lines. Joseph Fraunhofer (1787-1826) made more discoveries along this line in 1814. The interest in these discoveries grew among theorists. Stokes, for one, used the principle of Euler to explain them as atoms absorbing light waves by means of resonance.

Pierre Prevost (1751-1839) had provided evidence indicating all bodies radiate heat. The evidence suggested further that poor absorbers of heat are also poor emitters of it, and good absorbers are good emitters, and it became evident materials in thermal equilibrium emit what they absorb. In 1858, Balfour Stewart stated the law that the absorptivity of a material in a state of thermal equilibrium is equal to its emissivity. Stewart assumed the absorptive and emissive ability of different materials varies in relation to the nature of their internal substance. Gustav Kirchhoff (1824-1887) proposed in 1859 a particular condition of "blackbody" radiation applies to all bodies regardless of their material composition.

Kirchhoff examined the spectrum of sunlight through a sodium flame to discover dark lines of the spectrum change to yellow when the sunlight is of low intensity, being darker with more intense sunlight. He also found sodium emits the same part of the light spectrum absorbed with an appropriate increase in temperature of the sodium flame. Kirchhoff thus surmised the ability of substance to absorb and emit a certain color of light depends on its relative state of equilibrium. Further experiments to confirm this premise indicated absorptivity and emissivity for a material is a function of its temperature and wavelength or frequency.

The mathematical formulation of the law assumes a system obtains the state of thermal equilibrium at sub temperature below incandescence. Thus, if A denotes the total radiation per surface area on each body of

mass, ***a*** the fractional amount of radiation actually absorbed by its material, and E is the permissible radiation emitted from it, then the relations are mathematically expressed in the manner

$$\boldsymbol{a}A = E \qquad A = {}^{E}/_{\boldsymbol{a}}$$

For all materials in a state of thermal equilibrium, the powers of emissivity (E_1, E_2, E_3, etc.) divided by their respective factors of absorptivity (a_1, a_2, a_3, etc.) equal the same amount of light incident per surface area:

$$A = \frac{E_1}{a_1} = \frac{E_2}{a_2} = \frac{E_3}{a_3} \cdots = \frac{E_n}{a_n}$$

Kirchhoff defined the blackbody as one absorbing and emitting radiation of all frequencies or wavelengths, but the power of emissivity of the blackbody is E_B, and the fraction of light absorbed is unity, $a_B = 1$, wherefrom

$$\frac{E}{a} = \frac{E_B}{1}$$

Dividing by E_B, multiplying by ***a***, changing order and assuming absorptivity equals emissivity obtains

$$\boldsymbol{a} = \frac{E}{E_B} = \varepsilon$$

The symbols **a** and ε denote absorptivity and emissivity, respectively, of a material body in ratio to a blackbody.

Further relations are of the discovery of a fourth power law commonly referred to as the Stefan-Boltzmann Law.

The Stefan-Boltzmann Law

The rate systems change from one temperature to another to obtain a state of equilibrium with its environment is further significant. Newton had assumed the process is linear inasmuch as the rate of change in temperature is proportional to the difference in temperatures between the system and its environment, but experimental data indicated the relation is approximate, as only true at relatively normal temperatures, as the data did not appear linear at higher ones.

Another relation superseded Newton's in the late nineteenth century. It came from a study of temperature and light intensity by John Tyndall (1820-1893) and Joseph Stefan (1835-1893). Tyndall had run an electric current through a platinum wire that resulted in heating the wire to a

state of incandescence. On measuring the radiation emitted at different temperatures he found the light intensity to be about twelve times greater with a wire being about 1200 degrees centigrade than if only 525 degrees centigrade. Stefan calculated

$$\left[\frac{273°+1200°}{273°+525°}\right]^4 = \left[\frac{1473°}{798°}\right]^4 \approx 12$$

The 273° is the centigrade scale of 273° above absolute zero. The ratios thus relate to absolute zero.

This mathematical relation appeared the same for all substances at all temperatures. Stefan concluded the intensity I is proportional to the fourth power of the absolute temperature T:

$$I = k_B T^4$$

The constant k_B is named the Boltzmann constant. Its value is 1.3806503 x 10^{-23} J/K, which is 1.38065 X 10^{-16} grams multiplied by centimeters squared per seconds squared per one-degree Kelvin.

Because of such minuteness of the numerical value of the constant, a slight change in temperature, even to the fourth power, causes only a slight change in light intensity. However, Tyndall's measurements were not accurate. More recent results give a ratio of about 18 to 1, but not according to Kirchhoff's black-body condition by which Ludwig Boltzmann (1844-1916) deduced the law in accordance with the second law of thermodynamics.

Boltzmann's derivation includes an exchange of heat between different systems. System S_2 receives heat energy Q_2 from system S_1. The loss of Q_2 in ratio to absolute temperature T_2, as negative entropy, equals the amount of positive entropy Q_1/T_1 remaining in S_1. Along with the exchange of heat are differences in size of energy densities. Energy density u_1 of S_1 is reduced in size from V_1 to V_4, and energy density u_2 is increased in sized from V_2 to V_3.

A change in state of heat energy can be interpreted in terms of work performed. Work energy by means of an adiabatic process further relates to conservation of entropy. The process can further be in compliance with Boyle's Law whereby a product of pressure p and volume V of a gas at given temperature T is constant: pV = k, as pressure further relates in terms of force F, such as the force of gravity maintaining the pressure in a tire per surface area $2\pi r^2$. With V as proportional to radius cubed, further relations result as

$$pV = \frac{FV}{r^2} = Fr = FV^{\frac{1}{3}} = k$$

Energy density u relates as mass-energy mc^2 per volume in the manner

$$u = \frac{F}{V} \qquad F = uV$$

By substituting u for F in the previous equations, it becomes

$$uVV^{\frac{1}{3}} = uV^{\frac{4}{3}} = k$$

The square root of the square root of the equation cubed relates it in terms of volume space as

$$u^{\frac{3}{4}}V = k^{\frac{3}{4}}$$

Entropy is next considered in relation to different temperatures. States S_1 and S_2 relate as conserved entropy in the manner

$$\frac{Q_1}{T_1} + \frac{Q_2}{T_2} = 0$$

The difference in entropy states Q_1 and Q_2 further relate to different energy densities and change in size in the manner

$$Q_2 = u_2(V_3 - V_2)$$

$$Q_1 = u_1(V_1 - V_4)$$

Hence

$$\frac{Q_2}{T_2} + \frac{Q_1}{T_1} = \frac{u_2(V_3 - V_2)}{T_2} + \frac{u_1(V_1 - V_4)}{T_1} = 0$$

In relation to Boyle's Law, which requires different constants for different temperatures and sizes of energy densities, k_1 and k_2 become the respective constants in the manner

$$u_2^{\frac{3}{4}} V_3 - u_2^{\frac{3}{4}} V_2 = k_2^{\frac{3}{4}} - k_1^{\frac{3}{4}} \qquad u_1^{\frac{3}{4}} V_1 - u_1^{\frac{3}{4}} V_4 = k_1^{\frac{3}{4}} - k_2^{\frac{3}{4}}$$

$$u_2^{\frac{3}{4}}(V_3 - V_2) = k_2^{\frac{3}{4}} - k_1^{\frac{3}{4}} \qquad u_1^{\frac{3}{4}}(V_1 - V_4) = k_1^{\frac{3}{4}} - k_2^{\frac{3}{4}}$$

$$V_3 - V_2 = \frac{k_2^{\frac{3}{4}} - k_1^{\frac{3}{4}}}{u_2^{\frac{3}{4}}} \qquad V_1 - V_4 = \frac{k_1^{\frac{3}{4}} - k_2^{\frac{3}{4}}}{u_1^{\frac{3}{4}}}$$

Substituting the right-hand sides of these latter equations into the thermodynamic equation obtains

$$\frac{Q_2}{T_2} + \frac{Q_1}{T_1} = \frac{u_2(V_3 - V_2)}{T_2} + \frac{u_1(V_1 - V_4)}{T_1}$$

$$= \frac{u_2}{T_2}\left[\frac{k_2^{\frac{3}{4}} - k_1^{\frac{3}{4}}}{u_2^{\frac{3}{4}}}\right] + \frac{u_1}{T_1}\left[\frac{k_1^{\frac{3}{4}} - k_2^{\frac{3}{4}}}{u_1^{\frac{3}{4}}}\right]$$

$$= \frac{u_2^{\frac{1}{4}}}{T_2}\left(k_2^{\frac{3}{4}} - k_1^{\frac{3}{4}}\right) + \frac{u_1^{\frac{1}{4}}}{T_1}\left(k_1^{\frac{3}{4}} - k_2^{\frac{3}{4}}\right)$$

$$= \frac{u_2^{\frac{1}{4}}}{T_2}\left(k_2^{\frac{3}{4}} - k_1^{\frac{3}{4}}\right) - \frac{u_1^{\frac{1}{4}}}{T_1}\left(k_2^{\frac{3}{4}} - k_1^{\frac{3}{4}}\right) = 0$$

Hence

$$\frac{u_2^{\frac{1}{4}}}{T_2} - \frac{u_1^{\frac{1}{4}}}{T_1} = 0 \qquad \frac{u_2^{\frac{1}{4}}}{T_2} = \frac{u_1^{\frac{1}{4}}}{T_1}$$

Because energy densities and temperatures equal, the adiabatic cyclic change is constant, such that

$$\frac{u^{\frac{1}{4}}}{T} = k^{\frac{1}{4}} \qquad u = kT^4$$

Moreover, u is energy density of the radiation of intensity I absorbed or emitted, as proportional to a change in energy per volume, or as the intensity of a radiation incident on a blackbody. They express different aspects of energy, but they are the result of the same process. By substituting I for u, $I = k_B T^4$ is a mathematical interpretation of the Stefan-Boltzmann's law, with k_B designated as the Boltzmann constant.

Wien's Displacement Law

The Stefan-Boltzmann law relates the difference in intensity of radiation to temperature, but it does not specify how either frequency or wavelength of light applies. Wilhelm Wien (1864-1928) determined the relation for the intensity of radiation for a temperature and the range in the wavelength or frequency of the temperature. He noted shorter wavelengths are more frequent, numerous and energetic than longer waves.

For further analyses Wien adopted the adiabatic concept in relation to blackbody radiation. However, a true blackbody is not available to study within the confines of the laboratory. Although soot is black, for instance, it still emits a radiation invisible to the eye. Even so, blackbody conditions of equilibrium tend to occur with a slight change in the environment from its interaction with radiation. Although an oven allows radiation to escape, the oven temperature can still be maintained by means of using fuel. Wien thus considered a hollow container staying in thermal equilibrium, as by having a tiny hole at its surface to allow radiation to enter and reflect here and there on the walls of the container before it finally escapes.

Wien surmised a blackbody varies with a small range in wavelength of radiation at maximum intensity in inverse proportion to temperature. Thus, a shorter more frequent wave at maximum intensity correlates with a higher temperature in the manner $\lambda_{max}T = b$ as Wien's displacement law, where b is a constant.

Relating the intensity of radiation along with both the temperature and wavelength is more complex. Although total intensity is to the fourth power of temperature, determining it according to any particular wavelength at any given temperature needs to include three variables as wavelength, intensity and temperature. Since total intensity is to the fourth power of temperature, since the wavelength shortens per higher temperature, and because of such other considerations as with regard to the Doppler Effect, Wien eventually concluded the intensity for a particular wavelength at a given temperature is to the fifth power of the wavelength.

To derive a formula he related wavelength and temperature according to a distribution law derived by Maxwell for relating molecular speeds of gas particles in relation to temperature:

$$dN = \left[\frac{m}{2\pi T}\right]^{\frac{1}{2}} \cdot e^{-\frac{1}{2}mv^2/k_B T}$$

The exponential function $e \approx 2.71828182$ in Maxwell's formula is raised to a power of kinetic energy per k_BT, a product of the Boltzmann constant k_B and temperature T.

Wien associated cavity radiation as molecular resonance and frequency in relation to kinetic energy to derive a function F(λ ,T) for temperature and range in wavelength λ with the insertion of constants ***a*** and b in relation to the intensity I_λ :

$$I_\lambda \cdot d\lambda = \frac{a}{\lambda^5} \cdot \ e^{-b/\lambda k_B T}$$

It fared well with data in relation to high frequencies, but not in relation to low ones.

Plank's Solution

Scientists had been aware from the mid-nineteenth century that light escaping from an oven of higher temperature through a tiny crack is more energetic. Therefore, Ferdinand Kurlbaum (1857-1927) and Heinrich Leopold Rubens (1865-1922) experimented in observing waves as long as 59 microns, which is one twentieth of a millimeter. Wien's formula failed in predicting accurate results for these longer wavelengths.

When Rubens revealed the experimental results to Max Planck (1858-1947) in 1900, Planck had a solution the same day. He assumed resonators of radiant heat mediate between molecules and radiation, as for absorbing, storing and releasing the same particular quantity of radiant energy. Planck's solution to the problem was therefore to quantize energy as multiples of hf, wherefore h is now known as Planck's constant, and f is light frequency in relation to energy.

The amount of energy of an oscillator is according to the values of each energy level, which are 0, hf, 2hf, etc. With some values as zero, neither the energy level nor the spatial distribution is continuous. The distribution itself is determined according to an exponential function of the Boltzmann factor

$$e^{-E/k_B T}$$

As to further develop Maxwell's statistical treatment of the kinetic theory of gases, Boltzmann had derived the probabilities in terms of the exponential function, and he also applied discrete energy levels as infinitesimal divisions among the actions of molecules. Planck instead assumed non-infinitesimal-discrete-energy-levels apply (as similar to renormalization).

A number N of oscillators in an incremental range of frequency near f has various multiples of energy E = hf, including zero, and is the number n times each consecutive level of the probability distribution, as in accordance with

$$N = n + ne^{-hf/k_BT} + ne^{-2hf/k_BT} + \ldots$$

$$= n\left(1 + e^{-hf/k_BT} + ne^{-2hf/k_BT} + \ldots\right)$$

The infinite series in the equation converges to

$$V = n\left(e^{-hf/k_BT}\right)^{-1}$$

The total energy of all oscillators is

$$E = n(0) + n(hf)^{-hf/k_BT} + \ldots$$

$$= nhfe^{-hf/k_BT}\left[1 + 2\left(e^{-hf/k_BT}\right) + 3\left(e^{-hf/k_BT}\right)^2 + \ldots\right]$$

This infinite series converges to

$$E = nhfe^{-hf/k_BT}\left(1 - e^{-hf/k_BT}\right)^{-2}$$

Dividing E by N obtains

$$\frac{E}{N} = \frac{nhfe^{-hf/k_BT}\left(1-e^{-hf/k_BT}\right)^{-2}}{n\left(1-e^{-hf/k_BT}\right)^{-1}} = \frac{hfe^{-hf/k_BT}}{1-e^{-hf/k_BT}} = \frac{hf}{e^{-hf/k_BT}-1}$$

E/N represents the average energy per oscillator of incremental frequency range between f and (f + df) inasmuch as n factors out of the equation.

Comparing Formulas

In comparison to Wein's formula, Planck derived

$$I_\lambda \cdot d\lambda = \frac{2c}{\lambda^5} \cdot \frac{h}{e^{hc/\lambda k_BT}-1}$$

A main difference in it and Wein's formula is Wein's constants ***a*** and b are replaced with 2hc and a different form of the exponential function. As for 2hc, it is twice a change in speed c with regard to a reverse in direction.

The constant h relates dimensionally as a product of mass, velocity and distance, whereas the constant k_B is the product mass and velocity squared. Thus, hc is dimensionally the same as λ k_B, such that they are of the same ratio no matter what are units of mass, distance and time used

to determine results. The exponential function thus changes only by the ratio of T, which is consistent with Wien's displacement law.

If c = λ f, then replacing each λ with c/f obtains

$$I_f \cdot df = \frac{2f^5}{c^4} \cdot \frac{h}{e^{hf/k_BT}-1}$$

Another formula was derived as

$$I_f \cdot df = \frac{2f^3}{c^3} \cdot \frac{h}{e^{hf/k_BT}-1}$$

However, these two formulas differ inasmuch as c ≠ λ f results from their ratio.

The reason the result of these formulas do not equate is because they pertain to different forms of energy. One form is a modification of Wien's formula and the other is from a formula derived by Sir James Jean (1877-1946) and John William Strutt (1842-1919), renamed Lord Rayleigh. Wien's distribution formula is in accordance with his displacement law for a change in temperature; the other formula was derived in accordance with an equipartition theorem that had been derived independently first by John James Waterston (1811-1883) and later by Maxwell and Clausius for advancing the kinetic theory of gases. It relates to degrees of freedom.

A degree of freedom relates in accordance with the number of modes of vibrations. The same space is assumed to be more capable of containing a greater number of modes of shorter wavelengths. Rayleigh assumed there is a tendency for shorter modes to dominate. However, the shorter waves are more energetic because of their more rapid vibrations, such as to result in an ultraviolet catastrophe from a tendency to increase to infinite energy. Such a result was considered in violation of conservation of energy, and the formula differs from the Stefan-Boltzmann fourth power law. The formula was thus in need of modification.

In Planck's formula, change in wavelength λ relates in the manner

$$\frac{hc}{\lambda^5} = \frac{hf\lambda}{\lambda^5} = \frac{hf}{\lambda^4} = \frac{mc^2}{\lambda^4}$$

The change in radiant energy is thus per fourth power of wavelength. In the other formula, change in frequency f relates in the manner

$$\frac{hf^3}{c^3} = \frac{mc^2f^2}{c^3} = \frac{mc^2f^2}{c(\lambda^2f^2)} = \frac{mc}{\lambda^2}$$

There is thus change in momentum occurring per wavelength squared, as in contrast of internal energy of mass per wavelength to the fourth power.

10
PARTICLE AND WAVE QUANTUM PHYSICS

An early application of the quantum was the Bohr Theory of the atom. The discoveries of a photoelectric effect and Compton Effect followed. Further advance came with the development of Quantum Wave Mechanics wherefrom its wave equations became interpreted as probability equations according to an Uncertainty Principle. Such new interpretation is now established with the evolution of Quantum Electrodynamics (QED), the quark model, string theory, Grand Unified Theories and so on. Although such development is complex, quantum theory itself can still be explained according to the simpler theory of the Bohr atom in establishing the fundamental relations of physical constants.

The Bohr Atom

Applying quanta to the structural nature of the atom came from Niehs Henrik David Bohr (1885-1962). He modified the atomic model previously announced by Ernst Rutherford (1871-1937) in 1911, who had contrived a model of the atom to describe how alpha particles reflect. Accordingly, the bulk of mass that scatters is contained within a nuclear radius of about 1836 times smaller than the radius of the atom itself. Rutherford further assumed atoms continually absorb and emit radiation as electrons accelerate around the nucleus. However, his model failed to predict results of all phenomena.

One such phenomenon pertains to the spectra of radiation emitted by atoms. The spectral lines of light associated with atoms did not conform to a pattern consistent with a known theory of continuous spectra. Formulae had been provided apart from theory, as in 1885 by Johanne Jakob Balmer (1825-1890), and the later experiments by Johannes Robert Rydberg (1854-1919), Carl Runge (1856-1927) and Henrich Kayser (1853-1910). Their *ad hoc* formulae, for the most part, agreed with observations, but they lacked the theoretical foundation until Bohr proposed,

in 1913, a quantum restriction for his modified version of Rutherford's atomic model.

Bohr assumed electrons orbit the nucleus of an atom in elliptical paths whereby atoms either emit or absorb radiation only when the electron state of angular momentum changes in multiples of the quantum.

Bohr only modified classical formula by applying quantum restrictions, as in assuming a force field exists consistent with Coulomb's inverse-square-law for electrostatics and magnetism. Electrons thus have a negative unit of charge –e and nuclei have a positive unit of charge e. The force between them is the product of charge per distance r squared:

$$F = \frac{e}{r} \cdot \frac{-e}{r} = \frac{-e^2}{r^2}$$

In comparison, Newton's second law of motion for centripetal force relates in the manner

$$F = \frac{-mv^2}{r}$$

Equating the right sides of the last two equations and dividing them in half obtains

$$\frac{-e^2}{2r^2} = \frac{-\frac{1}{2}mv^2}{r}$$

$$K = \frac{e^2}{2r} = \frac{1}{2}mv^2$$

It thus relates to classical formula for kinetic energy K of the electron.

The potential energy T of the electron, as within a conservative field of force, is

$$T = \frac{-e^2}{r}$$

The total energy W is therefore

$$W = K + T = \frac{e^2}{2r} - \frac{e^2}{r} = \frac{-e^2}{2r} = -\frac{1}{2}mv^2$$

The last two equalities become

$$\frac{-e^2}{2r} = -\frac{1}{2}mv^2 \qquad r = \frac{e^2}{mv^2}$$

The orbital radius of the electron is the unit of charge squared per twice the kinetic energy of the electron.

Bohr assumed total energy W becomes zero as r becomes infinite, or whenever the atom becomes ionized because of it losing an electron. By applying quantum restrictions to the atomic radius in using the relations $n\hbar = nh/2\pi = n(mvr)$ and $e^2 = mv^2r$, he deduced

$$r = \frac{e^2}{mv^2} = \frac{e^2n^2\hbar^2}{m^3v^4r^2} = \frac{e^2n^2\hbar^2}{me^4} = \frac{n^2\hbar^2}{me^2}$$

The letter m represents the mass of the electron, $\hbar$ is the Planck constant h divided by 2π, and n is an integer from one to infinity.

The respective velocity of the electron around the nucleus is

$$v^2 = \frac{e^2}{mr} = \left[\frac{e^2}{m}\right] \cdot \left[\frac{me^2}{n^2\hbar^2}\right] = \left[\frac{e^2}{n\hbar}\right]^2$$

$$v = \frac{e^2}{n\hbar}$$

$$\frac{v}{c} = \frac{e^2}{n\hbar c} = \frac{\delta}{n}$$

$$\delta = \frac{e^2}{\hbar c} \approx \frac{1}{137}$$

The fraction (1/137) is an approximation of the fine structure constant here denoted as δ .

Bohr further recalculated the energy to eliminate r from the equations. Previous equations gave

$$E = -\frac{1}{2}mv^2 \qquad v^2 = \frac{e^4}{n^2\hbar^2}$$

Multiplying both the numerator and denominator by c^2 and substituting δ^2 for $e^4/\hbar^2c^2$ obtains

$$E = \frac{1}{2}\frac{me^4}{n^2\hbar^2} = \left[\frac{\frac{1}{2}mc^2}{n^2}\right] \cdot \left[\frac{e^4}{\hbar^2c^2}\right] = \frac{-\delta^2\left(\frac{1}{2}mc^2\right)}{n^2}$$

The highest energy level is n = 1 electron, such that

$$E = -\delta^2\left(\frac{1}{2}mc^2\right)$$

It is the kinetic energy (½)mv^2 minus potential energy mv^2 of m.

Bohr's next assumption was the atom is able to obtain a lesser energy level by emitting a photon of energy E – E' as a difference of energy levels. This energy, as for a general formula predicting light spectra emitted from atoms, relates to the frequency f of the photon by the equation

$$E - E' = \hbar f = \frac{1}{2}\delta(mc^2)\left[\frac{1}{n^2} - \frac{1}{n'^2}\right]$$

A stipulation applies here for n = 1, and for n' to only be any integer greater than one, as for an atom to either decrease or increase from an energy level to another energy level by either absorbing or emitting a photon as a quantum of energy.

The Photoelectric Effect

Planck interpreted the nature of the quantum as a molecular oscillator, but Einstein interpreted it as applying to light as well as to the oscillators in explaining the photoelectric effect that was discovered in 1902 by Phillepps Lenard (1862-1947). Lenard discovered the result of electrons emitted from a metal due to light shining on the metal depends more on the frequency of light instead of its intensity. No electrons are emitted if the frequency is too low.

Einstein interpreted Lenard's findings according to Planck's quantum condition of energy as discrete multiple units of hf. Light quanta now called photons therefore collide with a metal such that the energy of each photon transfers to an electron for the electron to break loose its bondage with the metal. The energy E of the particle of light is called a photon. However, its particle description remains controversial since frequency is also a wave property, and there is also an interference pattern of superposition of light with other light as compliable to wave theory.

Even though the electron only absorbs a particular light quantum, the possible energy of light is still continuous along with energy of matter with regard to relative motion. The continuousness of light energy is associated with varying wavelength λ and varying frequency f with regard to how they interact with matter according to the Doppler principle of relative motion. The quantum relation hf increased by a relativistic factor for relative motion of matter, for instance, allows continuous energy of light to correspond to continuous energy of matter in relative motion such that more intense light reflected by matter can increase thermal temperature and kinetic energy, but the ejection of electrons is still de-

termined by the quantum states of matter and light, as too frequent of a collision for elastic response of a metal.

After determining a numerical value for the fundamental charge of the electron, Robert Andrews Millikan (1868-1953) was able to verify Einstein's explanation of the photoelectric effect as well. His experiment was that of a statistical nature in measuring the electrical voltage of electron emissions in comparison to the light intensity on a metal screen. It produced a photon to electron emission in accordance with the light energy needed of a particular frequency. In 1915, Millikan's controlled experiments were able to interpret the data in a way it not only convincingly verified the photoelectric effect, it confirmed the value of Planck's constant as well.

The Compton Effect

Similar to the photoelectric effect is the Compton Effect that includes the redirection and loss of photon energy as well as an ejection of electrons from atoms. However, only reflection between light and free electrons apart from containment, such as by a metal, are observed. In explaining statistical results of electron and light interaction Arthur Holly Compton (1892-1962) assumed light and electrons are particle-like. Laws of conservation of energy and momentum thus apply to statistical results for equating with a loss of energy of photons, according to their angle of deflection and the gain in energy of the electrons recoiling in opposite directions.

In 1922, Compton bombarded graphite with x-rays in examining how x-rays scatter electrons. He discovered their angle of scattering is consistent with conservation of momentum. The momentum of a scattered electron at a particular angle of a scattered electron coincides with a loss in momentum of the scattering x-ray and its recoil angle, as according to a Doppler shift to a longer wavelength. In manner of conservation of momentum a change in wavelength of an x-ray after it collides with an electron is

$$\Delta\lambda = \lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta)$$

With straight ahead collision the cosine angle is unity such that 1 – 1 = 0, as zero change in wavelength. Since the right-angle reflection is a zero-degree cosine angle, the Compton wavelength for the electron is

$$\lambda_C = \frac{h}{m_e c} = 2.43 \times 10^{-10} \ \ centimeters$$

For a 180-degree reflection the cosine angle is minus unity, as for a change in wavelength that is twice the Compton wavelength.

The Compton wavelength λ and frequency f represent properties of a photon moving at speed c. For interacting with an atomic particle, they also relate to a quantum h of energy and mass m relatively at rest in the manner

$$E = hf = \frac{hc}{\lambda} = mc^2$$

Note: Potential or twice kinetic energy K of the electron around the nucleus of the hydrogen atom is $2K = m_e v^2 = hv/2\pi r_a = \hbar\, v/r_a$. The fraction 2K/E is such that its square root equal to v/c further equals the fine structure constant as 1/137.036.

Wave Mechanics

William Rowan Hamilton (1805-1865) formulated wave mechanics to combine wave properties with particle interaction. He noticed a similarity in form in mathematical formulations of the principles of least-time and least-action. Pierre de Fermat (1601-1665) offered the principle of least-time as a means to describe a light path. The least-action principle was formulated by Pierre Louis Moreau de Maupertis (1698-1759) for describing the dynamics of interaction between particles.

Properties of various physical media for the propagation of light waves are according to their refractive indexes, as defined by the equation

$$\mu = \frac{c}{v}$$

The Greek letter μ denotes the refractive index of the medium, c is light speed in vacuum space (or æther), and v is its speed through a physical medium. The refractive index for vacuum space or æther is unity. It is greater than unity for other media. Since c is constant, and since $\mu\, v =$ c, the speed of light is slower in a refractive index greater than one. The slower speed of c is justified by conservation of momentum since the wave of increased inertia is of the denser medium. A speculative interpretation could be the denser medium converts light energy to mass momentum.

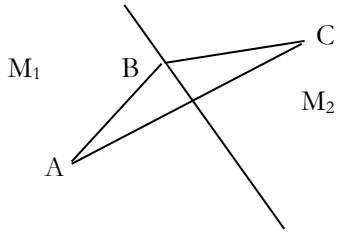
Fermat's principle of least time is according to the relation where time along the total path from point A to point B at each increment of distance ds through a medium of refractive index u is

$$\int_A^B u \cdot ds$$

A particular requirement of this integral is it needs to be an extremum, as either a maximum or a minimum value. The value of least time comes by way of associating u with c/v, such that the greater u results in a slower v for more time.

The significance of this integral with regard to the law of refraction is in realizing a total path that light takes through two media of two different indices. Light paths from A to B through the first medium and from B to C through the second medium need to be a minimum for the total time. The least time does not mean the shortest path; it, rather, depends on the angle of entry. The shortest path is a straight line from A to C, but the time along this path is greater for the medium having a greater refractive index. If the angle of entry is from a shorter path of the medium of a greater index, then the time can be less in the new and longer path. The law of refraction also expresses this result. The least time principle is thus according to the law of refraction in view of wave theory.

A straight line is shorter from point A to point C, but the path from point A to point B to point C is faster because of the shorter distance from point A to point B in the denser medium, M_1.



The principle of least action is similarly expressed as

$$\int_A^B mv \cdot ds$$

Momentum mv replaces refractive index μ of the medium. An increment of distance ds along some path from A to B thus has the momentum mv for action. For the total path from A to C through two media of two different indexes of reflections the same condition exists for less

action as it does for less time. The least action principle thus determines the path of a particle in a conservative field of force in the same manner the principle of least time determines the path of the light wave. A conservative field of force is one in which the total energy, as potential and kinetic, stays the same.

The Hamiltonian Action is a formulation of Least Action in view of a conservative field of force. A constant force in a homogeneous medium is simply the product of a particle's momentum mv and its distance moved r. Total energy before, during or after a particle passes is the potential energy of a field in association with the particle in addition to its kinetic energy of relative motion. For constant field energy, Hamilton distinguished between the action of the particle and the total field energy as varying in time and place. The Hamiltonian Action A thus takes the form A = S – Et. E denotes total energy, t is the time of action, and S is the Maupertuisian Action mvr.

Anywhere along the path of the particle, or along the crossing of paths of a swarm of particles, the action varies with time. At any place where total positive and negative action is zero are the relations

$$Et = mvr$$

$$\frac{E}{mv} = \frac{r}{t} = v$$

An internal action of a field in equilibrium is thus describable.

Hamilton's Wave Mechanics are significant in describing the evolution of waves as multiple interactions of particles and manifestations of particles in an association with wave packets. A mathematical theory of wave packets was later developed by Lord Rayleigh. It foreshadowed the wave mechanics of de Broglie and Schrodinger that included Planck's constant h.

Quantum Wave Particles

The discovery of the quantum along with the success of wave theory for describing the behavior of light indicates light has a dualistic nature. It behaves partly as a particle and partly as continuous waves. Louis de Broglie (1892-1987) further theorized the nature of matter as a particle-wave duality as well with regard to his formulating theory according to special relativity, wave properties and the quantum. Accordingly, energy E and momentum P of a particle moving freely in space relate to the number σ of waves having frequency f and wavelength λ and equate with Planck's constant h in the manner

$$E = mc^2 = \frac{m_o c^2}{\sqrt{1-\beta^2}} = hf$$

$$\vec{P} = m\vec{v} = \frac{m_0 \vec{v}}{\sqrt{1-\beta^2}} = \frac{hf}{\vec{V}} = \frac{h}{\vec{\lambda}} = h\vec{\sigma}$$

The arrows indicate the waves and particles move in the same direction.

V denotes the velocity of the waves. As with waves in general it equates to the product of their wavelength λ and frequency f as

$$V = f\lambda$$

This equation in relation to momentum and energy further equates as

$$V = \lambda f = \left[\frac{E}{h}\right] \cdot \left[\frac{h}{P}\right] = \frac{E}{P} = \frac{mc^2}{mv} = \frac{c^2}{v}$$

The case of photons moving at speed c gives

$$V = \frac{c^2}{v=c} = \frac{c^2}{c} = c$$

Since special relativity stipulates no information of events can exceed light speed in vacuum, the de Broglie waves carry no momentum or energy for them not to transmit direct effect to the observable world.

De Broglie depicted an electron orbiting the nucleus of the atom as a superposing of waves creating effects similar to the beats of sound waves of the vibrating strings of a violin.

Wave equations relating musical harmony of musical instruments were developed in the eighteenth century. Particularly, Jean le Rond d' Alembert (1717-1783) proposed, in 1746, a one-dimensional wave equation for a string-like vibration:

$$\frac{\partial^2 u}{\partial^2 x} = \frac{1}{v^2}\frac{\partial^2 u}{\partial^2 t^2}$$

The letter u represents the amplitude of waves as a function of energy, time and distance: energy being proportional to the square of the amplitude. The symbol ∂ represents partial differential, x its axis of direction in time t, and v its velocity. Although the equation is one dimensional, a plane is indicated by string-like vibration along a y-axis, such that the average displacement is

$$\left(v\frac{\partial}{\partial x} + \frac{\partial}{\partial t}\right)\left(v\frac{\partial}{\partial x} - \frac{\partial}{\partial t}\right)y = 0 = \left(v^2\frac{\partial^2}{\partial x^2} - \frac{\partial^2}{\partial t^2}\right)y$$

The equation thus allows for solutions of internal action.

A three-dimensional wave equation was proposed three years later by Leonard Euler (1707-1783) with the symbol ∇ for three perpendicular axes. Erwin Schrodinger (1887-1961) also transformed de Broglie's particle-wave duality into a three-dimensional-space quantum wave mechanics in deriving more wave equations, such as a non-relativistic one for a particle moving in an electric field of the form

$$i\hbar\frac{\partial}{\partial t}\square(r,t) = \left[\frac{\hbar^2}{2u}\nabla^2 + \mathrm{V(r,t)}\right]\psi(r,t)$$

$\boldsymbol{\psi}$ is the Schrodinger symbol for wave function, as for (r,t), ∇ is the Laplace symbol for three dimensional (x,y,z) coordinates, V represents total kinetic and potential energy according to Hamilton's conservation field rule, i is an imaginary number for the square root of –1, u is a reduced mass of a particle, and ħ is the reduced Planck constant by 2π. The equation is in compliance with conservation of energy according to classical theory.

Schrodinger's wave equation with quantum restrictions reinterprets the quantum conditions of the atom that was previously given by Bohr. Bohr had postulated a correspondence principle for including a wave condition where needed. Bohr's model further describes electrons circling the nucleus of the atom as being corpuscular in nature, whereas Schrodinger considered electrons as a diffused cloud whereby quantum restrictions result as certain nodal points of de Broglie standing waves.

A particular significance of Schrodinger's wave interpretation is Bohr's theory only explains refractive properties of atomic spectra as arising from an electron's change of orbit, as one of more energy closer to the nucleus, whereas refractive index of a medium for wave propagation explains why there is greater energy of attraction closer to the nucleus as a reflection of more energetic light.

Probability Interpretation

Leading physicists as Max Born (1882-1970), Werner Karl Heisenberg (1901-1976) and Niehs Bohr reinterpreted Schrodinger's wave equations as probability equations. Born proposed the wave packet associated with the intensity of the action is the probable whereabouts of a particle. Heisenberg and Bohr then associated both waves and particles according to probability.

Born reinterpreted Schrodinger's theory being a cloud of negative charge in place of Bohr's original model of the particle circling the nucleus of the atom. For instance, in the hydrogen atom, which consists of

one electron, as one unit of charge, the total charge of the electron cloud, as Schrodinger had envisioned, is a charge –e. In addition, he proposed the product of charge and an equilibrium state of wave intensities, as the product of amplitudes equals its energy density ρ at any point dxdydz when the energy of the atom is in a stable state:

$$\rho = -e\psi_n\psi_n^*$$

The product of the wave functions is proportional to the wave intensity. It is used instead of a mere wave function squared for it to allow their product to be negative for a positive density–being a negative density in the natural world is incomprehensible. Representation of total effect over infinite space is by integrating point-charge-density at coordinate point dxdydz. However, total charge of the cloud is still only

$$-e \iiint \psi_n\varphi_n^* dxdydz = -e$$

$$\iiint \psi_n\psi_n^* dxdydz = 1$$

A proportion of the charged cloud therefore condenses at one moment to a specific and stable location dxdydz.

Heisenberg and Bohr interpreted the condition according to principles of uncertainty and complementarity. They found it difficult in view of the particle-wave paradox to conceive of a single particle obeying interference of two wave patterns after they pass through only one of two holes. They preferred instead to view the particle as a sort of diffused cloud capable of interfering with itself, or as consolidating into a particle-like form in that the nature of particle-wave effect is neither wave nor corpuscular in an ordinary sense; it manifests instead as certain observable effects of whatever it is that causes them to appear as such. A diffused cloud represents the effect when less observed; a tinier, more precise wave packet represents the effect when observed more accurately.

Although Schrodinger depicted the diffused cloud of negative charge as well, the depiction by Heisenberg and Bohr differed as according to their view of an electron or any other particle inasmuch as they interpreted wave equations as probability equations of how particle effects can be observed.

An explanation of the probability condition could be it is because total energy moving through space is greater than what is actually observed. The observable secondary effects of nature, as Gassendi had proposed centuries earlier, could arise from the primary unobservable source underlying nature. However, without means of verification the explanation is not science; it is speculation. Nonetheless, by the probabil-

ity conditions of quantum physics suggesting an existence of a virtual field of virtual particles, the philosophy of Gassendi is worthy of consideration for a more complete understanding regarding wave-particle duality and physics in general.

Uncertainty

Heisenberg established a principle of uncertainty in order to determine the probability of finding the location or time of a particle effect from the probable outcome of its momentum or energy, respectively. According to Born's interpretation of Schrodinger's equations a wave-packet defines the region where a particle is locatable. The probability of the particle's position is at any point within the wave-packet where it is proportional to the product of the total volume of the wave packet and its relative intensity. The relative size of the wave packet is dependent on observation, as by the ability of a photon to penetrate a certain level within the wave packet. Photons having higher frequency, greater momentum and more energy penetrate deeper into the wave packet for a more precise location of the particle. Photons with less frequency determine instead more exact momentum from the packet's larger size.

Heisenberg's uncertainty principle follows from how Born viewed the wave packet. By Born, any one of the waves in the packet is representative of a probable particle of particular momentum and energy according to the range in energy by which waves vary. The causes of their spreading apart by impact of the photon, and by the difference in energies of waves, render the momentum and energy more uncertain. In following this lead Heisenberg surmised more exact determination of the particle's position by a more energetic photon causes more uncertainty of the particle's momentum and energy. Conversely, the determination of momentum and energy by a less energetic photon results in more uncertainty of position.

The relative momentum of the photon in relation to wave parameters and Planck's constant h is provided in relation to the equation $P = \hbar/\lambda$. The uncertainty of the change in momentum ΔP with regard to the wavelength of the photon is opposite to the uncertainty of its change in position Δx. Certainty of position is uncertainty of momentum; conversely, certainty of momentum is uncertainty of position. Therefore, a range of positions for each momentum and a range in momenta for each position exist. The total uncertainty is the product

$$(\Delta x)(\Delta P) \geq \lambda(\hbar/2\lambda) = \hbar/2$$

Total uncertainty further includes energy and time. The dimensions of h (as mass-velocity-distance or mass-distance squared per time) can also be

interpreted as the product of distance and momentum (mass multiplied by distance and velocity) or as the product of time and energy (time multiplied by mass and velocity squared):

$$(\Delta t)(E) \geq \hbar/2$$

This probable uncertainty is not interpreted the same as that of flipping a coin. The coin can come up heads 3 times and tails 7 times after 10 tosses. After a million flips the heads-tails ratio is more apt to approximate as 1. In contrast, the probability of quantum physics is an exact prediction. If there is a probability of a particle showing up 3 times out of 10, then it is predicted as such. It can show up 1 time for the first 8 observations, 1 time for the 9th observation, and 1 time for the 10th observation, or otherwise, but it is predicted to show 3 times in any combination of 10 observations.

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Renormalized Quantum Physics

Plank derived the Plank Constant as a resolution to an infinity result by means of quantization. However, another infinity paradox reappeared in view of the Heisenberg Uncertainty Principle along with the mass-energy equation and further discoveries of particle interaction relating to the nucleus of the atom. They led to such advanced technology as the invention of the atomic bomb. A resolution of the latter paradox is referred to as renormalization. It distinguishes between normal reality of direct observation and a virtual field of energy beyond that of direct observation.

Although such new theory as quarks interacting within the nucleus of the atom emerged, its development is still connected to the development of wave mechanics in that there is now both positive and negative charge associated with matter and antimatter in further association with the concept of spin distinguishing particles as photons and gravitons resulting in effects of direct observation. Quarks associate with perturbation theory regarding internal action between subatomic particles within the atomic structure of matter instead of mere action of matter on other matter according to classical mechanics.

Spin

Schrodinger's wave mechanics explained nearly all conditions of light spectra that Bohr's theory explained except for one that became explained with an assumption of spin as needed for explaining a particular spectrum. Bohr's theory explained it with the assumption of the magnetic moment of the electron being defined by its own spin, as defined as half the value of the quantum constant $\hbar$. Nowadays it is simply said that the electron has a spin of ½, but the spin is symbolic in concept insofar as it does not compare with the spin of such a physical object as a ball.

George E. Uhlumbeck (1900-1988) along with Samuel A. Goudsmit (1902-1978) proposed a spinning electron to correct certain inadequacies of Bohr's theory to describe finer radiant spectra detected from the hydrogen atom. Although evidence supported the spinning electron explanation, there was no known reason for its existence except for Wolfgang

Pauli (1900-1958) explaining it as consistent with wave equations presented in the form of a matrix. The matrix allows for the splitting of the wave equation as representative of an electron spin in either of two directions. When combined with the amplitude function ψ of waves it further suggests polarization.

Charles Galton Darwin (1887-1962) then derived a wave equation that includes a polarization effect of the spinning electron in describing the fine structure of the hydrogen atom by means of a wave equation. Neither Pauli nor Darwin, however, derived wave equations consistent with the theory of relativity. This was a task taken on by Adrien Maurice Dirac (1902-1984) in deriving a relativistic form of Schrodinger's wave equations.

Schrodinger succeeded in deriving wave equations in classical form, as consistent with conservation of potential and kinetic energies:

$$\frac{1}{2m}\left(P_x^2 + P_y^2 + P_z^2\right) - K = 0$$

For wave interpretation, Schrodinger replaced momentum-vectors P_x, P_y, P_z with respective operators for wave interpretation of particle effects:

$$\frac{h}{2\pi i}\frac{\partial}{\partial x} \quad , \quad \frac{h}{2\pi i}\frac{\partial}{\partial y} \quad , \quad \frac{h}{2\pi i}\frac{\partial}{\partial z}$$

In addition, he replaced the energy K with the operator

$$-\frac{h}{2\pi i}\frac{\partial}{\partial t}$$

The operators above are only in compliance with conservation laws of classical mechanics, not those of relativity theory. Schrodinger attempted a relativistic version, but he was unsatisfied with the result. Another version of theory was proposed by Walter Gordon (1893-1939) and Oskar Klein (1894-1977), but it also had reservations with regard to determining the probability density of a particular state of particle motion. The relativistic form of the wave equations requires symmetry for compliance with the principle of covariance, which was complicated because the Schrodinger equations in wave form indicated possible negative densities of matter, which was difficult to accept by physicists at the time.

Negative values of relativistic invariance are still possible, but the form of the energy equation requires a more complex solution for including SRT conditions of combining energy with momentum according to the invariant

$$E^2 = P^2c^2 + m_o^2c^4$$

In the form of three dimensional space coordinates for momentum P the invariant is

$$P_x^2 + P_y^2 + P_z^2 + m_o^2c^2 = \frac{E^2}{c^2}$$

The significance of this invariance is that it is according to four dimensional spacetime in connecting to light speed and electromagnetism.

Including relativistic invariance in wave equations can unify theory, but the unification does not mean one theory becomes the same as the other; it means each becomes part of the other as parts of a more embracing theory. The new theory describes more phenomena, as exemplified by Dirac's inclusion of relativistic invariance in quantum wave mechanics.

Invariance allows calculation of unknown variables from known ones. Significant with regard to the derivation of relativistic invariance is the nullification of one factor canceling out another one. Derivation of Minkowski invariance does, in fact, consist of nullifications by way of cancellation: The Lorentz transformations for coordinates of time t' and distance s' relate as ct' and s'; the transformation equation of s' is both subtracted and added to the ct' transformation equation. Results of added and subtracted values are then multiplied to become the invariant with some of the positive and negatives cancelling each other. Wave theory also identifies with nullification in that waves of opposite phase cancel each other out in effect when they superimpose.

Wave interpretation provides insight into the physical natures of such nullifications, which entails a different interpretation of the mathematics. A different commutative rule for multiplication, for instance, was pioneered by Hamilton and applied by Dirac for the application of his matrices in allowing Schrodinger's quantum wave mechanics to connect with special relativity theory. The commutative rule means A + B = B + A, as does AB = BA. To the contrary, A – B ≠ B – A is non-commutative, as 5 – 3 = 2 is positive and 3 – 5 = –2 is negative. Generally, 3 x 5 = 5 x 3 = 15 is commutative, but not according to Dirac's matrix rules.

Of particular significance to the non-commuting rule is its compliance with the number i as the square root of –1. In ordinary algebra the number one can either be $(1)^2$ or $(-1)^2$. The symmetry of Dirac's matrices, however, is such that $i^2 = -1$ has a unique interpretation: For every positive solution there is a negative or an imaginary solution as well. In

reference to particle effects of electrons, for instance, the positive and negative factors represent opposite directions of counterclockwise or clockwise electron spin, and for antimatter to exist as an opposite state of matter.

Further significance is with regard to the Pythagorean Theorem, which is a foundation of relativity theory. For instance, consider

$$(A + B)^2 = A^2 + AB + BA + B^2 = A^2 + 2AB + B^2$$

AB + BA = 2AB does not apply to Dirac matrices. Instead, BA is negative if BA is positive, and A and B represent coefficients whereby AB + BA = 0 and $A^2 = B^2 = 1$ for light speed as unity. The non-commuting rule is thus a means of interpreting the positive and negative subtractions for deriving Minkowski invariance from Lorentz transformations.

Further significance is with regard to dimensionality. The matrices can increase to include four dimensional spacetime in compliance with relativity theory, but the particular significance of the non-commuting rule along with the number i for positive and negative values is what provides insight into a symmetry of relativistic covariance with regard to spin and antimatter.

This indication of antimatter is a square root of the momentum-energy equation being either positive or negative. It need not necessarily be either, as positive numbers each squared and added have only a positive value for the square root of their summation, but Dirac's matrices are of a symmetry consistent with the interpretation of Schrodinger's equations by Bohr, Born and Heisenberg whereby the wave aspect merely represents the probability of existence, and whereby Dirac's theory is verifiable as a test of predicting the positive and negative symmetry of nature.

Unity

An even greater significance of Dirac's approach is with regard to the unification of QED and relativity theory. This unification is in relation to spin. Bohr had accepted a suggestion to assume it applies as another condition of the electron in its orbit about the nucleus, as with a ½ spin of the electron to account for the empirical findings of a Stern-Gerlach experiment. It was discovered that a beam of atoms splits into a number of parts depending on the angular momentum of the atoms, even for angular momentum small as unity. This result indicated atoms split into three parts: –1, 0, 1, such that splitting the beam resulted in three parts, being positive, neutral and negative for half angular momentum in one direction balancing half angular momentum in the opposite direction.

Wolfgang Pauli (1900-1958) proposed in 1924 a new quantum degree of freedom with two possible values to explain observable effects of nuclear spectral. In 1926, he offered a 2 x 2 matrix for describing the two degrees of freedom in manner of non-relativistic spin of the electron. Shortly later, but independently, Dirac revealed a 4 x 4 matrix as a relativistic version of spin, as in accordance with the Minkowski invariant for energy and momentum. Dirac thus succeeded in uniting Quantum Mechanics with special relativity, but not with general relativity in view of the singularity.

Previously noted in this book is the fraction ½ as unique to general relativity relating gravitational potential to escape-speed-squared. Hamilton also included a fraction ½ in relation to three-dimensional rotation, as mathematically indicating it rotates consecutively in perpendicular directions, as subsequently one way and then the perpendicular way around the surface of a sphere for twice time and distance of spin. Similarly, a significant factor of a Fourier transform is the square root of ½. Joseph Fourier (1768-1830) is noted for his mathematical analyses of heat transfer and his awareness of the greenhouse effect, but application of his mathematics applies to other areas of science as well. The square root of ½, for instance, applies to the amplitude A of a plane wave superposition in the manner

$$A(k) = \frac{1}{\sqrt{2}} e^{-(k-k_0)^2}$$

It relates to a wave-packet moving to the right and left according to a wave function w(k) = kv whereby u(x,t) equals both F(x ± vt) and further relates to localized disturbance of superimposed waves formed into a wave packet. Particular amounts of wave frequencies are needed to sustain a wave packet whereas destruction of any possible wave packet from it occurs instead. The result is consistent with Huygens' Principle of every point of disturbance is the creation of more waves. Instead of waves being annihilated behind the front progression of wave action, they disperse from being a wave-packet.

The main reason here for pointing out the significance of the fraction ½ is for relating quantum wave mechanics to general relativity. The spin ½ of quantum mechanics relates as angular momentum. Similarly, gravitational potential, as in relation to orbital speed squared, is ½ the gravitational escape speed squared.

Light speed is a limiting condition of SRT by which matter cannot even reach. By GRT, the limiting condition is the escape speed instead of the orbital speed. For an addition of gravitational potentials theorem in analogy to the addition of velocities theorem, the limiting condition of

the rotational speed is the square root of one-half c instead of c. The analogy is thus slightly more complex.

Unique is ½ as a limiting aspect of gravity. If a Schwartzschild radius for an escape speed is (½)c, then

$$c\square = c\left[1 - \frac{2GM}{rc^2}\right] = c\left[1 - \frac{2}{4}\right] = \frac{c}{2}$$

If the rotational speed is also (½)c, then it calculates by a slower clock moving at that speed in the gravitational field as

$$\frac{\frac{1}{2}c}{\left(1-\frac{2GM}{rc^2}\right)} = \frac{\frac{1}{2}}{\left(1-\frac{1}{2}\right)} = c$$

$$\frac{c\sqrt{\frac{1}{2}}}{\sqrt{1-\frac{2GM}{rc^2}}} = \frac{c\sqrt{\frac{1}{2}}}{\sqrt{1-\frac{1}{2}}} = c$$

Gravitational potential can thus be perceived as that of escape speed.

Potential is a key word. Light speed of a gravitational potential for an orbital speed of one-half light speed decreases to one-half light speed. The gravitational potential thus equals internal energy of mass. Since light is electromagnetic energy, it implies energy is split at the limiting aspect of c to maintain itself. Half of it could be gravitational potential; the other half could be electromagnetic potential.

Quantum Singularity Implications

A singularity was indicated of the Schwartzschild Metric of general relativity in that on one side of the equation the increment dt equaling zero directly relates to dr equaling infinity. Special relativity, however, is conditional to light speed c being a limiting factor that matter can neither equal nor succeed. To increase to infinite mass-energy at light speed the mass needs to absorb infinite mass-energy from the mass or electromagnetic energy accelerating it. However, in quantum physics is perturbation, the probability of interaction between virtual particles having greater mass-energy density if smaller in size. For instance, virtual energy approaches infinity for the wavelength of a virtual photon approaching zero. The potential of greater energy being smaller in size for less detection of it in the same amount of surrounding space allows for a singularity to exist as a particle.

Renormalization of virtual energy can be considered consistent with special relativity. The infinite possibilities of infinite-positive-fields of energy could be nullified by the infinite possibilities of infinite-negative-

fields, as can infinite mass-energy of matter also be nullified by infinite mass-energy of antimatter further counterbalances by an infinite volume of space in which to interact according to perturbation theory. As to how general relativity can also apply to renormalization in this way is open to debatable speculation. By renormalization in quantum field theory (QFT) the virtual energy is merely discarded by renormalizing the mass, say, of an electron by equating it again to that which is empirically detectable by experiment.

What has developed of Quantum Electrodynamics (QED) from these new discoveries is Quantum Chromo-dynamics (QCD). It is a theory of strong interaction between quarks and gluons being composites of such hadrons as protons, neutrons and pions. Their nature varies more in comparison to the simple positive or negative charge of QED. For instance, such baryons as protons and neutrons are composites of three quarks of different color for the baryon to be internally neutral of parts. Apart from the nucleus, such mesons as muons are comprised of quarks and anti-quarks as matter and antimatter comparable to positive and negative charge. As for maintaining the greater energy of the atomic nucleus at shorter range, it occurs by emitting gluons for the transformation of a baryon into a meson being comprised of a quark and anti-quark pair.

The Heisenberg Uncertainty Principle is a determining factor of infinities. The combined probability of determining an electron's whereabouts and momentum, for instance, equals the Plank Constant $\hbar = h/2\pi$. By interpretation, as according Perturbation Theory, there is a probability of an electron interacting with a photon of nearly a zero wavelength for it to be equivalent to a particle of nearly infinite mass-energy. However, if such virtual energy is less detectable by the natural world in which we live, then renormalization is plausible. It would also be consistent with special relativity inasmuch of its condition of no information of events is receivable from a distance faster than light speed refers to an observable event. The original locations of virtual particles are not observable.

Special relativity is also consistent with the Planck Constant whereby the parameters mvr are of constant value. With v also being constant, m increases or decreases in inverse proportion to r decreasing or increasing. Special relativity is similar in that an increase in relative motion increases m in inverse proportion to a decrease in r, and vice versa regarding a relative decease in relative motion.

General relativity is more complicated because of the gravitational constant G. If the radius of a particle decreases to nearly zero length for the mass to increase nearly to infinity, then a particle singularity becomes possible. However, if the entropy of matter exist in a state of equilibrium

with the virtual energy field of so-called vacuum space, then a finite reality of space and time is possible as well.

Massless Particles

What complicates unification of theory in physics is a difference in classification of particles. Photons and gravitons are classified as massless with the perception photons can occupy the same space as wave action whereas matter cannot. In QFT there exist both massless and massive particles. The neutrino is debatable as to whether it is massless or not. A gluon is an engage-particle classified as massless. It is an exchange-boson similar to the photon. Gluons are exchanges of energy between quarks; photons exchange energy between such electrically charged particles as electrons. In the weak force of electromagnetism, a boson denoted as W or Z is of a mass nearly one-hundred times that of the proton.

In the 1970s Robert Brout, Francois Englert and Peter Higgs initiated the standard model consisting of electromagnetism and the weak and strong quantum forces of the atom. They proposed a resolution as to the mass of the W and Z bosons. It has become known as the Higgs Mechanism of a Higg's Field whereby bosons can convert to mass.

The idea of bosons converting to mass is not without precedence. A photon can convert to mass by reflecting off a material particle to increase its relative motion, which by SRT increases according to the relativistic factor. Part of the photon is thus transformed into mass for the reflected part to be less of it. Conversely, a photon can counter the relative motion of a particle for mass to convert into electromagnetic energy.

It is also possible for photonic energy to be invisible. As waves can superimpose upon themselves, they can superimpose upon mass. Generally there an interference effect with a slight reduction in energy, but in view of entropy the invisibility is plausible in a state of equilibrium. It is thus disruptions of equilibrium that produce visible effect. In the nucleus of the atom this disruption is quicker, being more energetic at a particular moment but occurring in far less time, as consistent with both the Plank Constant and SRT.

Less energetic changes occur over long durations. Neutrinos, for instance, are now considered one of the most abundant particles in the universe, but they are extremely difficult to detect. They are found to have nearly no mass, if not any at all. They contribute to the weak force of charged leptons that include the electron, tau-meson (tau) and the mu-meson (muon), By means of oscillation they are assumed to continually transform back and forth from being either a muon-neutrino to tau-neutrino. The muon has more than 200 times the mass of an electron; the tau has more than 3500 times the mass of the electron, being about twice the mass of a proton.

Gravitons are also considered massless, but they are emitted energy that could decrease the mass of matter if it is not continually being absorbed from another source, as it continually absorbs and reflects starlight from the universe at large. It could thus be in a gravitational and electromagnetic state of equilibrium.

Such a theory of a state of gravitational and electromagnetic equilibrium has been proposed. Harold Aspden began formulating one in the 1950s. It includes gravitons of mass associated with the tau as a ghostly particle of either positive or negative charge being annihilated and recreated as a counterpart of a ghostly muon being annihilated and recreated to become the proton along with the atomic structure of matter.

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ÆTHER COSMOLOGY

Throughout history there has been lack of recognition of challenges to presently established theory. Examples include those of such theorists as John James Waterston, Olaf Kristian Birkeland and Harold Aspden. For instance, Waterston's idea of degrees of freedom as an equipartition theorem in relation to the kinetic theory of gases was rejected for publication, but the same idea, as credited to James Clerk Maxwell along with his formulating electromagnetic theory, was published twelve years later.

Birkeland proposed a theory as early as 1896 that did not receive acceptance until it was confirmed by space probes starting in 1967. His idea was an extension of Maxwell's electromagnetic theory for explaining the auroras of the northern and southern lights near their respective poles as disturbances between the sun's radiant energy and magnetic fields above Earth's atmosphere. Because he described the fields as consisting of an ionized gas, and because Lord Kelvin had stated that all space between the sun and above Earth's atmosphere is void of matter, Birkeland's theory was disregarded until a magnetic field of plasma was discovered by a military probe in 1967. Overwhelming evidence in support of it, as in the 1970s, occurred by way of orbiting satellites. It is now estimated that more than ninety-nine percent of the mass in the universe is in an ionized state that is now referred to as plasma.

Harold Aspden, in the 1950s, began formulating a theory based on previous development of æther theory. Although it is a credible theory in support of other credible ideas, it has not received enough recognition for what it deserves. Einstein's dismissal of the æther as necessary for the mathematical formulation of theory is likely the reason for this lack of recognition. Although Einstein later acknowledged that the æther could be useful for explaining theory, the principle establishment being that natural science is restrictive to a mathematical formulation of observational facts with no need of explanation seems to have prevailed instead.

Aspden initially did not have access to a computer while formulating theory. His equations were verified independently by an Australian

National Standards Laboratory that did have a computer. His results are thus less likely fabrications merely to comply with known values.

It is here acknowledged that our finite minds do not perceive infinite existence. How an infinite world formed an infinite time ago is not understood; it is merely assumed mass-energy is allowed to exist according to established laws of motion and such principles as conservation of energy. How the æther is analyzed consistent with a so-called vacuum space of virtual particles is only to be theorized in explaining how it relates to the observable world in which we live.

Aspden Æther Cosmology

Although not receiving much recognition for his mass-energy formula prior to Einstein's formulation of it, J. J. Thomson has been credited for discovering the electron in 1997. Aspden noted that Thomson had derived a mass-energy equation prior to Einstein's derivation of it. Accordingly, Thomson derived it as relating to a particular value of electrostatic charge q of the electron according to its kinetic energy in the manner

$$\frac{\left({}^{qv}/_{c}\right)^2}{3a} = \frac{1}{2}m_e v^2$$

$$\frac{q^2v^2}{3ac^2} = \frac{1}{2}m_e v^2$$

$$\frac{2q^2}{3a} = m_e c^2$$

The letter **a** denotes the radius of a sphere in which the electric charge is contained as the electron.

The electron with its charge unit q as e is fundamental in Aspden's theory as a particular electrostatic charge for relating gravity to the atomic structure of matter according to the interaction between ghostly particles similar to the virtual particles of the so-called vacuum state assumed of quantum physics. Referring to them as ghostly merely distinguishes his theory apart from other theory. In regard to the electron and its charge being primary as the fundamental action of the annihilation and recreation process, it is essentially a key part of explaining how ghostly particles relate to photons and gravitons having direct effects of observation. For example, the photon having a Compton frequency in relation to the internal mass-energy of the electron in the hydrogen atom is explained according to a cubic array of 27 æther particles that Aspden named quons. Their interaction with photons results in the presence of gravitons and ghostly muons. The latter is part of the atomic structure

being in constant proportion to the former that is part of the gravitational action.

There is an annihilation and recreation process consistent with that of the interaction between electrons and positrons, and more generally of matter and antimatter. Aspden's theory contains ghostly muons of positive and negative charge polarity that annihilate to be recreated in a recycling process that results in the formation of protons. Gravitons of opposite polarity are similarly annihilated and recreated for gravitational effect. The degree of effect for either gravity or electromagnetic attraction is according to various frequencies of the recycling process.

A slower process for gravity occurs because of a condition required for stability. The æther thus exists as a uniform structure as a lattice system of particles characterized as cubic crystals. The most stable particle is the quon by it being of larger size with less frequent change in energy, as is consistent with atoms in general complying with the parameters of the Planck Constant.

The stability of the quon state is constantly interrupted by the annihilation and reformation of ghostly muons having relatively more energy in relation to frequency. As a result, the gravitational constant G, the fine structure constant, and the ratio of proton mass to electron mass are all derived accordingly.

Overall, the mass-energy of the quon relates as a primary existence of an æther cell regarding its lesser energy in proportion to the electron.

A Paradox

A questionable relation of electromagnetism with quantum physics is explained by Aspden's theory. It pertains to the fine structure constant as to its interrelating quantum mechanics with electromagnetism in the manner

$$\frac{e^e}{\hbar c} = \frac{m_e v^2 r_a}{m_e v r_a c} = \frac{v}{c} = \frac{1}{137.036}$$

The ratio becomes an issue regarding distance and speed parameters of electromagnetic charge and the Planck Constant for determining the internal mass-energy of the electron. By electromagnetism according to Thomson's formulation of mass-energy in relation to $e^2/\boldsymbol{a} = mc^2$ instead of mv^2, where $c/v = 137.036$, r_a needs to be shorter, as divided by $(137.036)^2$ to become $r_e = 3\mathbf{a}/2$ in relation to $e^3/r_e = m_e c^2$, but the same shorter distance in the Plank Constant does not then maintain its same value because of it relating to only $m_e v r_a$ instead of $m_e v^2 r_a$. For its quantum value to equate to internal mass-energy, Compton proposed frequency f is the determinable factor instead of shorter radial distance by

the fine structure constant squared. Since frequency is per time, parameters $m_e v 2\pi r_a$ of the Plank Constant h per time t relate in the manner $hf = m_e c^2$. In relation to wavelength $\lambda = c/f$ the equation becomes $h/\lambda = m_e c$. The wavelength λ regarding the hydrogen atom relates to the atomic perimeter of an electron rotating at orbital speed v. For there to be light frequency instead, the perimeter distance along with the radius r_a need to be shorter by the factor 137.036.

In contrast to the quantum formulation, the Thomson electromagnetic formula indicates internal mass-energy of the electron calculates in the manner

$$\frac{2q^2}{\frac{3r_a}{(137.036)^2}} = \frac{e^2}{\frac{r_e}{(137.036)}} = m_e c^2$$

By this equation the electron radius r_e is less than the radius r_a of the hydrogen atom by the factor of the fine structure constant squared whereas the Compton wavelength relates only as less than the perimeter $2\pi r_a$ by the factor of the fined structure constant, which relates to a reduced radius r_a by the same factor. As to how the electron can be of two different sizes, Aspen's theory interprets the Compton wavelength as a boundary condition between opposite polarity charges in a state of equilibrium.

The Compton frequency, as for the electron in the hydrogen atom, is according to the time it takes the electron to circle the atom, except for the orbit being shorter than the perimeter $2\pi r_a$ of the atom by the factor 137.036 that further equates as $m_e c^2/m_e v^2 = c/v = 137.036$. To speculate regarding the electron in the atom, the perimeter of the hydrogen atom divided by 137.036 and 2π calculates as a mean distance from that of the atomic radius and the actual electron radius being the distance parameter of an electromagnetic energy state of equilibrium whereby there is a constant increase of expansion from the annihilation and recreation process. The larger outer size thus balancing out the denser inner size as explanation of the ratio factors 137.036 and 137.036 squared.

In Aspden's theory the radius r, as equal to the atomic radius of the hydrogen atom divided by the fine structure constant, represents distance between a G-frame of a continuum of gravitational and electrostatic charge e and an E-frame of aether-lattice particles. Each system is of the same mass density moving at speed c/2 but having relative velocity c. By being in states of equilibrium opposing each other, no inertia propagates for gravity to only reveal itself with the presence of matter being given an intrinsic state of jitter motion in relation to the Compton frequency.

Inclusive to Aspden's theory is both the Thomson electromagnetic formula and the Compton quantum formula for the mass-energy of the electron. How they both apply according to Aspden's theory is explained

according to 27 quons contained within a cubic æther cell rotating within a sphere consisting of photons interacting with quons. The structure is of a crystallized form containing a state of 3 x 3 x 3 interaction that results in the formation of 27/3 = 9 ghostly muons of positive and negatives charges. Formation of the proton further results from interaction between positive and negative charged muons. The number 27 is thus a significant factor of Aspen's theory.

Number 27

Aspden's formulation of the lattice continuum includes a theorem proposed in 1813 by Carl Friedrich Gauss (1777-1855). By it a thickness of length D of planar slice of charge with thickness length D is in ratio to 4π, as the surface area of a charged sphere, for its parts being directed in opposite circular ways with each part moving at circular speed $c' = c/2$ and at speed c relative to each other.

Further development of theory pertains to a numerical factor 27. A length d of a cubic lattice cell equates to the Thomson electron radius **a** in the manner $d = 108\pi\mathbf{a}$, wherefrom $108\pi = (27)4\pi$. Within the cubic lattice is a sphere of 27 quons. Consider 3 quons interrelate with a ghostly muon, such that the æther cell contains 9 ghostly muons. The ghostly muons differ from the quons with regard to polarity. The nine ghostly muons combine as 9 states whereby 5 are of positive charge opposite to that of the electron, and 4 states are of the same negative charge as the electron. The nine states further combine into 3 states. There are 2 states containing a 2 to 1 ratio of positive charge to negative charge, and there is only one state of 2 to 1 ratio of negative charge to positive charge. Two of the opposite charged states nullify each other leaving a state with the ratio of 2 positive charges to 1 negative charge, as for the proton to be of opposite charge to that of the electron.

The proton is comprised of the 9 ghostly muons. However, Aspen's ghostly muons are more massive than what has been empirically measured of their more direct muon effects apart from being that of the proton. There is loss of energy when combined in states of 9 ghostly muons and further loss of energy by the continual interaction of one state of 2 to 1 ratio of positive to negative charge. The former loss results in a numerical proton mass equal to that of 1843 electrons. The latter loss for the muon mass-energy to be that of 1836.15 electrons, which is derived according to Thomson's internal mass-energy formula of the mutual interaction of two particles of internal mass-energy $2e^2/3x^2$ equating to a Charles Augustin Coulomb (1736-1806) relation of interaction energy as $-e^2/(x + y)^2$. The $(x + y)$ is the distance between centers of particles upon surface contact.

By combining into a state of equilibrium whereby their radii have contracted to minimal lengths, their addition equates as zero in a state of equilibrium for obtaining a numerical ratio of y to x in the manner

$$\frac{-e^2}{(x+y)^2} + \frac{2e^2}{3x^2} = 0$$

$$\frac{e^2}{(x+y)^2} = \frac{2e^2}{3x^2}$$

$$\frac{e^2}{e^2} = \frac{2(x+y)^2}{3x^2}$$

$$\frac{3}{2} = \frac{(x+y)^2}{x^2}$$

$$\sqrt{\frac{3}{2}} = \frac{x+y}{x} = 1 + \frac{y}{x}$$

$$\sqrt{\frac{3}{2}} - 1 = \frac{y}{x} = 0.2247$$

The energy loss relates to the distance ratio squared as

$$\frac{y^2}{x^2} = 0.0505$$

The proton-electron mass ratio is thus determined in the manner

$$\frac{m_p c^2}{m_e c^2} = \frac{\left\{9-2\left[\sqrt{\frac{3}{2}}-1\right]^2\right\} m_\mu c^2 = (8.8989795)(206.3329) = 1836.1522}{m_e c^2} = 1836.1522$$

An empirical value of m_p/m_e as 1836.1527 compares favorably to Aspden's 1836.1522, but his m_μ/m_e value of a ghostly muon as 206.3329 is slightly off the mark of the empirical value of 206.7683.

A derivation of the proton-electron ratio N = 1843 is complex, but it is in itself a numerical link to the g-frame of gravitons. The following equations are examples of the linkage:

$$\frac{hc}{2\pi e^2} = 108\pi \left[\frac{8}{N}\right]^{1/6} = 137.0359895(11)$$

$$E_o = \frac{3}{4\pi}(108\pi)^3\left[\frac{1}{N}\right]\frac{2e^2}{3b} = \frac{3}{4\pi}(108\pi)^3\left[\frac{1}{N}\right]^{4/3} m_e c^2$$

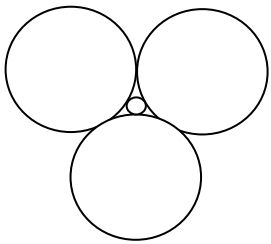
It thus links with the fine structure constant and energy E_o contained in each unit cell of æther, where b represents the quon radius.

Mass and Volume Ratios

A simple mathematical model speculated on by Arthur Stanley Eddington (1992-1944) regarding the fine structure constant was to add the numbers 1 through 16 equating to n(n + 1). For the addition of the first sixteen numbers: 16 x 17 = 136. Further speculation is to multiply 136 by 3 and then divide the result by 2, suggesting a muon of 204 electron masses. Nine muon masses then calculate as 1836 electron masses, suggestion the creation of the proton. However, the internal action of matter is not that simple. It is far more complex in consisting of internal actions between such virtual particles as various quark hyperons in the nucleuses of atoms that perplexingly influence the results in various ways.

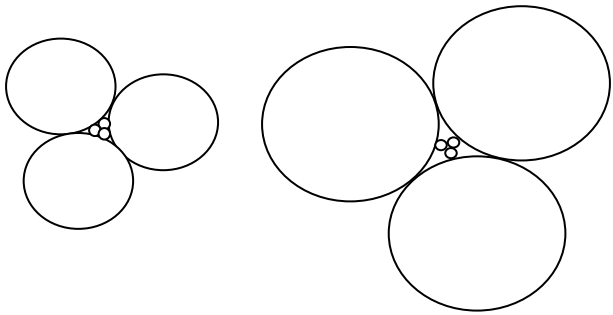
Carl R. Littmann spent decades analyzing mass and volume ratios of virtual energy particles. Much of his findings have been published in his Booklet of Large and Small Spheres in Patterns and Large and Small Mass Particles (For all Major Particle Groups in Physics).

One of Littmann's simplest volume ratios with mass ratios is that of a pion mass in ratio to an electron mass. As depicted below, if three large spheres circumscribe a smaller sphere, as in a plane, the radius of the large sphere is 6.464 times longer than the small sphere radius, and the volume of the large sphere is 270.1 times larger than the small one. A pion mass on the average, as with positive, negative or neutral charge, is 270.13 times the electron mass.



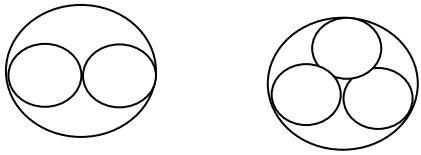
The kaon-electron mass ratio comparison, as depicted below on the left, is three large spheres circumscribing three small ones whereby a large sphere radius in ratio to an inner sphere radius is 9.89898 to 1, whereby their volume ratio is 969.99912 to 1. The average between the

kaon mass either charged or not charged in ratio to the electron mass is 969.98 to 1.



The proton relates average ratio of volumes, one ratio being of three small spheres packed between crevasses of three large spheres and the other of three small spheres positioned opposite the crevasses. As for the small spheres packed between crevasses, the big and small sphere radii ratios relate as the kaon, but if the small spheres are positioned opposite the crevasses, the radii and volume ratios are 13.9282 to 1 and 2702 to 1. The average of 970 + 2702 as 1836 is comparable to the proton mass of 1836.15 electron masses.

Muons below compare to the proton in manner of the average size of either two or three small circles circumscribed within the same larger circle. The large circle compares to a proton mass of 1836.15 electron masses. The radii ratio of one of two smaller circles to the large one is ½. The radii ratio of one of the three smaller circles to the large one is 0.4641 to 1. Volume ratios are 1/8 and 0.0999619 to 1, respectively. An average of the different volumes of the two smaller circles in ratio to the larger one of the 1836.5 electrons is a ratio of 206.53 to 1836.15. The empirical value of the muon has been determined as 206.7682838(24) electron masses.



In view of the volume ratios in relation to the proton, kaon and muon, it is conceivable that a muon of 206.77 electron masses is ejected along with an electron and light energy from 3879.92 total electron masses consisting of two non-charged kaons and two charged kaons in the formation of a proton and neutron totaling 3674.83 electron masses.

Four kaons minus the muon and an electron are twice 1836.12 electron masses.

The number 9.89898 as the ratio of a kaon radius to an electron radius is significant in that it has been derived separately by Greg Volk and Harold Aspden. Volk, in being acknowledgeable of Littmann's also related it in comparing mass ratios to volume ratios.

Aspden derived 8.89898, which is (9.89898 – 1), according to a combination of electrostatic formulas in relation to the creation of protons from muons. An electron volume and mass as one unit implies a loss of an electron.

Greg Volk explained the calculation of the number 9.89897 according to the tetrahedral pattern of four spheres packed around a common origin such that the surface of a sphere centered at the origin and touching centers of the four spheres calculates as coordinate distance points (1 1 1) (1 –1 –1) (–1 1 –1) (–1 –1 1) from 0 at distance **D** according to three perpendicular axes as an extension of the Pythagorean Theorem for three-dimensional space. **D** thus calculates as the square root of 3, 3 being the sum of each coordinate length squared. In contrast is the radius **R** of any one of the other four spheres. Since they are symmetrically aligned along planes of respective axes, **R** calculates as the square root of 2, 2 being the sum of each coordinate length squared to the plane.

The ratio of (**D** + **R**) to (**D** – R) calculates as

$$\frac{D+R}{D-R} = \frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}} = 9.898979486$$

It equals Littmann's radii ratio of the three large spheres circumscribing the three smaller spheres. It is also exactly one number greater than a particular factor used in relating muons to the ratio of proton mass to electron mass.

Aspden Gravitons

Gravitons are assumed to be gravitational waves. How, then, do they attract other matter towards the matter that emits them? If the graviton is somehow of negative momentum, its absorption could reverse the momentum of the matter it attracts, but in view of conservation of momentum it would then cancel its gravitational effect on other matter beyond the matter it attracts. On the other hand, if gravity is essentially a vacuum effect within a positive field of energy, it would comply with the inverse-square-law. What then needs to occur is a recycling process for energy emitted for the vacuum effect to be restored? If it is totally invisible to other matter, then it continues to infinite distance as it decreases to zero effect. If it is only partially invisible to matter, it could then be a

long-range-effect of repulsion that is extremely weaker than electromagnetic force, as for it to be restoring energy. Aspden proposed the gradual loss of graviton energy is part of the recreation of hydrogen. Neutrinos could also be a fundamental part of converting the gravitational energy to atomic energy.

Except for mention of the long range finite distance of gravitational effect, explanation of gravitational cause as vacuum effect was technically explained and mathematically formulated by Aspden whereby there is the e-frame of positive electrostatic energy complementing the g-frame of gravitational attraction. Common to the two frames is the unit of charge e whereby atomic particles, as leptons, are continually being annihilated and recreated. The leptons include electrons, protons, muons, gravitons and so forth.

The Aspden process occurs within a cubic lattice cell of each side d equal to $108\pi r_e$, r_e being the radius of an electron mass m_e. The electron equates to the muon in the manner

$$m_e = \frac{e}{\sqrt{G}}(4\pi)\left(\frac{1}{108\pi}\right)^3\left(\frac{1}{g}\right) = \frac{9m_o d^2}{4r^2}$$

G denotes the gravitational constant, g a pseudo graviton, m_o a quon mass, and r is a radius of a cyclic motion of g, which separates from another cyclic motion of another g at distance $x = 2r = \hbar / m_e c$. The quon is an æther particle of less mass-energy than that of the electron. Its charge radius is denoted as b.

The internal mass-energy of the electron relates in the manner

$$m_e c^2 = \frac{E_o}{\left(\frac{4}{3}\pi\right)(108\pi)^3\left(\frac{1}{N}\right)^{\frac{4}{3}}}$$

E_o denotes the energy of each cubic æther cell. N = 1843 denotes the ratio of a ghostly proton mass to electron mass, as the ghostly mass is slightly greater than measured mass before losing energy by its annihilation and reformation process.

Regarding Aspden's gravitons, there is one graviton dividing into others from quon interaction with ghostly muons whereby there is an initial τ -graviton gaining energy while separating into three gravitons of greater energy contracting into a smaller space. The greater energy consists of them having either positive or negative charge. Two g-gravitons further decay into two τ -gravitons of opposite charge while leaving the third g-graviton to escape in becoming the one for gravitational vacuum effect. The escaping energy is replaced by the positive charge of the con-

tinuum entering the extra space from increased charge density to recreate the primary τ -graviton.

Before escaping, there exist 2τ and g. Their ratio of quantum charge volume to their mass equates in the manner

$$\frac{\frac{2}{\tau^3}+\frac{1}{g^3}}{2\tau+g} = 3\frac{\frac{1}{g^3}}{g}$$

The right side of the equation pertains to volume charge of the undivided graviton in ratio to its total charge remaining the same. The equation simplifies in the manner

$$\frac{2g^4}{3\tau^3} + \frac{g}{3} = 2\tau + g$$

$$2g^4 + g\tau^3 = 6\tau^4 + 3g\tau^3$$

$$1 + \frac{\tau^3}{2g^3} = \frac{3\tau^4}{g^4} + \frac{3\tau^3}{2g^3}$$

$$1 = \frac{3\tau^4}{g^4} + \frac{\tau^3}{g^3}$$

Further simplification is by use of a computer. It was found that in terms of unit charge for all particles the mass ratios of τ and g to that of m_e are τ = 3585 m_e and g = 5062.3 m_e.

The value of the tau-lepton mass-energy in ratio to the electron mass-energy is determined to be 3485. The mass-energy ratio of the g-graviton to that of the electron is determined as 5062.3 from which the value of the gravitational constant G was determined nearly the same as has been determined as its present value.

How can the graviton g = 5062.3 m_e be more than twice that of the proton m_p = 1836.15 m_e and significantly weaker in effect?

Reconsider the Born Rule. Indications of the Plank Constant are that the product of mass and its radius is constant, as with greater atomic mass generally being smaller and denser according to the Stephan-Boltzmann Fourth Power Law. According to the Born Rule, the smaller denser particles, in being smaller and occupying less space, are less detectable. As wave action, they are stabilized by shorter and more energetic electromagnetic waves. When they do annihilate as wave action, they still remain nearly undetectable. There slight interaction with matter provides momentum in the same direction, but there is an equilibrium condition of total momenta of gravitons gradually interacting in all directions

with matter to create the energy of positive charge and maintain the recycling process.

Since Aspden's theory includes both the Thomson electromagnetic formula and the Compton formula, the Compton wavelength distance is denoted as $2\pi x = 4\pi r$, where $x = 2r$ is a displacement distance between the E-frame of the lattice system and the G-frame of gravity, whereas r itself is an orbital radius of a graviton's cyclic motion.

Thomson's formula itself further differs from implications of the established electromagnetic formula in that it contains the fraction 2/3. The difference of interpretation is that Thomson's derivation includes kinetic energy as well as internal energy, and it allows for different magnitudes of electric charge of internal components similar to quarks in the nucleus of the atom having one-third electric charge according to quark theory of quantum physics.

A process of continual creation and annihilation of electrons and positrons are included, and the inclusion is consistent with Heisenberg's principle of uncertainty. In the process there are corresponding changes in sizes and mass energies whereby greater frequency of more mass-energy is according to shorter distance and vice versa.

Regarding mathematical formulation, Aspden denotes $x = 2r$ as a displacement distance between a lattice system, as an e-frame, and a continuous charge, as a g-frame. Accordingly, an orbital radius r of cyclic motion of gravity equates in the manner

$$r = \frac{h}{4\pi m_e c} = \frac{\hbar}{2m_e c}$$

$$x = \frac{h}{2\pi m_e c} = \frac{\hbar}{m_e c} = \frac{m_e v r_a}{m_e c} = \frac{v r_a}{c}$$

$$\frac{x}{r_a} = \frac{v}{c}$$

The fine structure constant is thereby related in terms of distance x.

Continuum Charge Density

To summarize, the continuum consists of cubic volumes of lattice particles having side lengths $d = 108\pi r_e$, with r_e being the Thomson electron radius. Part of the 108π factor is 4π according to the theorem proposed by Gauss. By it, 4π is part of a thickness length of a planar slice of charge density directed in opposite directions. The remaining factor 27 represents a 3 x 3 x 3 cubic section of æther lattice particles whereby 24 of them are able to spin, as if 3 of them are at the center of the cube and

the other 24 are positioned evenly among the 8 side lengths of the cubic array for planar rotation within it.

The electrostatic lattice system of q = e charge is referred to as an E-frame in contrast to the continuum of charge of density σ being referred to as a G-frame in relation to gravity. The G-frame and E-frame orbit each other in having a common radius r. Their orbital speeds are both one-half light speed c, but there relative velocities are c, as if orbits themselves also moves at one-half c for total speed c.

The radius r equates to the Plank Constant h in the manner

$$r = \frac{h}{4\pi m_e c} = 1.9 \times 10^7 centimeters$$

Aspden assumed the static charge e is a fundamental starting point for relating all forms of energy, including gravity, to the æther. The æther is described as having a continuum of motion as positive charge. Within this continuation of motion are lattice cells of obstruction that result in vacuum effects of attraction as a counter state of negative charge. Negative charge results from the continual annihilation and recreation of the so-called lattice particles resulting in both gravitational and electrostatic attraction along with the atomic structure of matter. There is both gravity and a complementary construction of matter referred to, respectively, as a g-frame and an e-frame.

Such a condition is explainable in view of a plenum. Circular motion can result in wave motion. Waves can superimpose to occupy the same space whereas particles do not superimpose as such. Aspden merely assumes the quantum condition of particles does exist. He refers to their primary existence as ghostly muons

A significant aspect of Aspden's theory is that it explains gravity as part of the structural nature of the æther. In so doing, it relates gravity to a particular electrostatic unit of charge being equal to that of the electron. Included in his theory is the Planck Constant h for the quantum nature of the atom. Gravity is thus explained similar to how the proton mass is determined in ratio to electron mass.

Extending Theory

The explanation is also consistent with String Theory inasmuch as the theory includes higher dimensions. Higher dimensionality of General Relativity from four to five was also proposed by Theodor Franz Eduard Kaluza (1885-1954), who collaborated with Oscar Klein to formulate a unified field theory.

Einstein formulated general relativity theory according to a non-Euclidean geometry that had been proposed by George Friedrich Rie-

mann (1826-1866). Riemann's non-Euclidean geometry is of a matrix of four-dimensional space. A matrix of three dimensional coordinates is represented in the manner

$$\begin{matrix} g_{11} & g_{12} & g_{13} \\ g_{21} & g_{22} & g_{23} \\ g_{31} & g_{32} & g_{33} \end{matrix}$$

The four dimensional matrix is simply extended on the right and bottom to include seven more g symbols in manner of the same order for a total of sixteen instead of nine. They represent coordinate points wherefrom any two of them relate symmetrically to invariance of the interval ds.

Extra dimensionality was intended to explain how gravity differs from Maxwell's electromagnetic energy field. However, Einstein merely inserted time as the fourth dimension instead of using additional g's for space curvature as Riemann had intended for the use of his non-Euclidean geometry. The formulation of the two fields according to Kaluza and Klein is according to a five dimensional matrix with both vertical sequences on the right and bottom as (A_1 A_2 A_3 A_4 ?) in addition to the g symbols. The question mark placed on the far-right-bottom corner is representative of a scalar particle of the fifth dimension connecting the two fields.

Gravitational and Electromagnetic Equivalence

Significant of Aspden's formulation of theory is it derives the value of the gravitational constant G consistent with deriving the quantum value of the proton in relation to the atomic structure of matter, thus maintaining equivalence of inertial and gravitational mass. In so doing, it also maintains consistency with electrodynamics in equating a particular value of an electrostatic charge q to e, the unit charge of electromagnetism. It further assumes the orbital speeds of ghostly particles are c/2 instead of c. The one-half light speed is consistent with both quantum physics and general relativity. It is consistent with the former regarding fermions being one-half the spin of bosons. It is consistent with the latter regarding one-half light speed as a Schwartzschild maximum escape speed in relation to a maximum orbital speed.

The difference between electrostatics and electromagnetism is electrostatic charge pertains more specifically to electric force of non-moving sources whereas application of electromagnetic force is more general. Aspden's equating q to e applies to a static-rest-state filled with positive charge maintaining on the average an equilibrium-state-of-stability of the æther. Being on the average also allows for a tremendous diversity of existence of the reality in which we live.

Aspden considers gravity to be an electrostatic action. His consideration has reasonable merit. Electrostatics is part of electromagnetism whereby electric forces are static by not moving relative to each other. They also relate to a field of force consistent with the inverse-square-law of gravity, and their presence near an electromagnetic field can result in a Drift Velocity, an average back and forth velocity similar to how Clausius explained the stability of matter in defense of the kinetic theory of gases. An outside static charge slightly alters the direction of the average velocity of particles in the field. It is also similar to the previous explanation of mass existence by it reflecting radiation in opposite directions for allowing wave packets of mass to remain in relative motion.

Gravitons also need to be recycled in order for them to be continually created but not continually becoming greater in number in ratio to the mass creating them. Since the graviton has a long range effect, the recycling process is gradual. However, only a minute proportion of the annihilation and recreation process is gravitational energy escaping, as in proportion to the ratio of electromagnetic to gravitational force. They are thus of a longer life than such other forms of energy as electromagnetism, as the latter retains most of the annihilating energy for recreation in being consistent with say the advance in perihelia of planet Mercury do the finite speed of gravitons being the same as light speed.

Explanation as to the entropy of a graviton's greater energy is that it relates analogously to drift velocity and the advance in perihelia of orbital motion. Aspen noted that Mercury's advance in perihelia was explained prior to general relativity as a correction of Newtonian Mechanics. Newton assumed gravitational action is simultaneous. If gravity propagates at light speed in being consistent with Maxwell's theory of electromagnetism, then there is a time delay in the action. A time delay allows energy to escape instead of the annihilation and recreation process to be totally elastic. In analogy to drift velocity and Clausius principle of back and forth propagation from collision, slower relative motion becomes a reality along with less direct detection of gravitons.

As with the propagation of gravitons, their energies need to be recycled for the equilibrium state of the continuum to maintain its internal action. The recovery process is simply a slower process of gravitons being partly absorbable by the continuum, but the quicker annihilation and recreation process is according to difference in relation, as analogous to the entropy condition two systems are unable to exchange heat unless they are of different temperatures.

Aspden assumed photon creation is complementary to creating matter instead of being the primary source of its creation, In effect, he explained how it is possible for energy to be invisible in a state of equilibrium from which mutual forces cancel in allowing energy to move on

unaffected by its interaction with other forces as ghostly particles move on at light speed. It is merely consistent with entropy, the second law of thermodynamics, regarding states of equilibrium.

Aspden's theory does not explicitly explain the tired light condition of photons moving through the æther, but the process could be a determining factor for the quicker annihilation and recreation process if they are also gradually decreasing in energy while moving through the æther for it to maintain as well.

The cosmic implications of combining theories are boundless. With Tired Light it is possible that the observable universe is an observable part of an infinite universe whereby observable parts are according to relative motion and gravity for observers to perceive themselves at it center. With Black Holes it is also possible for countless universes to exist. With the singularity it is possible for mass to be squeezed into virtual energy whereby mass is created elsewhere in being consistent with conservation laws. With Steady State theory it is possible for our universe to expand while creating hydrogen to form new stars as old ones that have either been burned out of existence or have been squeezed enough to have become black holes. With String Theory it is possible for countless other worlds to exist in other dimensions.

In conclusion, indications are that the more we know seems to reveal how much more we do not know.

13
THE RELATIVITY OF HUBBLE COSMOLOGY

Why an infinite number of stars do not light up the sky at night is known as Olbers' Paradox. Aristotle had proposed a finite number of stars. Kepler had considered the night sky indicates a finite universe. A century later, Edmun Halley (1656-1742) argued to the contrary, an uneven distribution of stars could allow a dark sky. In 1743, Jean Phillippe Loys de Cheseaus (1718-1751) considered the universe is finite unless space somehow absorbs starlight (as does Tired Light theory). The debate continued. Heinrich Wilhelm Mauthaus Olbers (1768-1840) considered interstellar dust as an absorbing medium of space allowing for an infinite universe of infinite light.

A main criticism of the interstellar dust theory was the belief that dust in thermal equilibrium absorbs enough light from infinite stars to heat up and reemit the light. However, Eddington and others showed that if the overall temperature of the universe is only about three degrees Kelvin, then there can still be a state of thermal equilibrium for some other process than that of just heating the medium. According to Tired Light, for instance, space partially absorbs light energy. However, such theory is not presently established.

Presently established is Big Bang theory assuming the universe is finite and expanding. Tired Light has been dismissed for several reasons. For one reason, how the collision of light with dust particles does not result in a distortion of the cosmic background is in need of explanation. Another reason given for dismissal has been a Tolman Brightness Test supposedly distinguishing redshift effects in favor of recessional speed instead of absorption of light energy moving in space. However, the Tolman Brightness Test in favor of Big Bang in its original form is not supported by astronomical data. Big Bang has been modified to include dark energy allowing for an increased rate of expansion.

Big Bang

A birth nature of the universe in the form of crystallized matter from an explosion of energy was proposed by Robert Grosseteste (1175-1253) as early as 1225. The more modern version of cosmic expansion began in the 1910s when Vesto Slipher (1875-1969) began observing radial velocities of galaxies. Carl Wilhelm Wirtz (1876-1939) observed there is more redshift in the light spectrum from more distant sources. In 1929, Edwin P. Hubble (1889-1953) determined a systematic redshift-distance relationship. He and Milton Humason (1891-1972) then formulated the Hubble Law with regard to redshift per distance of cosmic light sources. A plausible explanation of it is the Doppler principle of light spectrum affected by relative motion of its sources, as because of galaxies of stars receding from us as well as from each other.

Einstein had inserted a cosmological constant into his field equations as a repulsive force counter to gravity in assuming the universe is finite and static, but an analysis of his field equations by Alexander Friedman (1888-1925) indicated a finite universe is not static even with the cosmological constant. Solutions to Einstein's field equations were then derived with the intent of explaining an expanding universe. Georges Lemaitre (1894-1966) had suggested in 1927 an expanding universe is traceable back to a time of origin. What developed is the now standard FLRW Metric that is named in honor of Friedman and Lemaitre along with contributors Arthur Geoffrey Walker (1909-2001) and Howard Percey Robertson (1903-1961).

The FLRW Metric is conceptually as well as mathematically complex. It includes a cosmological principle with regard to an observable expansion of the universe being conditional to homogeneity and isotropy. Conditional to it, for instance, is observers not actually located at the center of the universe still perceive themselves as relatively located at or near it, as consistent with special relativity whereby any system of inertial motion can be considered as relatively at rest.

Spacetime curvature of general relativity also applies whereby light paths curve for observers at the edge of the universe to perceive it as near its center. As to how curvature maintains as the universe expands is more complex. Spacetime curvature should decrease according to theory. Spacetime curvature is needed for a larger universe after it expands, and the curvature needed is in relation to gravitational escape speed relating to light whereby more mass of a larger universe is needed for light not to escape. However, relativistic effects are inclusive of both gravity and relative motion. Expansion itself is a relativistic factor.

The origin of the Big Bang is assumed a singularity expanding about 13.7 billion years ago from a dimensionless point space. Within an extremely minute second the expansion rate inflated to a rate faster than

the speed of light until becoming comparable to a golf ball. Its rate of expansion then decreased, cooling to allow mass to form. Neutrons formed after a second to suddenly fill the universe. Further expansion of the universe has cooled it to its present average temperature of about 2.7 degrees Kelvin, as assumed, observed and calculated in the 1960s.

Supposedly the universe was initially too hot for even light to shine. It did not shine until about 380,000 years to become a microwave background radiation of today with no common origin of location. The discovery of this radiation in the 1960s was what decided it in favor of Steady State, which is another theory of expansion whereby more stars and galaxies are created as other stars burn out of existence as the universe expands.

A timeline is an essential aspect of Big Bang. Simple explanation of it is twice distance equals twice the rate of recession. Assume a value of the Hubble Constant is 70 (km/sec)/Mps. Dividing 70 km/sec by a million parsecs (30.9 million kilometers) equals 2.27×10^{-18} of something per time. If the something is one centimeter, then the result is centimeter per second. If c is an upper limit for a Hubble distance R_p of the universe, then $R_p = c/H_0 \approx 1.32 \times 10^{28}$ centimeters. Dividing R_p by c obtains a time of about 4.4×10^{17} sec $\approx 7.3 \times 10^{15}$ min $\approx 1.2 \times 10^{14}$ hr $\approx 5 \times 10^{12}$ days $\approx 1.4 \times 10^{10}$ as 14 billion years. However, although R_p represents the present distance of the light source, it is not the same distance seen at because of there being more time for light to reach observers.

Another formula for distance d and present time T_p, as about 14 billion years, is $d/v + d/c = T$ wherefrom d/c is the time for light to reach Earth from its source after receding distance d at speed v during time d/v. The age of the universe thus maintains even though the actual distance observed is not the same distance when light was emitted from its source.

Calculating the current position of a light source from where it is seen in the past is in relation to the Tolman Brightness Test that was used to discard Tired Light in favor of Big Bang. For a light-source-speed-distance of one-half c, starlight moves that one-half distance to reach the observer. As seen, the emitted-distance of the source is thus two-thirds its present-distance.

This progression into the past relates to the Tolman Brightness Test in relation to light intensity decreasing per distance-squared while spreading to a larger surface area of an imaginary sphere from its source. Because of the source appearing closer than it actually is, light intensity of the past appears more intense. Actual distance is thus calculated according to light intensity instead of its frequency.

Cosmic Modifications

Modifications are often proposed of theory. For instance, Dirac speculated on some coincidental aspects of cosmic expansion nearly equating to atomic parameters. His speculation included an aspect of the Hubble Constant that is not constant. Even with the rate of expansion being constant the Hubble Constant decreases in value for it to determine the same recessional speed at a longer distance.

To explain the apparent coincidences, Dirac speculated on a solution in relation to how the Hubble Constant relates to the structural nature of mass. For instance, the gravitational constant G, electron mass m_e, light speed c and Hubble Constant H, as determined at the time within an accuracy of about 100 kilometers per second, seemed to relate in the manner

$$\frac{e^4 H}{Gc^3} \approx m_e^3$$

The Hubble Constant then relates in the manner

$$H \approx \frac{Gm_e^3 c^3}{e^4} = \frac{Gm_e^3 c^3}{m_e^2 c^4 r_e^2} = \frac{Gm_e}{r_e^2 c} \approx 2.55 \times 10^{-20}\ sec$$

The gravitational force of the electron per light speed thus approximates to the then accepted value of the Hubble Constant. However, with a decrease of H with time as the universe expands Dirac speculated that another one of the constants needed to decrease as well. He chose G. However, it seems a decrease in the electrostatic constant along with the gravitational constant would result in a more consistent theory.

Since spacetime curvature is needed for the cosmological principle, a modification is thus indicated. Being consistent with general relativity would be an increase in electrostatic energy along with gravity, as with a relative decrease in the radius of the atom for the observer's clock to be faster to measure shorter distance. With both increases the Cosmological Principle could then agree with nullification effects of relativity theory. For instance, perceptual decrease in size of the universe by means of a relatively faster clock and relatively longer unit of measure could counter the effect of expansion for it to be perceived consistent with Einstein's original proposal of a static and finite universe. It only entails a modification of relativity theory in indicating size is relative as well.

Other modifications of cosmology have been the inclusions of Dark Energy and Dark Matter. Dark Energy has been assumed due to the data of astronomical observation differing from the Big Bang prediction of the Tolman Brightness Test. Dark Matter has now been assumed because of a long-time discrepancy of data indicating galaxies rotate faster

than they should according to either Einstein's theory of general relativity as space-time curvature or Newton's inverse-square-law of gravity.

The Tolman Brightness Test was a deciding factor in discarding Tired Light in favor of Big Bang. In the 1990s, however, astronomical data did not appear to be in agreement with Big Bang predictions. Eric J. Lerner of the Lawrenceville Plasma Physics Inc., USA, published an article in 2009 titled Preliminary Results Challenge the Expanding Universe Model. Study of data favored a non-expanding-universe model instead. What resulted was Big Bang being modified to comply by assuming some unknown source of Dark Energy has increased the rate of expansion from that of the past.

Dark Matter has been assumed to explain why rotations of some galaxies are of speeds greater than their gravitational mass allows according to present theory. It constitutes a modification of theory in the sense Dark Matter is an unknown element invisible to electromagnetic radiation to thereby result in a change of effect to gravitational action. There have also been modifications proposed of general relativity and Newtonian Mechanics for other reasons.

Horace Babcock, as early as 1939, noted a discrepancy in the rotational speed of the Andromeda galaxy. In the 1970s and 1980s, a general study of galaxies under the guidance of Vera Rubin indicated rotational speeds from their galactic centers generally do not appear to decrease in accordance with Newton's inverse-square-law. Mordehai Milgrom proposed a modification of the law in 1983, referred to as MOND. In 2004, Jacob Bernstein offered a relativistic version of the modification according to space-time curvature. In 2008, John W. Moffat published his book Reinventing Gravity regarding modification of gravity (MOG) whereby the gravitational constant relatively increases farther away from the center of mass due to greater decrease in repulsive force away from the center of mass.

The observations of slower orbital speeds can be explained according to present gravitational theory. By it the orbital speed of a planet around the sun decreases for greater radial distance. However, the surface of a large spherical mass has more gravitational force outward than inward because of gravitational influence in opposite directions cancelling out. Gravity is essentially a condition of homogeneity. Consider, then, the growth of a large spherical mass wherefrom there is greater rotational speed nearer to its surface than its center. The perpendicular direction from its rotational center thus tends to become more of a disk than a sphere. Somewhat in between these two extremes of disk and sphere is a constant orbital speed of radial distance.

Further consideration is with regard to how cosmic mass is observed according to visible radiation. Of particular relevance is that

eighty percent of the mass in the universe has been estimated to be hydrogen. Cold hydrogen is relevant in that its presence is extremely difficult to detect. The electron of the hydrogen atom, as assumed, can either rotate in the same direction or the opposite direction that the proton in the nucleus of the atom rotates. It is change of rotational direction from same to opposite direction that describes events of radiation whereby low light-energy is detected, as typical of a Cosmic Microwave Background Radiation having no evidence of its direction of origin. Undetected cold hydrogen could thus very well be the missing mass in the spiral galaxies, and it could also be part of the creation of new stars.

Tired Light Difference of Effect

When Hubble and Humason formulated the Hubble Constant in 1929, Fritz Zwicky (1898-1974) proposed an explanation in terms of Tired Light. It assumes light loses energy by collisions with mass particles along its journey through space. For instance, electrons of cosmic plasma could more easily detach from atoms than do electrons of ordinary matter. Light would then decrease in energy by inelastic collision. However, the Zwicky proposal was dismissed for two reasons: It had been believed to have failed because of the Tolman Brightness Test distinguishing between the decreased energy effect of tired light and the Doppler one of recessional speed. The other reason for dismissal was because there is little or no blurring seen to occur of distant light sources, as is expected of light interacting with intergalactic particles in space to absorb the light energy.

The blurring condition was acknowledged by Zwicky, but explanation as to why it does not occur has been offered, as by Einstein and other physicists. Einstein proposed in relation to the wave-particle duality paradox that photons are of invisible waves with a minute particle of mass within them.

Justification for the consideration of Tired Light is that it provides a long-range-vacuum-effect in the wake of emitted radiation for explaining a relatively weak force of gravity compared to atomic forces, wherefore the average mass-energy density of the universe per nuclear density of the hydrogen atom equates to the ratio of gravitational force to electromagnetic force between the proton and electron of the hydrogen atom.

Along with this Tired Light consideration are many differences in effect than that of Big Bang. According to the original Big Bang, for instance, the value of the Hubble Constant supposedly decreases as the universe expands, as due to an increase in distance between galaxies, which could be empirically determinable by the difference of light sources within the galaxies providing they are not equally influenced by expansion. To the contrary of Big Bang, Tired Light allows a finite uni-

verse to exist as an observable part of an infinite universe. However, there is difference in calculation of distance of the source because of starlight decreasing in intensity from losing energy in proportion to its redshift. A decrease of light energy as such would be an opposite effect to that of Big Bang.

In comparing Tired Light radiation decreasing in energy proportional to its magnitude, at one-half maximum distance the intensity halfway closer is four times greater. However, there is one-half as much more decrease in energy as it continues on its way to the observer. If the decrease is correlated with distance, then it is with regard to a theoretical distance three-half greater than its actual distance with respect to a maximum light-speed-distance at the observable edge of the universe.

The Big Band and Tired Light calculations have opposite results, as to indicate they could annihilate each other in a way they combine similar to relativistic nullification. The decrease in light energy could even be the needed dark energy to increase the rate of expansion.

To the contrary, if all starlight decreases at the same rate independent of its magnitude instead of proportional to it, as with another interpretation of Tired Light, then the decreased energy from of a particular source of starlight could be a correct determination of its distance. However, the decreases in variable effects should then be observable of familiar stars of observable radiation because of different frequencies not decreasing in proportion to magnitude per distance. It is simply a possible test of theory.

Tired Light could also differ according to how the medium of space differs. If the lost energy is quantized for it not to be the same for all light, then different starlight has different observable distance rather than merely becoming weaker with distance. However, the decrease need not merely be the same for all space. A discovery of periodicity, or quantization, as it was interpreted, was announced in 1966 and 1967 by astronomer William G. Tifft. Other astronomers reported similar finds. What appears to occur is a greater Hubble Constant value between more dense clusters of galaxies. An average density of mass in the universe could thus be a determining factor of the Hubble Constant. More variance in effect is thus allowable. As for possible confirmation, a denser part of the universe absorbing more light energy should correlate with the missing mass of the universe as being more invisible.

Overall determination of the Hubble Constant value has varied over time along with different observations. Lyndon Ashmore, in proposing his New Tired Light theory, accepted an average value of determinations as 64 kilometers per million parsecs.

Tired Light

The New Tired Light theory proposed by Lyndon Ashmore is conditional to Quantum Mechanics and a Hubble Constant of an average value that has been determine by various astronomical observations over the years. His Hubble Constant H_1 is thus a mean value of various values of H. It relates in the manner

$$H_1 = \frac{hr_e}{m_e k} \approx 64 \frac{km}{(sec)(Mpc)} \tag{1}$$

H_1 is Ashmore's value of the Hubble Constant, m_e is the electron mass, h is the Plank Constant, r_e represents a particular value of the electron radius according to theory, and k is an added constant of proportionality.

A parsec is an astronomical distance of 3.09 X 10^{13} kilometers. Dividing 64 kilometer by one million parsecs results in a frequency of about 2.07 X 10^{-18} times per second. Multiplying that frequency by one second equates it as a speed of 2.07 centimeter per second. Multiplying it by any other distance in whatever units of distance also equates it as such to that particular speed.

The decrease in light energy is assumed to be caused by cosmic plasma whereby a weak portion of light energy splits off to become the main source of the Microwave Cosmic Background Radiation that appears from every direction with no common origin. That all space contains a varying degree of plasma has historical support. Olaf Kristian Bernhard Birkeland (1867-1917) explained as early as 1896 the origin of the auroras of northern and southern lights near the poles as due to an upper plasma. Even though his theory was an extension of Maxwell's electromagnetic theory, it was to be dismissed because of Lord Kelvin having stated that all space between Earth's upper atmosphere and the Sun is void of matter. However, a magnetic field of plasma was discovered in 1967 by a military probe. Overwhelming evidence in support of the theory occurred by way of orbiting satellites in the 1970s.

Noteworthy of Ashmore's constant k is it has an exact value of one cubic meter. Although the constant k being equal to exactly one cubic meter seems too much of a coincidence, it is consistent with the theory of general relativity inasmuch as the density of the universe in ratio to the nuclear density of the hydrogen atom equals the ratio of electrostatic and gravitational forces of the electron and proton in the hydrogen atom.

An average density ρ_u of the universe in relation to H_1, as according to Einstein's formula, is

$$\rho_u = \frac{3H_1^2}{8\pi G} = \frac{3c^2}{8\pi R_u^2 G} \approx \frac{3(2GM_u)}{8\pi R_u^3 G} = \frac{M_u}{\frac{4}{3}\pi R_u^3} \tag{2}$$

Since the dimensional value of the Hubble Constant refers to a velocity per distance, H_1 in the equation converts to light speed c for a critical radius R_u in relation to the gravitational escape velocity squared as $c^2 = 2GM_u/R_u$.

Further relation is with regard to a Bohr radius of the hydrogen atom that has been measured to be about 5.292 x 10^{-9} centimeters. The size of the nucleus is less measured, but a theoretical value consistent with the Plank Constant, the Fine Structure Constant and mutual-orbital-charge is about 2.882 x 10^{-9} centimeters. The ratio of radii is thus the same as the ratio of mass, with the proton being 1836.15 more massive than the electron. With internal mass-energy determined by the product of frequency and the Planck Constant, and the speed of orbit being conditional to the Fine Structure Constant, an electron orbital speed is the same as a proton orbital speed, such that the parameters $m_e v r_a$ of the electron's orbit and the parameters $m_p v r_n$ of the proton's orbit are each theoretically of the same total value. With mutual charge between the electron and proton, in contrast to gravitational interaction not being equal between mass of unequal magnitude, orbital radius varies instead.

Along with this theoretical condition the density of the universe in ratio to the density of an atomic nucleus of the hydrogen atom further approximates to the ratio of the gravitational and electrostatic forces between the proton and electron in the manner

$$\frac{M_u}{\frac{4}{3}\pi R_u^3} \div \frac{m_p}{\frac{4}{3}\pi r_n^3} = \frac{M_u r_n^3}{m_p R_u^3} \cong \frac{G m_p m_e}{e^2} = \frac{G m_p}{r_e c^2} \tag{3}$$

The average density of our finite universe in ratio to the nuclear density of the hydrogen atom is thus approximately the same ratio of gravitational and electrostatic forces between electron mass m_e and proton mass m_p.

In relation to equalities of equation (3), H_1 equates in the manner

$$\frac{3H_1^2}{8\pi G} \div \frac{3m_p}{4\pi r_n^3} \cong \frac{G m_p}{r_e c^2} \tag{4}$$

$$H_1^2 \cong \frac{2G^2 m_p^2}{r_n^3 r_e c^2} \tag{5}$$

Equation (5) is to be linked with another value of H.

As noted, H_1 represents an average value. It is also representative of an energy exchange between light and plasma. The decreased energy of light is assumed by Ashmore to be the Cosmic Microwave Background Radiation (CMBR).

The CMBR explanation is reasonable, but if the average Doppler shift is to the red end of the spectrum, the CMBR needs to somehow recycle in order for it not to continually increase without limit. It could, for instance, provide the material needed to create new stars while old ones burn out of existence in a manner consistent with Steady State Cosmology.

As for a recycling of the CMBR, perhaps matter reabsorbs it in various ways. It could, for instance, be absorbed by virtual particles conditional to the probability condition of quantum mechanics. As some stars evaporate, others form from the plasma and CMBR moving every which way.

The overall process might also simulate as a cause of gravity. If energy is given to intergalactic plasma, then the emission of light by greater density of mass could result in a vacuum effect in its wake of emission. The emitted light gradually interacts with plasma whereby the plasma acquires energy for a quick refill of mass that had been converted to radiation.

A cosmic-gravitational coincidence is evident of the Hubble Constant and the mass and size of the hydrogen atom, as within a determined accuracy of the values of parameters used in physics, which in dimensions of grams, centimeters and seconds are:

Values of Physical Parameters

Gravitational Constant: $G = 6.67428(67) \times 10^{-8}\ cm^3/(gm)(sec)^2$
Proton mass: $m_p = 1.67262137(13) \times 10^{-24}$ gm
Electron mass: $m_e = 9.10938215(45) \times 10^{-28}$ gm
Light speed c: $2.99792458 \times 10^{10}$ cm/sec
Bohr radius of hydrogen atom: $r_a = 5.2917721067 \times 10^{-9}$ cm
Neutron radius: $r_n = 2.881991 \times 10^{-12}$ cm
Fine Structure Constant: $\delta = 1/137.036 = e^2/\hbar c = v/c$
Planck Constant: $2\pi\hbar = h = 6.626069 \times 10^{-27}\ (gm)(cm)^2/sec$
Electronic charge unit squared: $e^2 = 23.07 \times 10^{-20}\ (gm)(cm)/(sec)^2$

The electrostatic unit of charge e has historically been associated with electric emissivity and magnetic permissibility constants, but these constants are here assumed to be part of the Hubble Constant in relation to a relative density and gravitational influence of the observable universe. This does not mean the constants are not meaningful to more complete understanding of theory. They are merely implied for simplicity sake with regard to light speed, as they combine as a product equal to light speed squared in vacuum space.

A Gravitational Cosmic Coincidence

Zwicky proposed the redshift in the more distant starlight is related to gravity. The redshift is also considered here as radiation absorbed by the medium of space as gravitational effect. Space not only absorbs light energy; the energy is further absorbed by matter for it to emit the energy as electromagnetic radiation whereby rate of decrease is coincidental to a ratio of gravitational and electrostatic forces.

There is thus a recycling process. The emitted radiation is a long range and partly elusive process determined according to the probability condition of quantum physics, as typical of Earth's detection of only a minute portion of the neutrinos passing through Earth. Part of the radiation thus escapes detection except for its gravitational-vacuum effect. As radiation is gradually detected, it converts into space inertia. Space inertia, in turn, superimposes on inertial mass for the continuance of the recycling process.

A simple relation with regard to the hydrogen atom is

$$\frac{H_2(2r_a)}{c} \cong \frac{Gm_a^2}{e^2} \cong 8.08 \times 10^{-37} \tag{6}$$

Dividing and multiplying each side of the equation by r_a, and e^2 obtains

$$\frac{2H_2e^2}{c} \cong \frac{Gm_a^2}{r_a} \tag{7}$$

By substituting the theoretical radius R_u as the observable radius of the universe for c/H_2, equation (7) becomes

$$\frac{2e^2}{R_u} \cong \frac{Gm_a^2}{r_a} \tag{8}$$

By substituting parameters $m_a v^2 r_a$ of e^2 for e^2, equation (8) becomes

$$\frac{2m_a v^2 r_a}{R_u} \cong \frac{Gm_a^2}{r_a} \tag{9}$$

By dividing both sides of equation (9) by r_a, it becomes

$$\frac{2m_a v^2}{R_u} \cong \frac{Gm_a^2}{r_a^2} \tag{10}$$

The centripetal force of two hydrogen atoms at opposite ends of the center of the observable universe thus equates with the gravitational force between two atoms separated a distance equal to the diameter of the atom.

A similar relation with regard to the proton mass m_p of the nuclear radius r_n of the hydrogen atom results from substations of m_e and r_n for one m_p and the r_a, as allowed by $m_e/r_a = m_p/r_n$. Equation (6) becomes

$$\frac{H_2(2r_n)}{c} \cong \frac{Gm_p m_e}{e^2} = \frac{Gm_p}{r_e c^2} \tag{11}$$

$$H_2 \cong \frac{Gm_p}{2r_e r_n c} \tag{12}$$

$$H_2^2 \cong \frac{G^2 m_p^2}{4r_e^2 r_n^2 c^2} \tag{13}$$

The ratio of Ashmore's value of H_1 squared to H_2 squared is

$$\frac{H_1^2}{H_2^2} = \frac{2G^2 m_p^2}{r_n^3 r_e c^2} \div \frac{G^2 m_p^2}{4r_e^2 r_n^2 c^2} = \frac{8r_e}{r_n} \tag{14}$$

The radii r_e and r_n relate respectively to internal mass-energy of the electron and potential energy of the proton-nucleus as

$$r_e = \frac{e^2}{m_e c^2} \tag{15}$$

$$r_n = \frac{e^2}{m_p v^2} \tag{16}$$

From equations (15) and (16), equation (14) further equates as

$$\frac{8r_e}{r_n} = \frac{8e^2}{m_e c^2} \div \frac{e^2}{m_p v^2} = \frac{8m_p v^2}{m_e c^2} \tag{17}$$

The ratio of the Hubble Constant values squared thus equate as 8 potential energies per internal energy of the electron.

The velocity v relates to the fine structure constant, as $v/c = e^2/\hbar c = 1/137.036$. The ratio squared to c indicates an approximate relativistic effect:

$$1 + \frac{v^2}{c^2} \approx \frac{1}{1-\frac{v^2}{c^2}} \tag{18}$$

It is significant with regard to the equivalence principle whereby free fall is according to a relatively homogeneous field of gravity. (The numerical

value of v in this case is also the fine structure constant equal to the electrostatic unit e squared in ratio to ħ c.)

The factor 8 is according to the Schwartzschild Metric for a maximum escape speed c calculating as the square root of one-half c in the manner

$$c\left[1-\frac{2GM_u}{R_u c^2}\right]=c\left[1-\frac{1}{2}\right]=\frac{1}{2}c' \tag{19}$$

Moreover, in ratio to the escape speed is the orbital speed c", such that

$$c=\frac{1}{2}c\square=\frac{1}{2\sqrt{2}}c'' \tag{20}$$

$$c^2=\frac{1}{4}c\square^2=\frac{1}{8}c''^2 \tag{21}$$

The factor 8 is thus explained as relativistic effect of gravitational potential of mass approaching one eighth light speed whereby light speed in the field becomes one half of c as its upper limit.

The application of the orbital speed is here explained as emerging with the escape speed as the gravitational field becomes homogeneous regarding the cosmic scale at large for average mass density. Estimated from astronomical observations is a cosmic scale distance for cosmic homogeneity of 250 million light years, which is about 55.2 times smaller than the perceived size of our universe.

Interrelating equations (2), (4), (5), (13), (14), (17) and (21) with v" in relation to c" obtains a density relation in the manner

$$\frac{3H_2^2}{8\pi G}\div\frac{3m_p}{4\pi r_n^3}\cong\frac{Gm_p m_e}{e^2}\cdot\frac{m_e c^2}{8m_p v^2}=\frac{Gm_e^2 c^2}{8e^2 v^2}=\frac{Gm_e}{8r_e v^2}=\frac{Gm_e}{r_e v''^2} \tag{22}$$

With regard to densities is the relation

$$\frac{M_u}{R_u^3}\div\frac{m_p}{r_n^3}=\frac{Gm_p m_e}{e^2} \tag{23}$$

The density of the observable universe in ratio to the nuclear density of the hydrogen atom thus equates to the ratio of gravitational to electromagnetic force between the proton and electron.

Explaining Unified Field Theory

To simplify, approximations of relativistic factors are of the forms

A singularity is evident of general relativity for infinite mass within an infinitesimal volume of space. A singularity is also evident of quantum physics in that an interacting photon of infinitesimal wavelength can be of infinite mass-energy even though the smallest radius of such a particle as an electron is according to its internal mass-energy mc^2.

How do these singularities interrelate in the context of unified field theory?

There is a missing step in the unification of theory with regard to mass frequency. Harold Aspden's theory, for instance, derived conditions of gravitons and material particles from the same quantum conditions of the æther, but he did not link particle frequencies to the scale of the universe at large, as with regard to the Hubble Constant.

As Frequency Of

Consider dividing the Hubble Constant H_2 by the product of the Plank Constant h and Compton Frequency f_e of the electron in the hydrogen atom as equal to electron's internal mass energy m_ec^2:

$$\frac{H_2(2r_n)}{chf_e} = \frac{Gm_pm_e}{e^2m_ec^2} \tag{24}$$

By factoring out particular equalities, the ratio of frequencies equate as

$$\frac{H_2}{f_e} = \frac{Gm_p}{2r_nc^2} \cdot \frac{hc}{e^2} = \frac{Gm_p}{2r_nc^2} \cdot 2\pi(137.036) \tag{25}$$

Change in frequency of the Hubble Constant per Compton Frequency is thus in proportion to one-half the gravitational potential per light speed squared multiplied by 2π and the fine structure constant. The light speed squared factor could be indicative of $2GM_U/R_U = c^2$. It being $2c^2$ could also be indicative of the approximation of a gravitational relativistic factor for the equation to have an interpretation consistent with special and general relativity in the manner.

$$\frac{x}{\sqrt{1-\frac{v^2}{c^2}}} \approx x + \frac{xv^2}{2c^2} \tag{26}$$

$$\frac{x}{\sqrt{1-\frac{2Gm}{rc^2}}} \approx x + \frac{Gmx}{rc^2} \tag{27}$$

A relativistic approximation of a relativistic increase in gravitational potential of a proton the size of an electron is

$$\frac{Gm_p}{r_e\sqrt{1-\frac{2Gm_p}{r_e c^2}}} - \frac{Gm_p}{r_e} \approx \frac{Gm_p}{r_e c^2} \approx \frac{Gm_p m_e}{e^2} \tag{28}$$

The last theoretical approximation 4.3261 X 10^{-40} in comparison of an empirical determination of the gravitational to electromagnetic ratio of forces as 4.408 X 10^{-40} is less than two percent difference. Although that is a significant difference in view of the more accurate empirical values of G, m_p and so forth, the factoring out equalities and reversing order of the approximation relates in the manner $e^2/r_e \approx m_e c^2$. Interpretation is that the electron charge unit is the fundamental factor determining the relativistic nature of the proton and other mass particles.

14
GRAVITY CAUSE EXPLAINED

Newton formulated gravitational force according to his inverse-square-law, but he was unable to explain the cause of gravity other than by an action at a distance principle. Einstein explained gravity as spacetime curvature due to the presence of mass, but more entailed explanation of how the presence of mass causes spacetime curvature is still lacking.

In the previous chapter gravity was associated with the Hubble Constant insofar as a minute decrease in radiant energy allows for a long-range effect of a relatively weak force of gravity per mass in comparison to such other forces of nature as atomic and electromagnetic. An explanation of gravity in this chapter is explained as an integral part of quantum physics regarding a vacuum state of virtual particles as a field of virtual energy. Gravitons as gravitational radiation emitted for gravitational effect are also virtual particles. Gravity is thus to be explained more intricately in view of a vacuum effect from the wake of emitted radiation. They are only less energetic than electromagnetic waves with regard to their visibility. By losing less energy for only gradual detection, they provide a longer range of their recycling effect. It the long range cycling effect as a modifying factor of otherwise continuous loss of gravity because of indefinite range that renders the explanation feasible.

The explanation assumes gravitational radiation is consistent with the tired light mechanism, which has been accused of not having a viable explanation as to how light can decrease in energy and still allow the visibility of distant stars. How this visibility is possible is thus further explained along with an electric charge explanation as well.

Further explanation includes more indebt analysis of the method of radiation superimposing to form observable mass as consistent with how mass relates to both relative motion and gravity. Mass is to be considered as the superimposition of wave packets of radiation wherefrom it is further explained how a restoring force is created as a recycling process of emitted gravitational radiation to maintain an equilibrium state of mass as part of the tired-light-vacuum-effect in the wake of emitted radiation in a

manner of continuous action consistent with the Doppler principle of relative motion.

Virtual energy is part of the visibility explanation that is also explained here as more causal than as Feynman described it. For instance, no causal explanation of how virtual particles causing attraction was considered necessary according to Feynman. Mathematical consistency was only required by him, whereas explanation is here given as more causal with inclusion of a concept of zero-point-energy (ZPE), which Plank later proposed as a modification of his original formulation of the quantum.

All in all, visibility of stars is explained along with the cause of electromagnetic attraction and repulsion along with gravitational attraction. Further included is explanation of a Casimir Effect of attraction related to the closeness of metal walls. As for its implications, such explanation leads to further explanation regarding the structural nature of mass within an infinite universe of only finite distance of visibility.

Virtual Vacuum Space

It has been argued primary substance would dissipate into empty space without any internal mechanism to form into particles if space were partially empty within a finite portion of space. Whether space is only partially filled or is a plenum, quantum theory now describes vacuum space as containing virtual energy particles according to the Heisenberg uncertainty principle. Such virtual particles as gluons are assumed in order to explain observable effects that do not otherwise comply with predictions of quantum theory. The gluon is confined as part of a proton or neutron whereby it cannot be observed directly as an individual particle apart from a proton or neutron. It is verifiable only as an indirect effect according to mathematical analysis. It thus seemingly exists as a virtual particle. In general, the vacuum of space is now assumed to contain an enormous assortment of virtual particles.

This quantum vacuum condition is not here contested; it is to include non-quantum conditions of continuous change in motion as well as discrete quantum effects. Matter at rest absorbs and emits discrete units of electromagnetic radiation as quanta, but quanta can also vary according to relative motion, gravity and electric charge. For a more complete description of reality, relative motion, gravity and electric charge all comply with the Doppler principle as a continuous nature of change in effect as well as a discrete quantum effect.

Electrostatic and gravitational effects are explained as vacuum effects occurring in the wake of emitted radiation. Even though effects are visible, gravitons are virtual particles. Although ordinary light is a visible part of the electromagnetic spectrum, as x-rays and radio waves are di-

rectly detectable, virtual particles can explain electromagnetic effects as well. Both gravity and electromagnetism are related to a virtual-vacuum-cause-and-effect condition of attraction.

ZPE

The explaining of electromagnetic effects as virtual energy is in view of Feynman diagrams, but continuous change in force is explained according to a concept of zero-point-energy Planck proposed to modify his own quantum theory for it to comply with the classical theories of continuous change. His effort was continued with proposed causal explanations of the particle-wave paradox by De-Broglie and a hidden variable approach by David Bohm (1917-1992). A stochastic interpretation of quantum probability conditions was also proposed by Jean-Pierre Vigier (1920-2004).

Plank revolutionized physics in the year 1900 with the introduction of the quantum as a solution to an infinity paradox of blackbody radiation, but he did not accept some of its implications. He continued to pursue a more consistent solution with classical electromagnetism. He contrived a possible solution in 1911 assuming quantum effects are particular oscillation modes of atoms. However, his assumption contrasted with Bohr's atomic theory whereby quantum jumps of discreet energy occur with absorption of radiation as well as its emission. In effect, the continuous manner of change in the relative motion of mass only occurs by reflecting radiation instead of by either absorbing or emitting it. However, a particular aspect of Planck's revised theory did receive recognition.

Plank added the term (½)hf to his original equation relating energy of radiation to absolute temperature. He referred to this one-half quantum h at any frequency f as zero-point-energy of an oscillator. Walther Nerst (1864-1941), who had formulated the third law of thermodynamics, interpreted the term in consideration of a possible heat death due to a loss of radiation emitted out of the universe (which would apply to an observable part of an infinite universe). He compared the half quantum frequency to k_BT, where k_B is the Boltzmann constant of temperature T. Further consideration of Plank's additional term became evident in view of Heisenberg's uncertainty principle in that otherwise zero energy at absolute zero temperature contradicts the condition of no possible determination of exact energy for any particular time.

With superposition of wave action it is possible infinite energy exists within any part of space. To the contrary, the uncertainty principle implies an infinite magnitude of energy is undetectable with regard to a particular time and location being uncertain, which would also be conditional to light speed according to relativity theory. This uncertainty is

explainable as invisible effects of interaction between virtual energies, as similar to no exchange of thermal energy occurring between two systems of the same temperature as an aspect of entropy.

Such invisibility is typical of wave action. Waves superimpose to produce visible effect only if the medium of wave action changes in a way it can be seen. If action within a medium is counterbalanced, then a direct change occurring within the interaction need not be seen beyond it.

A connection between ZPE and continuous change is with regard to a particle-wave paradox. The photoelectric effect revealed that electrons freed by radiation are according to frequency instead of the intensity of radiation. Einstein explained this result as particle effects of electromagnetic radiation. The particles were referred to as photons, as distinguished from particles of matter. However, further experimental evidence of interference supported a wave interpretation of light, and frequency is also a wave property as well as a particle property. Einstein actually referred to the photon as a wave packet. He even attempted to resolve the wave-particle paradox in speculating wave packets contain a minute particle within them.

Higher frequency waves can free more electrons than does the same energy of less frequent waves of more intense light if the less frequent light converts part of its energy as molecular motion of heat, as microwaves of a microwave ovens are much lower energy radiation than, for instance, ultraviolet waves.

Einstein later offered an explanation of photons guided by waves. The waves can superimpose to be invisible to each other, but that does not conclude they do not lose energy while moving through space in manner of maintaining the visibility of their light sources. The lost energy could occur evenly in perpendicular directions for no change in direction of the remaining energy.

With regard to the existence of the particle, De Broglie considered particle effects result from overlapping waves in analogy to the beats of sound occurring from sound waves. Schrodinger then developed De Broglie's idea in a consistent manner of Plank's attempt to relate the quantum to classical electrodynamics and relativity theory. Moreover, in 1954, Bohm and Vigier mathematically developed a casual wave-particle duality explanation, but the stricter indeterminism interpretation of the Heisenberg uncertainty principle prevailed to instead only explain effects according to the probability conditions of quantum theory with no further need of causal explanation.

The primary distinction between electromagnetic waves as either light or mass is that of the former can superimpose to occupy the same space whereas the latter cannot. To the extreme, light is invisible to other

light. However, light contains momentum and converts to mass in increasing the speed of mass by either absorbing or reflecting it. The action can be either elastic or inelastic. Somewhere between these two extremes various inelastic effects occur. Rather than light being reflected straight back from a metal, it can be partially converted to heat, or it can result in an emission of electrons if the light frequency is too fast for electrons to absorb it thermodynamically. To the extreme is the principle condition whereby mass emits fully what it absorbs. By theory, it absorbs and emits it as quanta, but what a system absorbs and emits also depends on particular temperatures as determined by Kirchhoff and other physicists in the nineteenth century.

The Casimir Effect

More support for ZPE is an explanation of the Casimir Effect. It was proposed in 1947 by Hendrik B. G. Casimir (1909-2000). He and Dirk Potter (1919-2001) experimented with metallic plates for the measure of the van der Waals force between the plates and their polarized molecules. They discovered an attractive force between the plates if they were close enough to each other.

Niels Bohr suggested to Casimir the experiments could relate to ZPE. Casimir formulated in 1948 a theory in compliance with Bohr's suggestion. Experimental evidence as accurate to within fifteen percent of the predicted value of theory was claimed in 1997 by Steve K. Lamoreaux. More accurate claims followed. However, exact results require experimental conditions to the extreme, such as exact vacuum conditions and perfectly smooth walls.

Note: Even though the Casimir effect is to be explained according to ZPE and the Heisenberg uncertainty principle, as in compliance with the quantum vacuum aspect of virtual energy of quantum wave mechanics, it is also explainable in accordance with the van der Waals force in being consistent with the polarization of positive and negative charge. Since like poles repel and opposite poles attract, bar magnets tend to align with opposites facing each other. The atoms of two metal walls close together thus tend to attract by also aligning as such. The significance of this explanation is of it relating to how the visibility of distant stars is to be explained.

The Casimir effect in relation to ZPE can also relate to the Heisenberg uncertainty principle, which applies to the quantum vacuum in further reference to quantum wave mechanics. Assuming the vacuum is comprised of waves of any possible frequency, equilibrium conditions vary according to arrangements from which waves fluctuate in and out of phase. Two superposing waves in opposite phase can momentarily cancel effect, or superposing waves in phase can combine for greater effect.

The cancelling of effect could result in attraction, but the greater effect should result in repulsion. However, if the volume of space between the walls is relatively small, such that momentary loss of energy allows the walls to momentarily contract, then wave energy as a virtual particle reappears outside from between walls in allowing for the existence of a new state of equilibrium. Interpretation with regard to virtual particles is that they are emitted from their confinement as immediate response to outside pressure with not enough time for another virtual particle to replace the emitted one.

Another explanation of attraction could be shorter enclosures exclude longer waves of less energy. Although the smaller space contains an average energy that is greater, it can have less total energy acting outward than does the total of greater and lesser energy waves acting inward. In effect, the possible containment within a smaller, more energetic space is explainable.

The greater frequency is again in play, but with different results. Contraction of the system occurs for a stronger bond within smaller space instead of a photoelectric effect as previously explained for metals losing electrons. Furthermore, this explanation of the Casimir Effect is consistent with the smaller nucleus within the atom containing more energetic mass-energy particles than those of the larger outer part of the atom.

Distant Visibility

In relation to the Feynman diagrams there are particles responsible for attraction and repulsion. Virtual particles repel electrons from electrons and protons from protons, and they attract electrons to protons and protons to electrons. Various effects arise. For instance, two parallel wires, as Ampere discovered, contract if they both have electric currents flowing in the same direction and repel if the currents flow in opposite directions. Explanation is here to be given in a manner consistent with both Feynman diagrams of interaction between atomic or virtual particles and conservation of momentum. However, particles are here considered as discrete units of wave action being consistent with the laws of motion.

Accordingly an electric current through a wire emits virtual particles having more momenta in the direction of flow than perpendicular to it and the direction of two wires relatively at rest. The emitted virtual particles, in turn, collide to emit secondary virtual particles with less energy because they move partly in the same direction. There is thus relatively less momentum of energy moving in perpendicular directions between wires. There is a vacuum effect of attraction occurring. In contrast, virtual particles from currents moving in opposite directions collide more

energetically for virtual particles to have more momentum in perpendicular directions between wires for a repulsive field of action created instead.

Regard this explanation as fundamental on a primary level from which attraction and repulsion become functional on subatomic and atomic levels. What results is a method of bonding whereby magnets can either combine to become one large magnet or disperse into tinier magnets in number.

The reason here for explaining electromagnetism is with regard to the need of explaining the visibility of the distant stars according to a tired light theory. An analogy for the explanation is with regard to television. How is it possible that images are transmitted through wires for countless viewers to clearly see? The explanation is with regard to bar magnets having ability to divide into multiple magnets.

The video of television consists of the collection of images by cameras transmitted as electromagnetic signals that propagate through both space and wires (or more clearly through cables). Required is a transmission of signals to be consistent with how the human brain distinguishes the data it receives. In general, a visible image maintains in the human brain for only a tenth of a second for each pictorial change given by the light source. Ten different images per second are what the brain comprehends with regard to a continuous sequence of scenery. In practice, between 25 and 30 complete pictures per second are received by the brain, with each picture divided into about 200,000 elements, or pixels. About two million individual details are thus perceived in total by the brain per second.

For transmission of data to be consistent with perceptual ability of the brain the signals need to be within a frequency range as bandwidth. Entailed in the process are antennas to both transmit and receive, and transformers. The signals are somehow amplified and multiplied for numerous observers. Signals themselves are electromagnetic waves as parts of an electric current surrounded by an induced magnetic field. How all individual images can be maintained is explainable if we consider the magnetic field is divisible into a field of numerous parts similar to how a bar magnet divides into smaller bar magnets. Packets of bar magnets of particular images are thus amplified and duplicated for alternate routes.

Significantly, individual arrangements of bar magnets do not change as long as their medium of propagation is in balance, even though their energy for propagation either reduces or is amplified. Maxwell explained the process of electromagnetic propagation as conditional to space alone, as separate from a physical medium. Starlight being electromagnetic waves of energy can thus exist as bar-magnet-packets that maintain individual images while losing energy as they interact with the virtual field of energy by which they advance as wave action through space. What re-

mains to be determined is whether starlight itself is amplified for revealing more or less detailed information of individual stars in similar manner of the broadcast of television.

Mass Light Gravity and Relative Motion

Einstein explained gravity as following spacetime curvature due to the presence of mass. What are mass, light and their difference? The main difference between them is that light superimposes with other light to occupy the same space whereas mass cannot. Einstein's mass-energy equation indicates mass relatively at rest is energy per light speed squared. It would become infinite mass-energy at light speed except for the needed infinite energy not being attainable as such. Mass also varies in speed, but the speed of light in the virtual vacuum of gravitational free space is assumed constant. However, light speed relatively decreases in a massive medium and in a gravitational field. It is even assumed to convert into matter, as by means of the Higgs Mechanism. Further assumed here is that light both superimposes and reflects from matter. As to how these two properties interrelate, a Quon Algebra has been proposed.

A Pauli Exclusion Principle refers to a condition whereby mass particles named fermions cannot occupy the same space that other fermions occupy. To the contrary is electromagnetic radiation of such boson particles as photons superimposing on other bosons according to a probability condition of quantum wave theory. As to how such opposite conditions coexist, a so-called Quon Algebra has been proposed as a possible method of allowing for slight interpolations to occur between the extremes of these two principles in view of a particle-wave duality possessing both light and matter properties. For instance, J. W. Goodison and D. J. Toms proposed in 1993 that particle creation and annihilation in the quantum vacuum state of virtual particles is allowed by different energy densities for interpolation according to the Quon Algebra.

The Quon Algebra is similar to previous methods of formulation prior to mainstream physicists regarding æther as unscientific, even if it does exist, because of its invisibleness not allowing for empirical confirmation. Einstein excluded it as unnecessary for his formulation of special relativity theory, but he suggested it could be useful for understanding theory. Even though it is controversial, its history underlies the general development of cosmological theory, and some physicists have still used it for developing theory.

Although light and mass differ, they both relate similarly to the invisibility of the virtual field. As for non-detection of radiation by matter, there is the Born Rule of quantum physics wherefrom the virtual forms of energy are detectable according a quantum wave function interpreted as a probability amplitude (as the measure of change) for detecting an

atomic particle within some particular time and/or location. The probability of detection can be extremely slight. Billions of neutrinos, for instance, move through our bodies every second while only a few neutrinos are detected by all of Earth. Neutrinos are thus secondary effects virtually invisible to us for the most part.

Light waves are consistent both with quantum and wave effects in that the Plank constant consisting of parameters $mv(2\pi r)$ are maintained by light speed being constant whereby a change in light momentum mc is nullified by an equal but opposite change in magnitude of r. Shorter waves of higher frequency are thus more energetic in relation to greater mass.

Assuming light and matter exist as two different forms of energy that convert from one form to the other, further assume matter is a particular form of light energy due to particular spacetime conditions. Superposing of light waves is thus limited. For explaining this limitation consistent with the relative motion of mass, assume electromagnetic energy becomes standing waves of mass from which relative motion of the standing waves is caused by further interaction with the virtual field of energy. If the packet of standing waves reflects in one direction more frequent waves than waves reflected in the opposite direction, a packet then obtains relative motion in the opposite direction in order to balance out the frequency of reflection.

Although this condition of relative motion is reasonably possible, it does not in itself explain the attractive and repulsive properties of mass. For it to explain gravity, for instance, there is the equivalence of inertial and gravitational mass principle to consider. It could thus be necessary for mass to convert one form of virtual energy into that of gravitons in proportion to its mass. Gravitons could change how other mass either reflects radiation or changes the space medium between mass for it to result in a vacuum effect. In either case, there is an internal action of mass converting energy from one form to another.

How can the vacuum effect occur?

It can occur from the conversion of virtual particles by matter that becomes more invisible to matter. If space is full of virtual particles repelling equally in all directions, and if matter and antimatter are rapidly colliding to convert into a form of radiation that is less detectable by matter and other radiation, then there can occur a change in direction of the total repulsive energy towards the wake of the emitted energy from the interaction of matter and antimatter. In being consistent with the Hubble Constant, the more invisible virtual energy is gradually detected to gradually convert back to the repulsive field of virtual energy. The length of the conversion process is simply the radius of the observable

universe R_u. The frequency of the total conversion is thus the inverse of the Hubble Constant occurring during time c/R_u.

In effect, gravity becomes explainable as a long-range-recycling effect in allowing continual annihilation and recreation of them instead of them being continually created only to continue indefinitely to infinity.

Gravity Mass and Electric Charge

Instead of describing gravitational effect as force, Einstein interpreted it as spacetime curvature: the warping of space in relation to the presence of mass. However, he provided no explanation for the presence of mass. Mass itself remained somewhat of an enigma.

Mass and light interrelate according to Einstein's mass-energy equation $E = mc^2$. How mass contains this tremendous amount of energy is in itself of significance. Consider a spherical container of energy in equilibrium with its environment. Outside pressure of light on the wall of the container is the same as inside pressure. If its radius is doubled, then the light inside the container moves twice the distance to collide with four times more parts of surface area. There should be eight times less inside pressure in ratio to four times more outside pressure. A greater atomic energy thus somehow exists within the smaller nucleus that somehow needs to be contained by the outer part of the atom.

The weaker field of electrons cannot itself maintain the stronger energy field of the nucleus. They even have an opposite charge of attraction. How both fields are self-contained must thus relate to different sources of energy, which is here to be explained consistent with the previous explanation of relative motion through the virtual field of energy.

A plausible explanation of this containment is with regard to the mean free path principle proposed by Clausius in support of the kinetic theory of gasses. More mass interferes with the free path of escape. If the interference is in proportion to mass radius, such that the nucleus of the hydrogen atom with one proton has a radius 1836.15 times smaller than the radius itself of the atom, and the proton is 1836.15 times more massive than electron mass surrounding it, then the nucleus has 1836.15 more mass interfering with the light speed for it to maintain equilibrium with its environment. In effect, the energy is internalized relative motion preventing action outside its domain.

The nucleus in comparison to the rest of the atom is thus greater to the fourth power, which is consistent with the Stefan-Boltzmann fourth power law relating Black Body temperature to light intensity as an adiabatic process of conserving entropy.

Although the greater mass of the proton is explainable, not explained is its relation to gravity and electromagnetism. They differ in that gravity is a simple formula for attraction whereas electromagnetism is

bipolar of positive and negative charges attracting each other, positive charge repelling other positive charge, and negative charge repelling other negative charge. Gravity and electromagnetism also differ whereby increase in gravitational potential Gm/r increases along with an increase in m, but electromagnetic potential e^2/mr decreases along with an increase in m. However, even though electric charge is bipolar, there is also a difference to consider regarding electromagnetism and electrostatics. The latter is formulated according to an inverse-square-law similar to the gravitational one derived by Newton.

For explanation of this difference assume mass consists of packets of superposed standing waves. Wave packets reflect, absorb and emit radiation in creating the effects of nature. Within wave packets are quantum states of equilibrium contained by surrounding energy fields. By interacting with an energy field, they convert its energy into gravitons that gradually convert back to the field. However, the equilibrium state of the wave packet itself separates into states that reflect, absorb and emit different frequencies of radiation, as for the creation of positive and negative charges that tend to restore balance for the existence of neutral states.

Gravity and electric charge differ even though both partly result from the conversion of virtual particles into other virtual particles. A conversion of virtual particles into slightly detectable gravitons is that of gravity containing mass-energy. Similarly, the conversion of virtual particles into other virtual particles by an electron or proton results in fields of containment. An electron interacting with different types of virtual particles converts them into a positive field of force that not only surrounds the electron, a repulsive force also occurs from the overlapping of multiple creations from other electrons. Positive force fields are likewise created by the proton. However, when the electron and proton fields overlap, the virtual particles convert back to their original forms. The nullification of repulsive charges thus further constitutes a recycling process and a vacuum state of attraction for opposite charge. Gravitational effect is similar, but it relates to different fields of energy for its effect being significantly gradual in comparison.

In effect, the proton inside the nucleus is in equilibrium with higher frequency radiation of the virtual field than is the electron, whereby the action between the proton and the electron is an indirect action of them as equilibrium states.

In Summary

Unification of theory also needs to be understood in the context of drift velocity, particle wave duality, the Higgs Mechanism, and entropy. The latter allows particular equilibrium states of energy to exist as virtual

fields of energy with non-observable direct effect. Drift velocity, as similar to the Clausius mean-free-path principle allows slower action to exist separate from the electromagnetic field, as for electrostatic and gravitational action to occur.

The Higgs Mechanism along with particle duality relate to the creation of mass-energy from wave action. Waves can superimpose with no direct observable effect. However, observable photons have momentum in their interaction with matter. They can thus convert into mass within a Higgs Field. Photons can also partially interact with the space through which they propagate in proportion to the relative density of mass. Similarly, gravitons partially interact with the space through which they propagate in proportion to the relative density of mass for their effects to equate in proportion to the photon interaction.

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