THE RELATIVITY OF LIGHT MATTER ENERGY AND GRAVITY

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When Shayla got off the school bus she laid down on the sidewalk beside the neighbor kid. He was doing her homework for her.

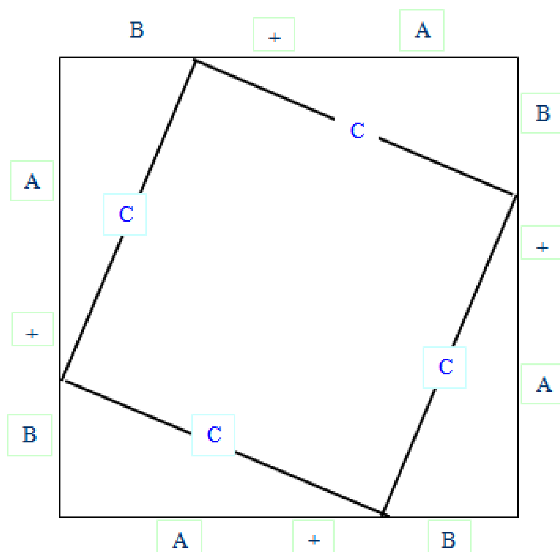
I had to convince Shayla that you learn by doing and that she was not learning by letting someone else do her homework.

The reason she did not do her homework was because she had a mental block with math. I told her it was a small step by step process and that taking each small step would lead to success, but that getting behind for a larger step up would cause a mental block.

She did not understand how to subtract 60 from 80 to get 20, but she knew how to subtract 6 from 8 to get 2. I told her she did not need to memorize each math relation, as math essentially has only ten numbers that add, subtract, multiply and divide, as with some use of mathematical logic. For instance, to subtract 6 from 13, which is 10 + 3, you subtract 6 from 10 to get 4 and then add 3 to get 7.

Physicists have said a supercomputer is needed to solve Einstein's general field equations, but computer programming is based on a binary code, a simple two number system.

Einstein suggested relativity can be understood in relation to the Pythagorean Theorem. I was introduced to this theorem in grade school. At one time or another I wanted to be sure it was true.



By the Pythagorean Theorem the hypotenuse length C squared of a right triangle equals the sum of each length A and B squared of the two other sides. I formed an outward square from the hypotenuse. I extended the lengths A and B to form a larger square about the other one such that it contained the other square along with four equal triangles formed with a side of the inner square.

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

At that time I knew a right triangle is half a rectangle and that the area of a rectangle is side A times side B. I therefore subtracted the area of four half rectangles as 4(½AB) = 2AB from the area of the outer square as $(A + B)^2 + (A + B)^2 = A^2 + 2AB + B^2$ and found out the resulting area to be equal to the area of the inner square: $A^2 + B^2$. The Pythagorean Theorem is thereby proved.

Introduction

In the latter half of the 19th century light became viewed as the propagation of electromagnetic waves of energy through a sea of ether. In contrast to the relative motion of material objects simply being relative to each other, all light propagates through the ether at the same speed, as according to theory, providing that it does not also propagate through a material medium as well, such as through glass, water or a gravitational field. It was thus believed the ether was a particular state of existence in relation to light speed that could be designated as absolute rest to which all other motion could compare.

Experiment after experiment failed to detect absolute rest. What the results indicated instead was that light speed is the same no matter what is the velocity of the source or the observer. No adequate theory to explain them was established until 1905 when Albert Einstein's paper on it was published in a journal. Electrodynamics and the mechanical laws of motion were thereby unified by modifying Galilean relativity according to Einstein's special theory of relativity.

Einstein founded special relativity theory on two postulates. The first one is with regard to the constant nature of light speed. The second one is referred to as the principle of covariance. Covariance means the laws of physics are the same no matter what is the velocity of the system they are determined from. A second, for example, is the same no matter what velocity the observer and the observer's clock move at relative to another observer, but the second is relatively longer if the clock moves relative to the observer instead of with the observer. Light speed is itself covariant, as being the same to all observers, but a distinct property of it is it has the same speed everywhere in vacuum space whereas particles of matter vary in speed.

Instead of light speed varying according to the relative motion of the observer what varies instead are the clocks and measuring rods used to measure space and time—such that the variance depends only on the relative motion between the observer and the measuring device and not on any particular state of motion designated as absolute rest.

Instead of the ether being the special reference frame to refer all other relative motion, constant light speed is the determining factor. The conditions of nature comply. Instead of calculating variable light speed to offset relative effects of nature on space and time, space and time are no longer absolutes. They vary instead in such a way that light speed is the same for any velocity of the observer who measures events.

Along with covariance came paradoxes. A famous one is the clock paradox whereby two observers moving relative to each other determine each other's clock as slow. Nonetheless special relativity theory remains a mathematically consistent theory in agreement with observation. All of its formulation, as with regard to the mathematical derivation of further principles and theorems, is consistent with the two postulates that had been founded on fact of observation and experiment. Further derivation by algebra produced the addition of velocities theorem and so on. By the addition of velocities theorem, in particular, it is determined that matter can neither equal nor exceed light speed.

Another paradox less publicized than the well-known clock one is with regard to relative mass. Similar to a clock in relative motion being relatively slow, mass in relative motion is relatively greater than if it is relatively at rest, but relative mass is also derived with the condition that total mass is conserved by way of inelastic collision. That is to say, if you change speed by way of inelastic collision with an asteroid, the total mass of you and the asteroid does not change, but all mass everywhere apart from the collision does change due to your change in relative motion.

The condition of mass as relative is consistent with theory and in agreement with observation. Its derivation is now reviewed with regard to the inelastic collision of mass obeying the laws of conservation of mass and conservation of momentum. Verification by example is provided by comparing results of two equal relative masses in inelastic collision with specified velocities.

Examples for more general conditions, as with regard to unequal masses in either inelastic or elastic collision are also given. A particular example is with regard to elastic collision, which involves the process of an inelastic one plus its reverse process. Although the reverse process is opposite to inelastic collision, it differs inasmuch as an exchange of mass occurs whereas masses in inelastic collision merely combine to become one mass.

Mass can also accelerate by it absorbing, emitting and reflecting light. The derivation of Einstein's famous mass-energy equation, $E = mc^2$, is thus reviewed as well. In addition, it is showed by example how relative mass is able to exchange mass-energy with light by either reflecting it, or absorbing and emitting it in analogy to inelastic and elastic collision.

Relative mass and momentum are conserved with regard to both inelastic and elastic collision between masses. They are further conserved with regard to the reflection, absorption and emission of light by matter. Gravity, however, is another matter.

In Newtonian Mechanics, whereby space and time are assumed to be absolute conditions of nature, conservation of momentum is simply maintained by the gravitational attraction being mutual between masses. The change in momentum of the moon by Earth's gravity is thus equal to a change in momentum of Earth caused by the moon's gravity, whereby a change in velocity of the Earth's greater mass is far less than the more noticeable change in velocity of the moon's smaller mass. The moon thus circles around Earth's smaller orbit around the center of mass. However, although the Earth and the moon mutually attract each other, they never actually come into direct contact with each other, such that Newton's law of gravity is only explained as an action at a distance principle.

In contrast, Einstein's general theory of relativity does not merely modify Newton's inverse square law of gravity for it to comply with the conditions of relative space-time; it avoids action at a distance by way of a unique interpretation of a principle on which the theory is formulated, the equivalence of inertial and gravitational mass. According to Einstein's own interpretation of the principle an observer in free fall has no internal awareness of acceleration. All mass-energies simply follow the path of a space-time continuum that the presence of mass curves. Therefore, the conservation laws of momentum and relative mass-energy that apply in accordance with special relativity theory apply to space-time curvature as well.

Unfortunately space-time curvature is not as simple as is relative motion. Portions of space-time curvature relate to a general distribution of mass at large instead of only between two particular masses, such that tidal effects occur. For instance, the ocean tides relate to the moon being closer to one side of Earth than the other. Earth observers are thus aware of internal effects of Earth's free fall towards the moon. In effect, there is an enormous complexity involved with Einstein's general field equations. Super computers are now used to solve them.

Since the mathematics of general relativity is extremely complex, the focus here is to elaborate on its fundamental principles. Newton, for instance, refused to declare his inverse square law of gravity as universal throughout the universe. He left open the possibility that gravity differs in other solar systems. It became accepted as universal nonetheless, except by a few challengers. Ernst Mach, in particular, offered the principle that the inertia of matter somehow depends on the whereabouts of all other mass in the universe. There is thus the possibility that inertial mass differs from gravitational mass. However, general relativity theory interprets the Mach according to the principle of equivalence along with a more general principle of covariance.

The principles of equivalence and general covariance can be easily explained philosophically. Somewhat more challenging is how to explain how the presence of mass determines space-time curvature. The theory of general relativity describes stress conditions of the space-continuum in relation to mass-energy, but there are some conceptual difficulties. Light approaching Earth, for instance, somehow increases in energy by way of the presence of mass. By Einstein's unique interpretation of the principle of equivalence there is no increase in energy relative to an observer in free fall with the light, as the increase in energy occurs instead relative to an observer on the surface of Earth who resists free fall. Light energy thus increases because the Earth observer accelerates toward it. This result is analogous to the simpler conditions of special relativity theory. However, to explain the increase in energy in view of how the presence of mass results in space-curvature is more difficult.

Another paradox is how light energy approaching Earth increases in view no information of events exceeds light speed according to special relativity theory, such that light is unable to mutually attract Earth until it gets to Earth. Moreover, if the increase in energy is by way of a graviton or some other direct action, there is a paradox as to how the graviton can continue forward unimpeded to attract other matter such that there is a direct change in momentum of matter in one direction without a direct compensation of it in the opposite direction.

Conditions of general relativity with regard to how momentum of gravitational energy is conserved by way of stress on space-time are thus subject to speculation. That is to say, since something acts on space-time to cause its curvature, space contains some form of energy. The existence of a plasmatic state of equilibrium, for instance, could very well cause the gravitational effect whereby contiguous action occurs in manner of being consistent with space-time curvature, conservation of momentum, and conservation of relative-mass energy.

This plasmatic explanation of gravity is speculative and *ad hoc* in that it explains the cause of gravity according to established theory, but it nonetheless serves its purpose, which is to provide a more down to Earth way of understanding theory.

Further theory is with regard to Hubble Cosmology. Cosmologists have interpreted the Hubble Constant in view of an expanding universe. Another possibility is a plasmatic one whereby the plasma in intergalactic space absorbs light energy moving through the plasma.

Verifying Relative Mass

A collision is inelastic if masses stick together after their collision with each other. Classical Newtonian Mechanics assumes the total mass and momentum are the same before and after the collision. These two conservation laws are also conditional to relativity theory. Paradoxically, however, also according to relativity theory the 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, as according to the equation

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad (1)$$

It therefore relatively increases in view of an observer accelerating apart from mass initially at rest with the observer, such as in a way the relative mass is not conserved.

Despite this paradox relative mass is mathematically verifiable by assuming both conservation of mass and conservation of momentum. The postulates of special relativity theory, as with regard to constant light speed and the principle of covariance, also apply, as does the addition of velocities theorem.

Relative mass is first distinguished from rest mass. Let m_0 be a quantity of mass relatively at rest with either observer A or observer B. Let m be the same mass moving with observer B at velocity v_1 relative to the positive direction of observer A.

The relative mass m and the rest m_0 become one, say M, relative to observer A by way of inelastic collision. Both conservation of relative mass and conservation of total momentum apply, as in accordance with equations (2) and (3) below.

$$m + m_0 = M \qquad (2)$$

$$mv_1 + m_0(0) = Mv_2 \qquad (3)$$

Equation (2) simply shows the total mass of two separate masses m and m_o relative to observer A before the inelastic collision are the same total mass M relative to observer A after the collision.

Equation (3) is somewhat more complex inasmuch as momentum is mass times velocity. Total momentum is the sum of all momentums of the two masses moving in either the same or the opposite direction. By conservation of momentum it is the same after a collision as it was before the collision. In inelastic collision, momentum of one mass moving in one direction negates the momentum of the other mass moving in the opposite direction, as both before and after the collision relative to say observer C with which they then move. Since equation (3) is with regard to inelastic collision between two masses whereby mass $m_0(0)$ before the collision is relatively at rest with observer A, its momentum relative to A is zero. Therefore, the total momentum relative to observer A before the collision is only mv_1. Since both masses move at velocity v_2 with observer C after the collision, the total momentum relative to observer A is Mv_2, which by equation (3) is the same as mv_1 before the collision.

By conservation of momentum of an inelastic collision the change, which is denoted by the symbol Δ, of momentum in one direction equals the same amount of change of momentum in the opposite direction

$$\Delta m v_1 = \Delta m_0(0) \qquad (4)$$

Since total mass is conserved the change in momentum is the difference in velocities of the masses:

$$\Delta v_1 = v_1 - v_2 \qquad (5)$$

$$\Delta v_0(0) = v_2 - 0 = v_2 \qquad (6)$$

The changes in velocities are still conditional to equation (4). Hence

$$m(v_1 - v_2) = m_0(v_2 - 0) = m_0 v_2$$

$$\frac{m}{m_0} = \frac{v_2}{v_1 - v_2} \qquad (7)$$

Equation (7) can also be obtained by substituting m and m_0 in equation (2) for M in equation (3):

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

$$mv_1 = mv_2 + m_0 v_2$$

$$mv_1 - mv_2 = m_0 v_2$$

$$m(v_1 - v_2) = m_0 v_2$$

$$\frac{m}{m_0} = \frac{v_2}{v_1 - v_2} \qquad (7)$$

The ratio of mass thus equals the inverse ratio of its changes in velocities.

Since equations (1) and (7) differ in form the objective here is to show that they are equal:

$$m = \frac{m_0 v_2}{v_1 - v_2} = \frac{m_0}{\sqrt{1 - \left(\frac{v_1}{c}\right)^2}} \qquad (8.1)$$

$$\frac{m}{m_0} = \frac{v_2}{v_1 - v_2} = \frac{1}{\sqrt{1 - \left(\frac{v_1}{c}\right)^2}} \qquad (8.2)$$

Proof of (8.1) or (8.2) is accomplished by converting v_2 in terms of v_1 and thereby showing the resulting form of the middle part of the equation is the same as on the far right side of the equation. In so doing the principle of covariance and the addition of velocities theorem apply.

The addition of velocities theorem, as for velocities in either the same or opposite direction, is of the form

$$v_{12} = \frac{v_1 + v_2}{1 + \beta_1 \beta_2} \qquad (9)$$

In equation (9), $\beta_1 = v_1/c$ and $\beta_2 = v_2/c$. The velocity v_{12} is of one observer moving relative to another, say observer B moving relative to observer A. It is also the velocity in relation to say observer C moving at velocity v_1 relative to observer A and the velocity v_2 of observer B moving relative to observer C. (Because clocks and other measuring devices differ because of their relative motion, the addition of velocities does not simply add up as $v_1 + v_2$.)

Instead of eliminating v_2 from equation (7), equation (9) adds v_{12} instead. However, since the velocity of observer B moving relative to observer A has already been denoted as v_1, it is simply substituted for v_{12}. Furthermore, it can be shown that the velocity v_1 of observer C moving relative to observer A is the same as the velocity v_2 of observer B moving relative to observer C.

The reason observer C moving relative to observer A is the same as observer B moving relative to observer C is because of covariance and symmetry. As by equation (3), after the inelastic collision, the velocity v_2 of M moving relative to observer A is zero relative to observer C moving at velocity v_2 relative to observer A. As by equation (9), the velocity of observer B moving relative to observer C is also v_2. (By covariance and by equation (1), observer B perceives the mass from observer A as relatively greater. In order not to be able to distinguish which mass is actually the greater one, observer C perceives both masses as equally the same. Since momentums in opposite directions cancel each other out, since relative mass is the same from both directions, the velocities are merely opposite in direction. The velocity of observer A relative to observer C is merely opposite as well. Since the velocity of observer B is v_2 relative to observer B, the velocity of observer A relative to observer C is $-v_2$, and because of covariance the velocity of observer C relative to observer A is v_2.)

Hence, by way of substituting v_1 for v_{12} and v_2 for v_1 equation (9) acquires the form

$$v_1 = \frac{2v_2}{1+\beta_2^2} \qquad (10)$$

The elimination of v_2 is accomplished by substituting the right side of the equality of equation (10) into equation (8.1), obtaining

$$m = \frac{m_0 v_2}{v_1 - v_2} = \frac{m_0}{\frac{2v_2}{1+\beta_2^2} - v_2} \qquad (11.1)$$

Dividing the left and right sides of the equation by m_0 gives

$$\frac{m}{m_0} = \frac{v_2}{\frac{2v_2}{1+\beta_2^2} - v_2} \qquad (11.2)$$

By dividing both the numerator and the denominator of the fraction on the right side of the equation (11.2) by v_2 it becomes

$$\frac{1}{\frac{2}{1+\beta_2^2}-1} \qquad (11.3)$$

By multiplying both the numerator and the denominator of (11.3) by the denominator of the fraction in the denominator it becomes

$$\frac{1+\beta_2^2}{2-\left(1+\beta_2^2\right)} = \frac{1+\beta_2^2}{1-\beta_2^2} \qquad (11.4)$$

The denominator on the right side of the equation further equates as

$$[(1-\beta_2^2)^2]^{\frac{1}{2}} = \sqrt{1-2\beta_2^2+\beta_2^4}$$

$$= \sqrt{1+2\beta_2^2+\beta_2^4-4\beta_2^2}$$

$$= \sqrt{(1+\beta_2^2)^2-4\beta_2^2} \qquad (11.5)$$

By substituting the far right side of equation (11.5) for the denominator of the fraction on the right side of equation (11.4) it becomes

$$\frac{1+\beta_2^2}{1-\beta_2^2} = \left[\frac{(1-\beta_2^2)^2}{(1+\beta_2^2)^2}\right]^{-\frac{1}{2}} = \left[\frac{(1+\beta_2^2)^2-4\beta_2^2}{(1+\beta_2^2)^2}\right]^{-\frac{1}{2}}$$

$$= \left[1-\frac{4\beta_2^2}{\left(1+\beta_2^2\right)^2}\right]^{-\frac{1}{2}} \qquad (11.6)$$

The fraction on the far right side of (11.6) equates in the manner

$$\frac{4\beta_2^2}{\left(1+\beta_2^2\right)^2} = \left[\frac{2\beta_2}{1+\beta_2^2}\right]^2 = \frac{1}{c^2}\left[\frac{2v_2}{1+\beta_2^2}\right]^2 \tag{11.7}$$

The fraction in the bracket on the far right side of equation (11.7) is by equation (10) the same as v_1. By substitution (11.7) becomes

$$\frac{v_1^2}{c^2} = \beta_1^2 \tag{11.8}$$

By substituting (11.8) for the fraction on the far right side of equation (11.6) the quantity of (11.6) becomes

$$\left[1 - \frac{4\beta_2^2}{1+\beta_2^2}\right]^{-\frac{1}{2}} = \frac{1}{\sqrt{1-\beta_1^2}} \tag{11.9}$$

Since the far right side of (11.6) equals the far right side of (11.4), which also equals (11.3) and (11.2), which equals the fraction of m/m_0, relative mass is thereby derived by way of conservation of mass and conservation of momentum:

$$m = \frac{m_0}{\sqrt{1-\beta_1^2}} \tag{12}$$

Equation (12) is identical in form to equation (1) except v in equation (12) is specified as v_1.

Examples

Verification of relative mass in view of conservation of mass and conservation of momentum was specifically with regard to an inelastic collision between two equal rest masses moving relative to each other. A more general verification includes any collision, whether it is inelastic or elastic, between any two masses. The general proof is more complicated. Verification by way of specific examples is here preferred instead.

The verification begins with a more specific example between two equal rest masses. Let m_0 = 1 unit of mass, grams or whatever. Let c also be unity, as one unit of distance per unit time. Let m be the rest mass m_0 in relative motion, as moving either from observer B towards observer C at say v_{bc} = .6c or from observer A towards observer C at v_{ac} = -.6c. After an inelastic collision between two equal rest masses from observers A and B the total mass is $2m_c$ relatively at rest as perceived by observer C.

With the velocity of observer A relative to observer C given as v_{ac} = -.6c, the mass $2m_c$ is determined in accordance with equation (1) as

$$2m_c = \frac{2m_0}{\sqrt{1-(.6c)^2}} = \frac{5}{2} \text{ units}$$

Momentum of inelastic collision is conserved relative to observer C because it is zero both before and after the collision, being momentum of one mass merely cancels the momentum of an equal mass moving at the same speed in the opposite direction.

To relate the same event relative to observer A instead of relative to observer C the addition of velocities theorem is applied in order to first determine the velocity of observer B relative to observer A as

$$v_{ba} = \frac{v_{ca} + v_{bc}}{1 + \frac{v_{ca}v_{bc}}{c^2}} = \frac{.6c + .6c}{1 + (.6)(.6)} = \frac{1.2}{1.36}c = \frac{15}{17}c$$

The units of relative mass m from observer B relative to observer A is thus

$$m = \frac{m_0}{\sqrt{1 - \frac{v_{ba}^2}{c^2}}} = \frac{1}{\sqrt{1 - \left(\frac{15}{17}\right)^2}} = \frac{17}{8}$$

The total units of mass before and after the inelastic collision relative to observer A is

$$m + m_0 = \frac{17}{8} + 1 = \frac{25}{8}$$

The total units of momentum before the collision relative to observer A is

$$mv_{ba} = \left[\frac{17}{8}\right]\left[\frac{15}{17}\right] = \frac{15}{8}$$

The total momentum units after the inelastic collision relative to observer A is

$$(m + m_0)v_{ca} = \left[\frac{25}{8}\right]\left[\frac{3}{5}\right] = \frac{15}{8}$$

Momentum is thus conserved in inelastic collision relative to observer A in view of conservation of mass.

Elastic collision is the same as inelastic collision plus the reverse of inelastic collision. The event of two equal masses colliding elastically head on at the same speeds relative to observer C is symmetrical in that the two masses relative to observer C recede from the collision in opposite directions than what they approached observer C at before the collision. The momentum mv_{bc} = - m_{ac} thus becomes mv_{cb} = - mv_{bc} = mv_{ac} and the momentum mv_{ac} becomes mv_{ca} = - mv_{ca} = m_{bc}.

The event is also symmetrical relative to observers A and B except for the added condition of an exchange of mass occurring between m and m_0 by way of the collision is more evident. The reversal of momentums and masses relative to observer A, for instance, is from mv_{ba} to $m_0(0)$ and from $m_0(0)$ to mv_{ba}. Observer C does not detect an exchange of mass only because both masses are still the same after the collision as they were before it occurred. Momentum in elastic collision is thereby conserved by way of an exchange of mass.

This process of exchanging relative mass is further verifiable with regard to the collision between two unequal masses.

Consider an inelastic-elastic collision of two unequal masses. Mass m_{xb} is the amount of mass units as perceived by observer B relatively at rest with them. They move at velocity v_{ba} = .8c relative to observer A to collide with unit mass m_0 = 1, as perceived by observer A relatively at rest with it. After inelastic collision the two masses are relatively at rest with observer C moving at velocity v_{ca} = .6c relative to observer A. After elastic collision, in consequence of the momentums being equal in magnitude relative to observer C before and after their elastic collision, the two new masses merely reverse direction with the same speeds they had before the collision.

Because the inelastic-elastic collision occurs with unequal masses, they also have different speeds, and because of the addition of velocities theorem, the speeds and relative mass of the new masses will not be the same relative to observer A after the elastic collision as they were before it. Therefore, to verify conservation of relative mass and conservation of momentum, what is to be determined from the values given above are these other values

1. The rest mass m_{xb} relative to observer B, as with it and observer B both moving towards observers A and C
2. The relative mass m_{xbc} of m_{xb} relative to observer C, as moving towards observer C before colliding with m_0
3. The velocity v_{bc} of m_{xbc} moving relative to observer C before the collision
4. The velocity v_{cb} of m_{xbc} moving relative to observer C after elastic collision
5. The relative mass m_{xba} of m_{xb} relative to observer A, as moving towards observer A before colliding with m_0
6. The relative mass m_{xbab} of m_{xb} relative to observer A, as moving away from observer A after an elastic collision with rest mass m_o
7. The velocity v_{ab} of m_{xbab} moving relative to observer A
8. The relative mass m_{0cc} relative to observer A, as the new mass of m_0 of it moving after elastic collision with mass m_{xba}
9. The velocity v_{caa} of m_{0cc} moving relative to observer A

Verification of conservations of momentum and of relative mass are achieved by showing they are the same relative to observer A before and after the elastic collision, as from where momentum is conserved by inelastic collision by way of conservation of mass:

$$m_{xbab} + m_{0cc} = m_{xba} + m_0 \tag{13.1}$$

$$m_{xbab}v_{ab} + m_{0cc}v_{caa} = m_{xba}v_{ba} \tag{13.2}$$

$$m_{xba}v_{ba} = (m_{xba} + m_0)v_{ca} \tag{13.3}$$

The value of m_{xb} as the units of rest mass m_0 relative to observer B is calculated by way of the condition that both momentum and total mass are conserved in inelastic collision. Since the rest mass is $m_0 = 1$ relative to observer A is with regard to the velocity $v_{va} = .8c$, it is further calculated in the manner of equation (12), where c = 1 is now used:

$$\frac{.8m_{xb}}{\sqrt{1-(.8)^2}} = .6\left[\frac{m_{xb}}{\sqrt{1-(.8)^2}} + 1\right]$$

$$\frac{.8m_{xb}}{.6} = .6\left[\frac{m_{xb}}{.6} + 1\right]$$

$$\frac{4}{3}m_{xb} = m_{xb} + \frac{3}{5}$$

$$\frac{m_{xb}}{3} = \frac{3}{5}$$

$$m_{xb} = \frac{9}{5}$$

The velocity v_{bc} of m_{xc} of observer B moving relative to observer C is calculated according to the addition of velocities formula, as with the numerical value given for the velocity $v_{ca} = .6c$ of observer C moving relative to observer A plus the value v_{bc} of observer B moving relative to observer C in relation to the numerical value $v_{ba} = .8c$ given of observer B moving relative to observer A:

$$.8 = \frac{v_{bc} + .6}{1 + .6v_{bc}}$$

$$.8(1 + .6v_{bc}) = v_{bc} + .6$$

$$\frac{4}{5} + \frac{12}{25}v_{bc} = v_{bc} + \frac{3}{5}$$

$$\frac{1}{5} = \frac{13}{25}v_{bc}$$

$$v_{bc} = \frac{5}{13}$$

With this numerical value of velocity along with the value of m_{xbc} is

$$m_{xbc} = m_0 \frac{9/5}{\sqrt{1 - \left(5/13\right)^2}} = m_0 \frac{9/5}{\sqrt{\frac{169}{169} - \frac{25}{169}}} = m_0 \frac{9/5}{\sqrt{\frac{144}{169}}} = \frac{9/5}{12/13} = \frac{117}{60} m_0$$

The $m_{xc}v_{bc}$ units of momentum relative to observer C are thus

$$m_{xc}v_{bc} = \left(\frac{117}{60}\right)\left(\frac{5}{13}\right) = \frac{3}{4}$$

These units of momentum are simply the product of relative mass and velocity relative to observer C before the inelastic collision occurred.

The values of relative mass m_{0ac} and relative momentum $m_{0ac}v_{ac}$ relative to observer C with respect to the rest mass m_o relative to observer A are calculated according to the velocity v_{ac} = -.6c of observer A moving relative to observer C:

$$m_{0c} = \frac{m_0}{\sqrt{1-(.6)^2}} = \frac{5}{4}m_0$$

Since observer C moves at .6c relative to observer A, observer A moves at -.6c relative to observer C, and the number of m_0v_{ac} units of momentum relative to observer C, with the mass m_0 calculated relative to observer C, is thus

$$m_0v_{ac} = \frac{-.6m_0}{\sqrt{1-(.6)^2}} = \frac{-.6}{\sqrt{1-.36}} = \frac{-.6}{\sqrt{.64}} = -\frac{.6}{.8} = -\frac{3}{4}$$

The two momentums relative to observer C are thus of equal magnitude and opposite in direction before the collision. The total momentum of the masses is zero before and after inelastic collision and thus conserved, as is the relative mass with respect to observer C. As for elastic collision, the two masses merely reverse direction to maintain equal speed, mass and momentum both ways.

What is now to be determined from these values is conservation of relative mass and momentum relative to observer A.

To determine equation (13.3) the relative mass m_{xba} of rest mass m_{xb} is calculated in the manner of equation (12). Since v_{ba} is given as .8c relative to observer A, the units of mass m_{xb} relative to A is

$$m_{xba} = \frac{m_{xb}}{\sqrt{1-\left(\frac{v_{ba}}{c}\right)^2}} = \frac{9/5}{\sqrt{1-\left(\frac{4}{5}\right)^2}} = \frac{9/5}{3/5} = 3$$

Substituting this value along with .8c for v_{ba}, 1 for m_0, and .6c for v_{ca} into equation (13.3) gives

$$(3)(.8) = (3+1)(.6)$$

Total momentum of the total mass $m_{xba} + m_0$ before and after an inelastic collision being .24 units on both sides of the equation it is thus conserved relative to observer A.

To verify equation (13.1) is to show the total mass after the elastic collision is still 4 units relative to observer A as it was before the collision. Unlike inelastic collision there is an exchange of relative mass by way of elastic collision such that equation (12) applies along with the addition of velocities theorem. Since the speeds of the masses are simply reversed in direction relative to observer C, such that $-v_{ac}$ as the reverse of observer C moving relative to observer A becomes the same as observer C moving relative to observer A, the velocity of m_{0cc} moving relative to observer A in proportion to light speed is

$$v_{0caa} = \frac{-v_{ac} + v_{ca}}{1 - \frac{v_{ac}v_{ca}}{c^2}} = \frac{2(.6c)}{1 + \left(\frac{v_{ca}}{c}\right)^2} = \frac{2(.6c)}{1 + (.6)^2} = \frac{1.2c}{1.36} = \frac{15}{17}c$$

The mass m_{0cc} relative to observer A after the collision is thus

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

Likewise, since the velocity v_{bc} before the collision was (5/13)c relative to observer c, it becomes v_{cb} = -(5/13)c after the collision. The velocity v_{ab} of m_{xbab} moving in proportion to light speed relative to observer A is thus

$$v_{ab} = \frac{v_{ca} + v_{cb}}{1 + \frac{v_{ca}v_{cb}}{c^2}} = \frac{\frac{3}{5}c - \frac{5}{13}c}{1 - \frac{3}{13}} = \frac{7}{25}c$$

The relative mass m_{xbab} relative to observer A after the collision is thus

$$\frac{m_0}{\sqrt{1-\left(\frac{v_{ab}}{c}\right)^2}} = \frac{\frac{9}{5}m_0}{\sqrt{1-\left(\frac{7}{25}\right)^2}} = \frac{\frac{9}{5}m_0}{24/25} = \frac{15}{8}m_0$$

Since $m_0 = 1$, the total units of mass after the collision are

$$\frac{17}{8} + \frac{15}{8} = \frac{32}{8} = 4$$

Since the total units of mass are 4 before and after the collision, equation (13.1) is thereby verified.

The number of momentum units relative to observer A before the collision was

$$m_{xba}v_{ba} = (3)\left(\frac{4}{5}c\right) = \frac{12}{5}c$$

After the collision they are

$$m_{xbab}v_{ab} + m_{0aa}v_{caa} = \left(\frac{7}{25}\right)\left(\frac{15}{8}c\right) + \left(\frac{17}{8}\right)\left(\frac{15}{17}c\right) = \frac{12}{5}c$$

Since the total units of momentum are the same after collision as they were before it occurred, equation (13.2) is therefore verified.

Kinetic Energy as Relative Mass

According to Classical Newtonian Mechanics the kinetic energy of relative motion is conserved by elastic collision, but it is not conserved by inelastic collision. The theory of relativity redefines kinetic energy as the difference in relative mass and its rest mass, and it is conserved by both elastic and inelastic collision. The energy of motion is thus internalized as mass-energy.

Newton assumed space and time are absolutes, as not altered by relative motion, gravity or some other influence on the observer. Kinetic energy is thereby defined by the equation $K = ½mv^2$. Say $m_1 = m_2$. Say m_2 is at rest while m_1 moves at velocity v before the inelastic collision occurs. The total momentum was m_1v before the collision occurred. It becomes $(m_1 + m_2)(½v) = m_1v$, as conserved. In contrast, the kinetic energy before the collision was $½m_1v^2$. After the collision, it becomes $½(m_1 + m_2)(½v)^2 = ¼m_1v^2$. The kinetic energy was thus reduced to one half as much after the inelastic collision occurred.

Newton thus argued that only momentum is fundamental to the laws of motion. Perhaps, then, the energy of relative motion is somehow internally contained by the state of inertia acquired of and between the mass. According to the theory of relativity this containment is actually an increase in relative mass.

In some ways the total relative motion of mass is increased by an elastic collision. This increase results when there is a change in direction of relative motion. Say m_1 moving at velocity v collides with m_2 relatively at rest such that the two equal masses both move opposite to each other at 45 degree angles from the original direction of relative motion. In the original direction their vector speeds are $m_1(½v) + m_2(½v) = m_1v$ such that momentum is conserved. Momentum is conserved in all other directions because its gain or loss in any particular one is compensated for by a gain or loss in the exact opposite direction.

As for calculating the speed in the newly acquired actual direction of relative motion it is according to the Pythagorean Theorem. It equates the length squared of the hypotenuse of a right triangle to the sum of the lengths, each squared, of the perpendicular sides. The new directions are indeed representative of a right triangle formed by the new direction, the original direction and a direction perpendicular to the original direction. Moreover, in this particular case the perpendicular sides equal in length.

Significantly, if the hypotenuse length is longer than the lengths of either perpendicular side, then motion along it is relatively faster for it to keep up with the original direction of motion. The hypotenuse C equates according to the Pythagorean Theorem to the perpendicular sides A and B in the manner $C^2 = A^2 + B^2$, which equals $2A^2$ in this case where $A = B$.

The hypotenuse is thus relatively longer by the square root of two such that the speed along it is relatively greater by the square root of two as well. Since the new vector speed in the original direction of motion is one half as much as the original speed in that direction, the speed along the hypotenuse is

$$\frac{1}{2}\mathrm{v}\sqrt{2} = \mathrm{v}\sqrt{\frac{2}{4}} = \mathrm{v}\sqrt{\frac{1}{2}}$$

The new speed is of two equal masses instead of one. The two speeds are thus twice the square root of one half. The total kinetic energy in the new directions of motion is thus

$$\mathrm{K} = \frac{1}{2}\mathrm{m}_1\left(\mathrm{v}\sqrt{{}^{1}/_{2}}\right)^2 + \frac{1}{2}\mathrm{m}_2\left(\mathrm{v}\sqrt{{}^{1}/_{2}}\right)^2 =$$

$$\frac{1}{4}\mathrm{m}_1\mathrm{v}^2 + \frac{1}{4}\mathrm{m}_2\mathrm{v}^2 = \frac{1}{4}(\mathrm{m}_1 + \mathrm{m}_2)\mathrm{v}^2 = \frac{1}{2}\mathrm{m}_1\mathrm{v}^2$$

It is therefore conserved.

In relativity theory kinetic energy is the difference in the relative mass and the rest mass, which is conserved by both elastic and inelastic collision. However, since verification of conservation of kinetic energy has been illustrated with regard to elastic reflections, it would be reassuring if conservation of relative mass is verifiable according to the conditions of special relativity theory as well.

Consider two equal masses, $m_1 = m_2$, approaching each other such that each one moves at speed $v_1 = (1/3)c$ relative to observer A. Each mass reflects the other for them to move in perpendicular directions from the original with the same speed at which they approached. Conservation of momentum is therefore maintained by its mutual exchanges in opposite directions.

Say mass m_2 is also relatively at rest with observer B such that the velocity of mass m_1 is relative to observer B by the addition of velocities theorem:

$$v_2 = \frac{\frac{2v_1}{c}}{1 + v_1^2} = \frac{(2/3)c}{1 + (1/3)^2} = \frac{3}{5}c$$

Also relative to observer B the two masses are not equal. Their total mass units before the reflection is

$$\frac{m_1}{\sqrt{1 - v_2^2}} + m_2 = \frac{5}{4} + 1 = \frac{9}{4}$$

After the reflection the masses m_1 and m_2 move, as vector speeds, in the original direction of motion. Since the new vector speed is perpendicular and therefore zero relative to observer A, it is the same speed v_3 relative to observer B for both masses. Since their relative speeds are the same, their relative masses are the same as well. With conservation of relative mass each relative mass is 9/8 as much as each rest mass.

The total units of momentum before the reflection is

$$\frac{m_1 v_2}{\sqrt{1 - v_2^2}} + m_2(0) = \left(\frac{5}{4}\right)\left(\frac{3}{5}\right) + 0 = \frac{3}{4}$$

For conservation of momentum after the reflection, the vector speed of each mass, as in the original direction of motion relative to observer B, is $v_1 = (1/3)c$ for each mass, such that the total momentum stays as

$$\left(\frac{9}{8}\right)\left(\frac{1}{3}\right) + \left(\frac{9}{8}\right)\left(\frac{1}{3}\right) = \frac{3}{4}$$

What is now determined is the common speed of the two masses in their new directions of relative motion relative to observer B. It is also determined in accordance with the Pythagorean Theorem. However, the addition of velocities with the direction one velocity perpendicular to the other is not calculated the same way they move in the same direction. A slower clock and a contraction of length influence the results in the same direction, but according to theory there is no contraction of length in the perpendicular direction of motion. There is only a slower clock consistent with slower speed such that (1/3)c timed by the slower clock of observer A is equally slower relative to observer B. The perpendicular vector speed of either m_1 or m_2 is thus

$$v_3 = v_1\sqrt{1 - {v_1^2}/{c^2}} = \frac{1}{3}c\sqrt{1 - \left({1}/{3}\right)^2} = \frac{1}{3}c\sqrt{{8}/{9}} = c\sqrt{{8}/{81}}$$

The actual speed in the new directions of motion relative to observer B is calculated according to the Pythagorean Theorem in the manner

$$v_4^2 = v_1^2 + v_3^2 = \left(\frac{1}{3}\right)^2 c^2 + \left(\frac{8}{81}\right)c^2 = \left(\frac{17}{81}\right)c^2$$

The relative mass $m'_1 + m'_2$ is thus

$$\frac{m_1 + m_2}{\sqrt{1 - \left(\sqrt{{17}/{81}}\right)^2}} = \frac{m_1 + m_2}{\sqrt{1 - {17}/{81}}} = \frac{m_1 + m_2}{\sqrt{{64}/{81}}} = \frac{m_1 + m_2}{{8}/{9}} = \frac{9}{8}(m_1 + m_2)$$

The relative mass is therefore conserved in the new direction of relative motion in a way it is consistent with the relative increase in rest mass of relative motion.

This result may seem redundant, but there is a worthy implication to consider from it. If the nature of light is primarily that of wave energy propagating at constant speed in a pure medium of space, then it would violate conservation of momentum if it changed direction, as in spreading outward. The quantum nature of light is therefore indicated with regard to conservation of momentum and the constant nature of light speed.

There is also further implication with regard to the nature of light and mass-energy.

Mass-Energy and Light

Say an inelastic collision occurs between two masses whereby they become internally the same as they were in relative motion. The law of conservation of energy comes into play. For, if collisions were inelastic in nature, then all motion would tend to cease. For motion to continue, some other form of energy must be involved in the process of collision. As with inelastic collision, the energy could be stored internally as heat or molecular motion. As with elastic collision, internal energy is immediately used to restore the relative motion of the masses in collision. For the collision to remain inelastic and for the masses to stay internally the same as they were in relative motion, the internal energy is surrendered to whatever system causes the collision to be inelastic.

Heat is viewed as internal motion of mass, as the random motion of molecules within it, but conservation of relative mass and momentum should apply to molecular motion as well. The molecules are not able to directly surrender their motion to molecules of another system if the two systems are separated by space. However, there is still the possibility to consider of heat being absorbed and emitted as radiant energy, or light.

Masses thus exchange energy when they collide, conserving it in the process. The kinetic energy of relative motion thus maintains in some form or another. Einstein agreed with this principle inasmuch as he went on to generalize conservation of relative mass and momentum as part of conservation of energy.

According to special relativity, mass and energy are equivalent and, in effect, the mass content of a body is only one of many possible forms of energy that are convertible from one form to another. Consider, for instance, the form of energy as light. Light incident on a body exerts pressure, as predicted by Maxwell in the middle of the 19^{th} century, and as experimentally verified by Lebedew in 1890. Two lightweight flags of paper, for instance, can rotate a small, frictionless pole if they are tightly hung opposite each other on it such that their front sides are white for them to reflect light and their back sides are black for them to absorb the light.

Considering the relativistic nature of his kinematics, Einstein went on to equate the internal energy constitutive of the mass to the specific quantity equal to the product of mass and light speed squared. He even derived this relation in a manner independent of the theory of relativity.

The relativistic mass and energy are according to the equation

$$E = \frac{E_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}} = mc^2 = \frac{m_0c^2}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{14}$$

The mass m_0 is the rest mass of m moving at relative velocity v and m_0c^2 is the "internal energy constitutive of the rest mass." The increase in the rest mass in relative motion by $m - m_0$ is identified as the kinetic energy of relative motion, which for speeds far below that of light approximates to the Classical-Newtonian formula of $K = ½m_0v^2$.

Einstein considered a long tube containing two spheres of mass positioned at each end. Let the two spheres be denoted as A and B such as contained inside a long tube of mass M relatively at rest. Sphere A contains an excess amount of energy E_0. When inelastic collision occurs between sphere A and the tube, it causes the tube to move at velocity v with momentum Mv. A photon of light with equal energy E_0 recoils in the opposite direction at speed c. Conservation of momentum applies such that the absolute value of E_0 is equal to the absolute value of MV. Since $E_0 = m_0c^2$

$$Mv = \frac{E_0}{c} \tag{15.1}$$

$$v = \frac{E_0}{Mc} \tag{15.2}$$

Equation (15.2) is used to substitute values.

The momentum that had been given to the tube is negated when sphere B absorbs the light and passes it on to the tube by means of an inelastic collision with the same magnitude of momentum E_0/c in the opposite direction. However, during the time t of light propagation from one sphere to the other, the tube had been displaced by the distance

$$x = vt \tag{15.3}$$

Substituting E_0/Mc of equation (15.2) for v of equation (15.3) gives

$$x = \frac{E_0t}{Mc} \tag{15.4}$$

To restore the tube to its original position a particle of mass m_0 equal in energy to that surrendered as light by sphere B is transported at a distance d back to sphere A. With all other related activity balancing out on the transporter's return trip, the transportation of the particle causes the tube to move back the distance x to its original position.

Work occurs during the process of the tube moving the distance x. The product dm_0 of weight and distance moved defines this work energy in the conventional sense inasmuch as mass is a measure of weight. Since the particle and light are of the same energy, and since the work energy used the particle to place the light energy back into position, which also restores the original position of the tube, the two actions are mutually related, such that

$$\mathrm{xM} = \mathrm{dm_0} \qquad (15.5.1)$$

$$\mathrm{x} = \frac{\mathrm{dm_0}}{\mathrm{M}} \qquad (15.5.2)$$

Combining equations (15.4) and (15.5.2) gives

$$\mathrm{x} = \frac{\mathrm{dm_0}}{\mathrm{M}} = \frac{\mathrm{E_0 t}}{\mathrm{Mc}} \qquad (15.6)$$

The last two equalities give

$$\frac{\mathrm{E_0 t}}{\mathrm{Mc}} = \frac{\mathrm{dm_0}}{\mathrm{M}}$$

$$\mathrm{E_0} = \frac{\mathrm{Mm_0 cd}}{\mathrm{Mt}} = \frac{\mathrm{m_0 cd}}{\mathrm{t}} \qquad (15.7)$$

However, d is the distance of light propagating from sphere A to sphere B in time t. In other words, d/t is the speed of light. Hence

$$\mathrm{E_0} = \mathrm{m_0 c^2} \qquad (15.8)$$

This last equation represents the internal energy constitutive of the rest mass m_0.

Since the rest mass in relative motion relatively increases by the factor $(1 - v^2/c^2)^{-1/2}$, the mass-energy equation becomes

$$E = mc^2 = \frac{m_0 c^2}{\sqrt{1 - v^2/c^2}} \qquad (14)$$

The energy constitutive of the mass is thus its internal energy plus that of its relative motion.

Conserving Light Energy

Conservation of momentum and mass-energy require them to be the same even though mass can convert to another form of energy such as light. Since light has momentum, its absorption and emission are subject to the same inelastic and elastic conditions of collision with which matter complies. To verify this compliance let unit mass $m_0 = 1$ with momentum $m_o(0) = 0$ relative to observer A absorb a photon of light of momentum $m_x c$ such that m_0 and the photon energy move along with observer C at velocity .6c relative to observer A. The total mass and momentum before and after the inelastic collision are 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 before and after the inelastic collision is therefore

$$\frac{3}{2}\mathrm{m}_0 + \mathrm{m}_0 = \frac{5}{2}\mathrm{m}_0$$

The total momentum before the collision was (3/2)(1) = 3/2 units. After the collision it is (3/2 + 1)(3/5) = (5/2)(3/5) = 3/2 units. Total momentum is thereby conserved relative to observer A.

The mass and momentum relative to observer C before and after the collision is related according to relative mass and a relativistic version of the Doppler formula. The Doppler formula for a decrease in energy of light due to the observer relatively moving away from the light source is according to the formula

$$\lambda = \lambda_0(1 - \mathrm{v})$$

The relativistic Doppler formula in comparison is similar to the formula for relative mass. It is

$$\lambda = \lambda_0 \frac{1 - \mathrm{v}}{\sqrt{1 - \frac{\mathrm{v}^2}{\mathrm{c}^2}}} = \lambda_0 \left|\frac{(1 - \mathrm{v})^2}{1 - \frac{\mathrm{v}^2}{\mathrm{c}^2}}\right|^{1/2} = \lambda_0 \left|\frac{(1 - \mathrm{v})^2}{(1 - \mathrm{v})(1 + \mathrm{v})}\right|^{1/2} = \lambda_0 \left|\frac{1 - \mathrm{v}}{1 + \mathrm{v}}\right|^{1/2}$$

Since the total momentum relative to observer C is zero after the collision, the momentums of the photon and the mass are equal in speed but opposite in direction before the absorption occurs. The relative mass m and momentum of m_0 moving at velocity -.6c away from observer C are

$$\mathrm{m} = \frac{\mathrm{m}_0}{\sqrt{1 - (.6)^2}} = \frac{5}{4}\mathrm{m}_0$$

$$-\mathrm{mv} = -\left(\frac{5}{4}\right)\mathrm{m}_0\left(\frac{3}{5}\right)\mathrm{c} = -\frac{3}{4}\mathrm{m}_0\mathrm{c}$$

The photon of mass-energy m_x and momentum $m_x c$ relative to observer C moving more away from the source of emission than observer A does is by the Doppler formula

$$m_{xx}c = m_x c \left|\frac{1-\frac{v}{c}}{1+\frac{v}{c}}\right|^{1/2} = \frac{3}{2} m_0 c \left|\frac{1-.6}{1+.6}\right|^{1/2} = \frac{3}{4} m_0 c$$

Conservation of both mass and conservation of momentum are thus both verified in view of observer C as well as in view of observer A.

To verify them in view of elastic collision, as with the same mass emitting the photon in the opposite direction in which it was absorbed, the mass (5/4)m_0 acquires a velocity of .6c relative to observer C, as with the same speed and direction caused by the absorption of the photon. However, the velocity relative to observer A is according to the addition of velocities formula

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

The mass relative to observer A becomes

$$m_2 = \frac{m_0}{\sqrt{1-\left(15/17\right)^2}} = \frac{17}{8} m_0$$

The numerical units of momentum relative to observer A are thus

$$\left(\frac{17}{8}\right)\left(\frac{15}{17}\right) = \frac{15}{8}$$

The mass and numerical units of momentum of the photon is calculated according to the Doppler formula in relation to observer A moving away from the photon source (mass m_2)

$$m_{xb} = m_{xc}\left|\frac{1 - v_{12}}{1 + v_{12}}\right|^{1/2} = \left|\frac{1 - {15}/{17}}{1 + {15}/{17}}\right|^{1/2} = \left(\frac{3}{2}\right)\left(\frac{1}{4}\right) = \frac{3}{8}$$

The total units of mass relative to observer A therefore remains as

$$\frac{17}{8} + \frac{3}{8} = \frac{20}{8} = \frac{5}{2}$$

The total units of momentum relative to observer A remain as

$$\left(\frac{17}{8}\right)\left(\frac{15}{17}\right) - \left(\frac{3}{8}\right)(1) = \frac{18}{8} - \frac{3}{8} = \frac{12}{8} = \frac{3}{2}$$

Relative mass and momentum are therefore conserved by way of a free moving particle of mass absorbing and emitting a photon such that the relative masses of the photon and the particle comply with the formula comparing the mass in relative motion with the same mass relatively at rest.

In showing that relative mass is conserved in inelastic collision it was assumed that the masses merely collide and stick together. However, if the collision between masses were ultimately inelastic in nature, then all of mass-energy would tend to coalesce as one inert mass. There thus exists a more complex process at work that allows inelastic collision to occur. Now that it is also shown that a particle can increase or decrease in relative mass by way of an exchange of energy with the light it reflects, or absorbs and emits, it should now be realized that two masses colliding stay together as one combined rest mass by surrendering energy as heat to other mass or simply radiating energy into space.

Particles of mass combining and decomposing as such are typical of quantum physics. They should also be typical of the stress conditions of space-time curvature that give rise to the gravitational effect according to general relativity theory.

Gravity and Variable Light Speed

Contrary to the constant nature of light speed in gravitational free space is it does move slower in a gravitational field. Conservation laws of momentum and energy are thus complicated in view of gravity.

This gravitational retardation of light speed and relative motion in general is derived from a particular metric as a solution of Einstein's field equations: the Schwartzschild metric. It is of the form

$$ds^2 = dt^2\left(1 - \frac{2GM}{r}\right) - \frac{dr^2}{1 - \frac{2GM}{r}} - r^2 d\theta^2 - (\sin^2\theta)d\varphi^2 \qquad (16)$$

The infinitesimal interval ds is with regard to the simultaneity of events in view of constant light speed, where dt and dr are increments of time and distance where the gravitational field of mass M is homogeneous within an infinitesimal volume of space for special relativity theory conditions to apply. Since conditions are relatively homogeneous, space-time curvature also compares in form to Newton's gravitational potential, GM/r = v^2, G being the gravitational constant and the escape velocity at r is the square root of 2GM/r. The escape velocity determines the gravitational strength of the field and replaces v for relative motion. Light speed c is defined as unity such that it does not visibly appear in ratio to the escape velocity. The polar coordinates are similar to perpendicular coordinates of relative motion and are omitted if inconsequential to the event in consideration. The direction of free fall, for instance, need not involve them.

If the event refers to a light particle (a photon) then the difference between its actual change in position and the observation of its change in position is zero, such that ds = 0. By omitting the polar coordinates from equation (16) it becomes

$$0 = \left(1 - \frac{2GM}{r}\right)dt^2 - \frac{dr^2}{1 - \frac{2GM}{r}}$$

$$\frac{dr^2}{1-\frac{2GM}{r}} = \left(1-\frac{2GM}{r}\right)dt^2$$

$$\frac{dr^2}{dt^2} = \left(1-\frac{2GM}{r}\right)^2$$

$$\frac{dr}{dt} = 1-\frac{2GM}{r} = c' \tag{17}$$

The relative speed of light in a gravitational field is thus less than unity.

Significantly, 2GM is zero in the absence of a gravitational field. The numerical value of dr/dt is thus the number one, which, in this case, is light speed in gravitational free space as one unit of distance divided by one unit of time.

In the Schwartzschild metric the speed of light is defined as unity such that it does not visibly appear in the equation but is still understood to apply. By inserting both c and c' into the equation its form becomes

$$s^2 = c'^2dt^2\left(1-\frac{2GM}{rc^2}\right) - \frac{dr^2}{1-\frac{2GM}{rc^2}} = \frac{c^2dt^2}{1-\frac{2GM}{rc^2}} - \frac{dr^2}{1-\frac{2GM}{rc^2}} \tag{18}$$

The insertion of c'^2 in front of dt^2 is with regard to clocks and light speed being retarded in the gravitational field. The insertion of c^2 instead of c'^2 in the relativistic factor is arbitrary in that the relative motion of light and matter are retarded in the same way such that v'/c' = v/c.

What is significant about equation (18) is that the equality on the far right of the equation is of the same form of invariance of the interval in special relativity theory. It relates mathematically to distance and time of an event. Say observer B moves towards observer A at velocity v such that observer A sees observer B at distance x = ct, where t is the time for light to move that distance at speed c. However, since observer B moves the distance vt towards observer A during the same time, the distance of observer B from observer A becomes x – vt. If observer B moves at speed c, for instance, then ct – ct = 0.

The difference in distance moved between light and observer B is observer B's velocity in ratio to light speed. Hence

$$x - \frac{v}{c}x = x - vt \tag{19.1}$$

Likewise, the difference in time for light to move the distances ct and vt is in ratio to light speed. Hence

$$t - \frac{v}{c}t = t - \frac{vx}{c^2} \tag{19.2}$$

By covariance observer A moves towards observer B such that the opposite sighting of observer A by observer B is the same as observer A's sighting of observer B. However, each observer perceives the other clock as slow by the factor $1/(1 - v^2/c^2)^{½}$. The equivalence of perception relates according to invariance of the interval s as

$$s^2 = x'^2 - t'^2 = x^2 - t^2 \tag{20}$$

This equivalence is derived first by comparing observer B's distance and time coordinates to observer A's distance and time coordinates.

$$x' - \frac{v}{c}x' = \frac{x - \frac{v}{c}x}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{x\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{21.1}$$

$$t' - \frac{v}{c}t' = \frac{t - \frac{v}{c}t}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{t\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{21.2}$$

The next step is to add and subtract coordinates:

$$x' + t' = \frac{x\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} + \frac{t\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{x\left(1 - \frac{v}{c}\right) + t\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{22.1}$$

$$x' - t' = \frac{x\left(1+\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}} = \frac{x\left(1+\frac{v}{c}\right)+t\left(1+\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}} \qquad (22.2)$$

The final step is to multiply equation (22.1) by equation (22.2):

$$(x' + t')(x' - t') = x'^2 - t'^2 =$$

$$\frac{x\left(1 - \frac{v}{c}\right) + t\left(1 - \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} \cdot \frac{x\left(1 + \frac{v}{c}\right) - t\left(1 + \frac{v}{c}\right)}{\sqrt{1 - \frac{v^2}{c^2}}} =$$

$$\frac{x^2\left(1-\frac{v^2}{c^2}\right)-t^2\left(1-\frac{v^2}{c^2}\right)}{1-\frac{v^2}{c^2}} = x^2 - t^2 \qquad (23)$$

An invariant is something that is the same for various relations of its internal components. The hypotenuse of a right triangle, for instance, is an invariant for all other right triangles that extend from it. The length of the hypotenuse squares is thus equal to the sum of lengths squared of the other two sides of any of the right triangles formed.

The significance of the invariant is that it allows the calculation of a component by way of knowledge of the other components. A surveyor, for instance, can detour by way of a right triangle to measure a distances that are obstructed by a hill or building. The invariants of relativity theory are similar inasmuch as they allow physicist to calculate, distance, time or some other component of interest by knowing the other components of the invariant.

As for the purpose of analyzing it here, it is with regard to light speed being slow in the gravitational field. Slower light is of less energetic unless is plows its way through space. The indication is thus that space is not empty of content.

Covariance and Equivalence

Special relativity theory was founded on constant light speed and covariance. General relativity theory is generally covariant with regard to gravity and it is further founded on the principle of equivalence whereby gravitational mass and inertial mass are equally the same. A change in momentum of a mass is thus the same whether caused by either gravity or a collision with another mass. Isaac Newton was reluctant to make this connection, as he left open the possibility that his inverse-square-law for gravity might not be universal everywhere in the universe. He assumed it was valid only locally. Experiment nonetheless confirms the equivalence of inertial and gravitational mass to at least one part in 10^{13}.

Some philosophers had argued against the equality of inertial and gravitational mass. Ernst Mach, in particular, argued that the inertia of a particular mass depends on the relative distribution of all other mass in the universe. General relativity theory actually explains Mach's principle by way of general covariance such that the principle of equivalence holds true.

Consider the gravity of matter as an anomalous condition of the space-time continuum. That is to say that there would be no gravity if all mass were distributed evenly throughout all of space. For instance, there is zero Earth gravity at Earth's center. Gravity thus occurs because of an uneven distribution of mass. By general covariance the same unevenness in the distribution of mass has the same exact effect no matter where it occurs.

Another interpretation of the principle of equivalence, as given by Einstein, is that an observer in free fall experiences no internal effect of gravity, as if inside an enclosure falling freely to Earth. The conditions of free fall are thus analogically the same as inertial motion wherefore the conditions of special relativity apply. The objects enclosed, however, fall towards the center of mass instead of parallel to each other. A path that is perpendicular to free fall also varies with speed, such that light inside a spacecraft in orbit will escape the orbit whereas a ball moving slower will not. Tidal effects also occur. Ocean tides, for instance, result because the moon's gravity influences the part of Earth the moon is closes to.

These effects still occur due to the presence of mass. According to Einstein mass and light simply follow the path of space curvature that the presence of mass somehow attributes to. Whatever contains mass in its present position warps or stresses space-time in producing the effect of gravity. Gravity is thus simply explained as matter and light following the path of space-time curvature due to the presence of mass. However, the explanation is not really simple. The variations in the relative positions of mass result in an extremely complex calculation of space-time curvature, as according to Einstein's tensor calculus.

Einstein's general field equations are complex in their description of nature. His tensor calculus involves various conditions of momentum, stress, density, pressure, and so on. Solutions to describe specific events usually assume simplified conditions of nature. An infinitesimal volume of space-time curvature, for instance, is relatively homogeneous enough for space-time conditions of special relativity theory to apply. Do they apply only as approximates truths or are the conservation laws truly an integral part of reality?

Although Einstein's tensor calculus is complex, it is only a means of notation for a complex array of effects. The laws of physics still apply according to the basic principles of theory. In plain English, conservation of relative mass-energy and momentum hold true for the complexity of space-time curvature in similar manner that they do for the conditions of special relativity theory in gravitational free space.

Conditions of special relativity theory apply with regard to free fall inasmuch as space-time conditions are homogeneous enough to equate as inertial motion. There is therefore no internal awareness of free fall. It is only observed externally by comparing the differences in accelerations of other masses, as seeing the moon orbit Earth, seeing how Earth orbits the sun and so forth.

Opposite of free fall is an observer on Earth's surface experiencing the weight of gravity, as resisting space-time curvature in analogy to the acceleration of a rocket to a greater speed. In effect, the surface mass of Earth pushes against Earth to accelerate outward. Whatever is in free fall is thus the same as if the observer accelerates towards it. The increase in kinetic energy of relative motion of a mass in free fall is thus attributed to the observer's state of acceleration instead of to the mass following the path of space-time curvature.

Likewise, since light also follows space-time curvature, its energy also relates to space-time curvature. The light from the mass in free fall, for instance, is Doppler shifted towards a more energetic blue end of the light spectrum as it approaches the Earth observer's state of acceleration.

In effect, matter and light energy simply follows the natural path of space-time curvature instead of some mysterious force of gravity.

From an internal perspective the increase in energy from free fall is inconsequential with regard to conservation laws. According to special relativity theory all energy apart from a local collision changes in view of the local observer's change in relative motion. However, the conservation laws are of issue with regard to external perspective. Curvature of space-time, as due to the presence of mass, only hides the action at a distance principle of Newtonian Mechanics. The issue that remains is with regard to the actual cause of space-time curvature. Does this cause, whatever it is, also comply with the conservation laws of special relativity theory?

The decrease in light speed and relative motion in a gravitational field and the contrary changes in light and kinetic energy during free fall is indicative that space-time exchanges energy with matter and light in a manner of maintaining conservation of mass-energy. How mass is able to curve space-time should be explainable as such—even with regard to the enormous complexity of tidal effects and other complications of free fall. An explanation as such is given in the final chapters.

Gravitational Simultaneity

Consider two masses gravitating towards each other. The free fall of either mass towards the other is observable with regard to a change in velocity of the mass. This observation is instantaneous with regard to the gravitational strength of the other mass at each position of the observer. According to the principle of covariance it should be instantaneous for all observers. However, according to special relativity theory no information of events can exceed light speed.

How then does an observer know the location of the other mass with the instantaneous effect of gravity given according to distance? The answer is with regard to the principle of simultaneity, which also can help explain why the nature of light speed is constant relative to all observers.

Consider observers A and B receding from each other at velocity v. The aim here is to verify both observers see each other's whereabouts as by being at absolute rest. For instance, if observer A is at absolute rest, then the total time for observer B to move away from observer A and for light to reach observer A from distance x is $T_A = x/v + x/c$ according to the clock and coordinate distance of observer A. By covariance, even moving relative to absolute rest, having a slower clock and contraction of length in the direction of relative motion, the time $T_B = x''/v + x''/c$ is determined the same according to the clock and coordinate distance of observer B.

First of all, since relative motion alters lengths and clocks, it is not yet determined that observer B perceives v as v. However, its verification is simple. Since clocks and coordinate lengths are mathematically altered by the same factor, the shorter distance nullifies the slower clock. Times T_A and T_B are thus perceived as simultaneous even if they are not relative to some other observer.

There is no contraction of length perpendicular to the direction of relative motion. Let an airplane have wide wings. Let it be passed directly under by an identical airplane. Pilots sitting exactly in the middle of each cockpit should thus see the perpendicular events at equal distance occur simultaneously. However, this is fallacious reasoning being that direction itself is relative. Since there is no absolute rest to be aware of, neither is there knowledge of absolute direction relative to it. Light actually moving at the same speed with regard to absolute rest actually moves relative to observers at variable speeds, but observers determine all light speed the same because the simultaneity of events is also relative.

Events at equal distance perpendicular to the direction of relative motion therefore do not necessarily occur simultaneously, as one side of the airplane could arrive sooner than does the other side. Perpendicular is therefore not absolutely perpendicular.

It is this simultaneity of events being relative that determines the constant nature of light speed. Light could be moving at the same speed respect to absolute rest, but it is still determined the same speed relative to the observer's state of rest because of the relativity of simultaneity of events.

As to relate all this to gravity consider a moon's orbit is around a planet moving somewhere outside the influence of any other mass. If an observer could know the absolute position of orbit and the absolute time light was emitted from each orbiting position, then light speed could be measurable with respect to absolute rest. Special relativity would then be contradicted. However, each position of the orbiting mass is according to the principle of simultaneity, which is also according to the velocity of the moon at each orbiting position, which is also according to the addition of velocities theorem. The absolute velocity and absolute time and absolute distance of events are therefore unknown.

There are preexisting gravitational fields enclosing all masses. The instantaneous effect of gravity, however, is local such that knowledge of exact location still complies with special relativity theory. Signs informing observers of distance, for instance, are also preexistent information, but if preexisting information could determine distance, time and light speed in view of absolute rest, it would contradict special relativity theory.

Both the earth and its moon have preexisting gravitational fields about them. However, their effects are such that neither the moon's nor the earth's absolute position is revealed to the other. This non disclosure is possible if the gravitational strength at the same relative distance from mass at each new position in absolute space is according to light speed.

Explaining Gravity

The principle of simultaneity indicates gravity propagates at light speed. Conservation of momentum suggests light energy is of a quantum nature. Light does appear as discreet units of energy called photons. It is thus attempting to describe gravity as discreet units of energy as well.

A photon of light is defined as having no rest mass, but it is never at rest and it does carry momentum at light speed, and relative mass that absorbs light does increase. Photons also vary in energy. They can thus be emitted from a particular mass to change other mass in a variety of ways. However, all masses gravitate at the same rate according to the amount of distance and mass they gravitate towards. The gravitational influence is thus more restrictive.

The aim here is nonetheless to explain the direct action of gravity on matter in a manner consistent with conservation laws. For instance, a graviton having no mass and causing an electron and a more massive and denser proton to accelerate at the same change in speed in one direction with no compensating change of speed in the opposite direction does not comply with conservation of momentum.

The explanation is also to be totally consistent with the theory of general relativity.

The theory: Space surrounding matter is not empty. There exists a plasmatic state of equilibrium that is inertly denser closer to matter. This inert density contains matter with which it is in dynamic equilibrium. The plasmatic state is more subject to stress. It either converts radiant energy to it or it converts to radiant energy depending on its relative equilibrium state. It releases its inert energy as radiant energy similar to how kinetic energy of relative motion is created by way of reflection. Released energy counteracts in pushing against the plasmatic state, thus freeing itself and creating a vacuum state in its wake in producing the gravitational effect. The radiant energy that is released is gradually reabsorbed by the plasma in manner of a recycling process according to the curvature of space due to the presence of mass.

The plasmatic state of equilibrium is in response to conservation of energy, which is the first law of thermodynamics. An observer on the surface of a mass resisting free fall feels the force of gravity measured as weight. Preventing free fall is work energy spent for it not to constitute a perpetual motion machine. It thus radiates energy into space. However, it also receives energy from space, as from distant stars and so forth. Mass-energy is therefore in a state of cosmic equilibrium.

Energy also increases and decreases in space away from matter. It increases, for instance, by a blue shift in the light spectrum of light falling towards Earth. Objects in free fall also increase in kinetic energy as they accelerate downward. Work is thus performed away from mass such that the state of equilibrium includes the confines of space as well.

An equilibrium state of energy in space does not itself explain the gravitational effect. To explain it, reference is made to the concept of the ethereal medium to determine how relativistic effects of relative motion and gravity come about.

When the transverse nature of light propagation was proposed to explain some known effects, the ethereal medium was deemed as rigid as metal, but it was not understood how matter could move freely through a solid medium as easily as it could in empty space. It is thus pertinent to answer how matter appears to move freely through a plasmatic medium.

If the primary nature of matter is wave action through a medium, then it could move through the medium as wavelets of energy. However, waves in ordinary three dimensional media generally disperse such that momentum in their original direction of motion would not be conserved. Therefore the explanation entails a particle nature of matter.

Matter is not all inert. It contains an enormous amount of internal energy, as according to Einstein's mass-energy equation $E = mc^2$. Plasma likewise contains internal energy and the plasmatic state of equilibrium is interactive with matter.

The explanation of free movement through the plasma is similar to wave action. Consider a sphere in equilibrium with its environment. It is hollow inside except for small energetic particles moving in equilibrium with outside particles. Say a force sets the sphere in motion. A new state of equilibrium is created in the process. Outside particles in opposition to the relative motion of the sphere hit it with more force and momentum. Inside particles, in turn, recoil with more force and momentum, and they hit the other side of the wall with more force and momentum, such that outside particles hitting the sphere with less force and momentum recoil with more force and momentum in the opposite direction of motion. The inside particle, recoils with less force and momentum, as will the outside particle do in turn. The result is the momentum from an outside particle at one end of the sphere is transferred to an outside particle at the other end of the sphere.

This explanation requires that matter and plasma exist in states of equilibrium that are unique to their coexistence. Other outside radiation, for instance, would exchange momentum with the total sphere, as if the outer edge of the sphere is a perfect insulator of its internal energy. It has to be a perfect conductor instead.

This uniqueness must also be in compliance with relativity theory. However, the process is not just simply of radiation inside and outside a hollow sphere. Plasma consists of an inert substance similar to the inertia of matter. Matter and plasma superimpose such that plasma becomes an integral part of matter. The total matter-plasma combo resonate internal energy at light speed.

The matter-plasma combo remains as such if both are at absolute rest. If matter moves relative to the plasma, then only the plasma lies in a state of absolute rest while matter superimposes with other plasma. The resonating of internal energy remains in effect with the state of relative motion. To be consistent with relativity theory it requires the contraction of matter in the direction of relative motion along with the retardation of clocks and an increase in mass-energy.

The internal energy is in relation to speed c, as in Einstein's mass-energy equation E = mc^2 for the rest mass. The time for light to move the diameter s of a spherical mass there and back is 2t = 2s/c. For the mass in motion its velocity v is added to and subtracted from c in the direction of relative motion. If the mass does not contract in the direction of motion, then the time of the to there and back propagation of light is

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

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

However, mass contracts in the direction of motion such that the time is

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

Perpendicular to the direction of motion in view of an observer moving at rest with the plasma light moves partly in that direction and partly in the direction of motion. The actual direction is along a hypotenuse of a right triangle with lengths of the two other sides as s and vt', and is according to the Pythagorean Theorem

$$ct'^2 = s^2 + vt'^2$$

$$ct'^2 - vt'^2 = s^2$$

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

$$ct'^2=\frac{s}{1-\frac{v^2}{c^2}}$$

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

$$t'=\frac{s}{c\sqrt{1-\frac{v^2}{c^2}}}$$

An increase in relative mass also occurs with relative motion. This increase in relative mass is consistent with the equations above and with the condition of matter and plasma superimposing in the unique state of equilibrium. The plasma remains in place while matter superimposes with other plasma. Since the time t' of the internal action between matter and plasma is in relation to a longer distance s, the interaction is with greater mass and greater plasma. There is an exchange of plasma and mass, but the conversion is according to conserving momentum and relative mass, as a decrease in relative mass of one mass compensates for an increase in mass of another mass.

In effect the plasma is invisible, not testable and therefore it does not scientifically exist. It is nonetheless useful for explaining the theory of relativity in a consistent manner.

The invisibility of plasma is with regard to the equilibrium state. It does influence the behavior of matter with regard to relativistic effects. The additional velocity of a mass is partly determined by the exchange of relative mass, as for matter to neither equal nor exceed light speed, and matter contracts in the relative direction of motion.

There are also effects with regard to gravity. The plasma being in a state of equilibrium reflects or absorbs and emits plasmatic radiation in determining the gravitational field.

The superimposing of matter and plasma changes the equilibrium state outside it. Outside plasma pushes more on mass. This containment spreads outward in a ripple effect where the force saturates among more plasma in proportion to surface area of the ripple. The inner plasma thus receives more force from the outer plasma than does the same amount of outer plasma receives from the inner plasma.

The inner plasma is more stressed, causing more of it to convert into the plasmatic radiation that is emitted and scattered. The scattering tends outward toward the path of least resistance to create a vacuum in its wake. This vacuum is immediately filled by outer plasma pushing in to fill the void while the escaping plasmatic radiation is partially reabsorbed by outer plasma in proportion to the least amount of stress suffered by it. This process is what produces the gravitational effect.

Hubble Cosmology

When astronomers examined the light spectrum of starlight they discovered it was, on the average, Doppler shifted more towards the red end from more distant sources. Calculation by Edward Hubble indicated, in particular, this red shift is linear with distance in relation to velocity. At a distance of one centimeter, for instance, the red shift equates to a light source in recession at about 2.2×10^{-18} centimeters per second. Twice the distance it equates to a recession of about 4.4 centimeters per second. At a distance of Mpc = one million parsecs = 3.09×10^{19} kilometers it equals a recessional velocity of about 68 km/sec/Mpc.

Several cosmologies were proposed to explain the red shift. One that has become most popular and accepted among physicists is the big bang theory whereby the universe is assumed to be finite and expanding by way of a mysterious cosmic explosion at the beginning of its creation. A similar theory proposed was a steady state universe where the universe expands to allow the formation of new stars from the released energy of the old ones. Plasma cosmology is another model that is considered by a minority of physicists. Complementary to it is tired light theory.

Since a known cause of a red shift is a recession between the light source and the observer, indications are the universe could be finite and expanding. After all, explosions occur in nature to various degrees. There are atomic bombs, volcanic eruptions, supernovae and so forth. Big Bang theory, however, is not the only explanation of the red shift. A red shift is also caused by loss of energy, which occurs with the partial absorption of light by matter in the process of conserving momentum and energy. Fritz Zwicky thus proposed the cosmic red shift could be the result of a partial absorption of light in interstellar space.

The absorbing agent is plasma. Plasma cosmology was proposed by Hannes Alfren and his work was developed further by Eric J. Lerner. A more recent tired light theory has been proposed by Lyndon Ashmore. By it electrons in interstellar space are in a plasmatic state that absorbs light energy. The light energy that is absorbed by the plasma is emitted every which way in space to become Cosmic Microwave Background Radiation. It is a background radiation in space that is evenly distributed in direction and density such that it appears to have no specific origin.

A question pertinent to Ashmore's tired light theory is with regard to a recycling process. Is all light to become background radiation or is it restored by a process similar to steady state cosmology? Alfren suggested it was part of the gravitational effect, an idea that has support in relation to equating the Hubble Constant to other constants of physics.

Equating the Hubble Constant with other constants of physics was proposed by Paul Adrien Maurice Dirac. By his cosmology the value of the gravitational constant decrease as the universe expands, but if it does not expand then there is no need of modifying gravitational theory.

Dirac made note that minute size masses can be constructed from the constants G, c, $\hbar$ and e:

$$m_x = \left[\frac{\hbar c}{G}\right]^{\frac{1}{2}} = 2.2 \times 10^{-5} \text{ grams}$$

$$m_y = \left[\frac{e^2}{G}\right]^{\frac{1}{2}} = 1.8 \times 10^{-6} \text{ grams}$$

However, these masses are between 10^{18} and 10^{22} times greater than the masses of such ordinary particles as the pion and electron, whose values approximate if constructed with the addition of the Hubble Constant H:

$$\left[\frac{\hbar H}{Gc}\right]^{\frac{1}{3}} \approx m_\pi \qquad \left[\frac{e^4}{Gc^3}\right]^{\frac{1}{3}} \approx m_e$$

The inclusion of the Hubble Constant is therefore significant inasmuch as it helps construct a particle comparable to the ordinary.

In solving the value of the Hubble Constant the last approximation becomes comparable to the gravitational acceleration per light speed at the surface of an electron of mass m_e in the manner

$$H \approx \frac{Gm_e^3c^3}{e^4} = \frac{Gm_e^3c^e}{m_e^2r_e^2c^4} = \frac{Gm_e}{r_e^2c} \cong 0.8\ \text{km/sec/Mpc}$$

The equality on the right side of the equation is obtained by substituting the product $r_em_ec^2$ (the electron radius, its mass and light speed squared) as the parameters of e^2 (the electronic charge squared). This value of H is about 2.6 X 10^{-17} times per second, which is an extremely slow vibration or weak action.

In Dirac's day the known value of the Hubble Constant was within an accuracy range of 100. Astronomers today are more confident that its value is close to 2.26 X 10^{-18} times per second or 70 km/sec/Mpc or about 87.5 times the above derived value.

With atoms a more massive one is usually smaller in proportion. If an atom 87.5 times more massive than the electron is substituted in the above formula it will thus render a value for H 87.5 times smaller instead of larger. An atom about 87.5 times smaller than the electron is needed for the formula to work, but no such particle is known to exist.

The structure of the atom is a possibility. The hydrogen atom, for instance has a radius of about $(137)^2$ times the radius of the electron. The radius of its nucleus r_n is about 1836 times smaller, as its proton mass m_p is about 1836 times more than the electron mass m_e outside the nucleus. Obtaining a value in the same manner of the above formula, however, is more complex. It takes the form

$$H \approx \frac{Gm_p}{2r_n r_e} \cong 2.29 \times 10^{-18}\ \ sec^{-1} \cong 70.7\text{ km/sec/Mpc}$$

Multiplying the denominator by e^2 and the numerator by the parameters $m_e c^2 r_e$ of e^2 renders the relation

$$\mathrm{H} \approx \frac{\mathrm{Gm_p m_e c^2 r_e}}{\mathrm{2r_n r_e ce^2}} = \frac{\mathrm{Gm_p m_e c}}{\mathrm{2r_n e^2}}$$

$$\frac{\mathrm{2Hr_n}}{\mathrm{c}} \approx \frac{\mathrm{Gm_p m_e}}{\mathrm{e^2}} \cong 4.3 \times 10^{-40}$$

Twice a Hubble Constant of 70.7 km/sec/Mpc speed at a distance r_n per light speed thus approximates to the ratio of the gravitational force and electromagnetic force between the proton and the electron.

In these relations the number 2 is not explained. Why is twice the Hubble Constant related to the ratio of gravitational and electromagnetic forces? Perhaps it relates to matter superposing with plasma. Maybe it is in relation to particles of matter having one half the spin of light. Another possibility is with regard to a cosmological relativistic Doppler shift in the Hubble Constant being squared in similar manner that the speed of light and relative motion is slower in a gravitational field by the 'square' of the relativistic factor $(1 - 2GM/rc^2)^{-½}$.

The product Hr has the same dimensions as velocity: distance per time. Twice the velocity relates to the addition of velocities theorem and it along with the Doppler formula renders the Doppler formula squared:

$$\left|\frac{\mathrm{c - v_{12}}}{\mathrm{c + v_{12}}}\right|^{\frac{1}{2}} = \left|\frac{\mathrm{c} - \dfrac{\mathrm{2v}}{1 + \dfrac{\mathrm{v^2}}{\mathrm{c^2}}}}{\mathrm{c} + \dfrac{\mathrm{2v}}{1 + \dfrac{\mathrm{v^2}}{\mathrm{c^2}}}}\right|^{\frac{1}{2}} = \left|\frac{\mathrm{c} + \dfrac{\mathrm{v^2}}{\mathrm{c^2}} - \mathrm{2v}}{\mathrm{c} + \dfrac{\mathrm{v^2}}{\mathrm{c^2}} + \mathrm{2v}}\right|^{\frac{1}{2}} = \frac{\mathrm{c - v}}{\mathrm{c + v}}$$

Twice the Hubble Constant in connection with the Doppler formula along with the addition of velocities theorem thus relates to the square of the Doppler formula, which is consistent with general relativity inasmuch as the slowing of light and all motion in a gravitational field is according to the square of the relativistic factor.

The Hubble Constant, as a Doppler shift in light spectrum caused by light absorption by plasma, is not really a constant. It decreases since the Doppler shift is in proportion to a decreasing light energy. However, this result is actually consistent with more recent observation, which big bang theory is modified in order to comply with.

According to big bang theory the Hubble Constant does not relate to a relativistic Doppler shift in light spectrum. The universe is just what it is from a local perspective. At twice the distance the recession is twice as fast. However, some astronomical observations now indicate the Hubble Constant is not constant; its rate appears to be increasing. To explain this increase in the rate of expansion big bangers have assumed the existence of dark energy. As the known universe expands, dark energy fills the void created by it and also provides more force for greater expansion. In other words, the big bang is still in the process of exploding.

Dark energy is a possibility, but it is not required in view of a tired light theory. By tired light theory the light from the more distant stars is from a more distant past, but the Doppler Shift in light spectrum is due to a loss of light energy occurring in proportion to the light energy. Since the light energy decreases with regard to both distance and time, the Hubble Constant decreases as well. This increase in the Hubble Constant in view of big bang theory is thus a decrease instead in view of tired light theory.

This tired light theory is relativistic in nature, as effects of gravity are described in a manner that is consistent with the relativistic effects of relative motion, as consistent with the principle of equivalence. However, this is not to say the results are inconsistent with quantum theory. To the contrary, inasmuch as matter is quantized local light energy reflected or emitted from matter is initially quantized as well. According to the atomic theory of the atom proposed by Bohr, for instance, the kinetic energy of the electron circling the nucleus in the hydrogen atom is according to the Planck Constant h times the Rydberg frequency R_y. It is also in relation to e^2 such that e^2/r_a equals twice the kinetic energy, where r_a is the radius of the hydrogen atom. Hence

$$hR_y = \frac{1}{2} m_e v^2$$

$$e^2 = m_e v^2 r_a = 2hR_y r_a$$

$$\frac{2Hr_n}{c} = \frac{Gm_p m_e}{e^2} = \frac{Gm_p m_e}{2hR_y r_a}$$

$$\frac{4HhR_y}{c} = \frac{Gm_p m_e}{r_n r_a}$$

This tired light theory can thus be formulated in a manner that is consistent with relativity theory that has further implications with regard to quantum theory as well.