b. The second term has an expression in the numerator for an increment of stored energy in the photon. The denominator is the photon length. The numerator and denominator are different from those contained in the particle's expression. However, they give the same measure of force.

c. The third term represents the changes the photon has undergone as a result of moving a sufficient distance into the unaffected background light-field. The photon's length has increased to dx_{c1} consistent with the speed of light increasing to v_{c1}.

d. The fourth term represents the changes the photon has undergone as it approaches very close to the second charged particle. Its length has decreased to the value dx_{c2}.

e. The fifth term shows the second particle has been acted upon by the photon. The transfer of stored force has been completed, and the particle has changed its speed by an incremental amount.

It can be seen in this series that there are three attributes belonging to the first particle that are conserved all through the process. These attributes are the value of its mass, the increment of its acceleration and, these two things together making up the third, the force exerted upon the particle that caused its acceleration.

Three attributes of the photon are not conserved. The first is the speed of light that varies according to particle velocities and the dictates of the background light-field. The other two are respectively the energy type expression in the numerator and the length of the photon in the denominator.

The conservation of force means Newton's law of force is invariant at every point. Even though this is true for a local observer, it is not true for the remote observer. It is this difference between local measurement and remote measurement that introduces relativity effects into the example problem.

For example, a remote observer standing stationary on the surface of the earth applies a constant force to a particle causing it to accelerate along a path in line with a stationary measuring rod. As the particle's speed increases the stationary observer will notice the applied force will result in less and less acceleration.

Even though the stationary observer sees a diminishing of the effect of force, this is not the case for an observer traveling with the particle. A local observer moving with the particle as it travels along the length of the stationary measuring rod sees the rod grow longer. His fundamental unit of measurement, the photon, is becoming smaller. The local observer is using dx_{c2}, and the stationary observer is using dx_{c1} as their fundamental units of measurement. Locally all seems to be remaining normal, but the remote world appears to be expanding.

This causes the local observer to measure his distance traveled per increment of time at a greater value than does the stationary observer. Both observers are making their measurements between the same two points. The distance x_d between these two points does not change. Only the local measurement is varying. The local measurement of distance between the two points is larger than the remote measurement.

For the remote observer the measurement of the particle's velocity is:

$$v_{pR} = \frac{dx_d}{dt}$$

The local observer measures the particle's velocity and finds:

$$v_{pL} > \frac{dx_d}{dt}$$

In order to measure the velocity or change of velocity of the particle from the perspective of the local observer, it is necessary to use the ratio of the constant remote unit of measurement to the changing local unit of measurement. This ratio has been derived as:

$$\frac{dx_R}{dx_L} = \frac{dx_{c1}}{dx_{c2}} = \frac{v_{c1}}{v_{c2}}$$

The remote observer measures an increment of the distance x_d as dx_{dR}. The local observer measures this same increment of distance as dx_{dL}:

$$dx_{dL} = dx_{dR}\frac{dx_R}{dx_L} = dx_R\frac{dx_{c1}}{dx_{c2}} = dx_{dR}\frac{v_{c1}}{v_{c2}}$$

Therefore:

$$v_{pL} = \frac{dx_{dL}}{dt} = \left(\frac{dx_{dR}}{dx_L}\right)\left(\frac{dx_R}{dt}\right) = \left(\frac{dx_R}{dx_L}\right)\left(\frac{dx_{dR}}{dt}\right) = \frac{v_{c1}}{v_{c2}}v_{pR}$$

Substituting for v_{c2} and simplifying:

$$v_{pL} = \frac{v_{c1}}{\left(v_{c1}^2 - v_{pR}^2\right)^{\frac{1}{2}}}\, v_{pR} = \frac{v_{pR}}{\left(1 - \frac{v_{pR}^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

The local observer can use his measurement of speed to calculate the force applied to his particle. Force is conserved locally, so he should calculate the true applied force:

$$f = \frac{d}{dt} m v_{pL} = \frac{d}{dt} \frac{m v_{pR}}{\left(1 - \frac{v_{pR}^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

If the source of force at the remote location is increased in a manner that causes the particle to maintain a constant acceleration as measured by the remote observer, then from a local perspective the acceleration increases in accordance with the change in the applied remote force. As the remote force is increasing the acceleration measured locally is correspondingly increasing.

The local observer does not measure a diminishing of the effectiveness of force with increasing speed. The arrival of force on the local level will produce the same measure of acceleration on the local level as would be expected from the perspective of the remote level if there were no relativity type effects. What the remote observer would predict as a result of non-relativistic calculations is what the local observer measures.

This formula for force can be used to calculate the expression for particle kinetic energy:

$$E_K = \int_0^x f\,dx$$

The solution of the kinetic energy equation, it will shortly be discussed further, is:

$$E_K = \frac{m v_{c1}^2}{\left(1 - \frac{v_{pR}^2}{v_{c1}^2}\right)^{\frac{1}{2}}} - \ m v_{c1}^2$$

Electromagnetism and Relativity Type Effects

The example problem used here is a single charged particle accelerated in a straight line by a force. As the particle is accelerated it releases a photon in a perpendicular direction. This event is the fundamental starting point for the theory of electromagnetic radiation.

Before beginning to describe the transfer of energy to the emitted photon, it needs to be established that the acceleration of the particle will change the orientation of the released photon. In other words, the changing velocity of the particle will impart a tilt to the released photon. Before doing this I will first demonstrate when tilt does not occur. In the absence of a secondary or background light-field, there can be no tilt.

The simplest example is to consider the event to occur in the absence of a background light-field. If there is no background light-field, then there is no way to define a change in speed. A change in speed has to be movement with respect to something. We cannot define motion of any kind with respect to space alone, because this implies detectable physical properties of space. The only thing established empirically about space is that it exists.

We know space is there because we measure distances in it. We cannot define a measurement of distance as occurring across nothing, so there must be something. This new theory makes no claim to predict physical properties for space other than to say it exists and gives us room to move about. In the absence of using space to serve as a source of control over either photons or matter, there is no basis upon which to determine any movement at all of an isolated particle.

Fortunately, this situation does not represent the conditions of the universe. The introduction of a background light-field approximates the real condition of the universe. So, I introduce into the example the existence of a background light-field. The change in speed of the particle can now be measured against the reference frame of the background light-field which, for this example, is considered to be stationary.

The problem is to analyze the emission process of the photon. The photon begins to leave the particle when the particle’s velocity is at the initial value. However, all through the very quick emission process the particle accelerates in a perpendicular direction. During this process the remaining part of the photon is not yet emitted and is dragged along with the particle as the particle’s velocity increases.

This is the case because of the relative strengths of the two light-fields. This conclusion results from the recognition there are two light-fields at work here. There are both the background light-field and the particle's light-field. Each exercises the same fundamental method of control over photons. The background light-field is composed of the combined effects of many light-fields belonging to distant particles.

When the photon is very close to the particle, the particle's light-field strength is high compared to the background light-field. Therefore, it is the particle's light-field that is the main reference of control for the photon. The propagation speed of the particle's light-field is treated as being much larger than C and possibly infinite. As the photon moves away from the particle the particle's light-field decreases rapidly in strength, and the photon becomes under the control of the background light-field.

The speed of the photon is controlled by the combined effects of both light-fields. At a point very close to the center of the emitting particle, the effect of the background light-field can be approximated as not even existing. Therefore, at that point there is virtually no effect of relative speed. As the photon moves away, the effect of the background light-field quickly becomes very significant. Under these conditions there is a very significant relative speed.

The result of this effect upon the photon, as it is released, is to cause the trailing end to be dragged along by the accelerating particle. As the photon is leaving the particle this dragging effect quickly diminishes and the leading end has a speed that is no longer referenced primarily to the particle. The leading end now has a speed strongly referenced to the background light-field that is not moving. The resulting effect upon the photon is to be left with a constant tilt relative to the direction it is moving.

While I am offering this physical example as an aid to visualize what is occurring, I am not insisting this is the precise physical event that occurs. It is intended as an aid to show how I bring together what we have learned from empirical evidence and the mathematics of this new theory. The purpose of this visual description is to make it clear why I solve the problem by working with a common increment of distance. This method is different from the one used in the preceding analysis of the horizontal component of acceleration.

The analysis of the horizontal component used a common increment of time for the measurement process. In that case the distance traveled by the particle was not equal to the distance the photon traveled during the time of emission. In this new example, concerning a perpendicular component of motion for the photon, the two distances are the same. In other words, the increment of distance across which the particle accelerates during the time of emission can be approximated as being the same as the offset distance for the trailing end of the photon. Therefore, I must define a different cause for relativity type effects for this case.

Since the distances traveled are the same, the change of velocities for both the particle and the speed of light can be treated in a manner analogous to an object falling freely between two points due to gravity. The previously derived equation using exceleration, which I can use here, is:

$$v_p dv_p = -v_{c1} dv_c$$

When I derived this equation, it described the effect of gravity. There was a clear singular direction for the gradient of the velocity of light. The direction of this gradient of v_c was unique so I included the appropriate sign.

In the example problem at hand, of a photon moving between two particles, the induced gradient of v_c may not have a singular direction. It may be the case that general relativity type effects are a special case of special relativity type effects. What I will try first is to apply opposite signs to the change in light speed and the change in particle speed. I also know that the change in kinetic energy of the particle has been of the opposite sign as that of the change in the energy of the light-field.

Until the implications of this new approach are made clear, I will continue to use:

$$v_p dv_p = -v_{c1} dv_c$$

Next I wish to solve for momentum and, it can be calculated from:

$$P = \frac{dE}{dv_p}$$

So, I set up the increment of energy:

$$dE = mv_p dv_p$$

Substituting from three steps above:

$$dE = m(-v_{c1} dv_c)$$

The variable speed of light is given by

$$v_c = \left(v_{c1}^2 - v_p^2\right)^{\frac{1}{2}}$$

Taking the differential:

$$dv_c = \frac{-v_p dv_p}{\left(v_{c1}^2 - v_p^2\right)^{\frac{1}{2}}}$$

I substitute this expression into the second increment of energy equation given above:

$$dE = \frac{mv_{c1} v_p dv_p}{\left(v_{c1}^2 - v_p^2\right)^{\frac{1}{2}}}$$

Simplifying:

$$dE = \frac{mv_p dv_p}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

Finally, dividing by the differential of particle velocity gives the momentum:

$$\frac{dE}{dv_p} = \frac{mv_p}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}} = P$$

Newton's original formula for force is the derivative of momentum with respect to time:

$$f = \frac{dP}{dt}$$

Then for this example:

$$f = \frac{d}{dt}\frac{mv_p}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

At this point of this theory, the value of mass is treated as the constant rest mass, therefore the m can be moved out of the differential expression:

$$f = m\frac{d}{dt}\frac{v_p}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

The normal use of this formula in a standard derivation of energy will give the equation for particle kinetic energy previously derived in this new theory. That equation is:

$$E_K = \frac{mv_{c1}^2}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}} - mv_{c1}^2$$

This result is analogous to Einstein's energy equation. However, it will predict more. For example, there is a connection between this energy equation and our concepts of frequency and wavelength.

There is also an observation that can be made with respect to how a photon's energy will change as it descends through the earth's light-field. The velocity of light is decreasing therefore; the length of the photon is becoming shorter. However, the perpendicular component of photon tilt, which is the origin of electromagnetism, has not been shown to also shrink.

This is a situation analogous to increasing the tilt of the photon. An increased tilt is representative of an increase in electromagnetic energy. This is a reason why a photon, which is slowing down as it approaches the earth, would actually increase its electromagnetic energy. I will more fully develop this new electromagnetic theory in later sections.

Particle Energy and Frequency

The concept of wavelength is accepted by quantum physics as a fundamental property of photons and matter. This new theory will present a different perspective on this concept. However, I will begin with the normal concept of wavelength for the purpose of using familiar theory to help introduce this analysis.

I earlier derived an equation defining the energy of a particle. I did not take the concepts of frequency or wavelength into consideration during its derivation, and yet it will inherently suggest a physical origin from which these proposed properties could be derived. In order to be able to conveniently relate this analysis to later work, I will not work directly with wavelength, but, instead, will first derive an interpretation of its counterpart, frequency.

The form of my energy equation is chosen to show its analogy to Einstein's energy equation; however, it has another useful form. I proceed through the following mathematical manipulative steps for the purpose of presenting my energy equation in a form where the origin of our concept of frequency can be seen.

I multiply the first term on the right side by an expression equaling unity:

$$E_K = \frac{v_{c1}}{v_{c1}} \frac{mv_{c1}^2}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}} - mv_{c1}^2$$

Performing the multiplication:

$$E_K = \frac{mv_{c1}^3}{\left(v_{c1}^2 - v_p^2\right)^{\frac{1}{2}}} - mv_{c1}^2$$

Since:

$$v_{c2} = \left(v_{c1}^2 - v_p^2\right)^{\frac{1}{2}}$$

I substitute this expression and have:

$$E_K = m\frac{v_{c1}^3}{v_{c2}} - mv_{c1}^2$$

Now rearranging terms:

$$E_K = mv_{c1}^2 \left(\frac{v_{c1} - v_{c2}}{v_{c2}} \right)$$

The form of the energy equation given above contains an expression within the parenthesis representing the physical origin of our concept of frequency. It says: Kinetic energy is equal to rest energy multiplied by this expression that I suggest is directly related to frequency. I will develop this relationship more fully.

The known empirical relationship between kinetic energy and frequency is given by:

$$E_K = h\omega$$

Where ω represents frequency, and h is Planck's constant. Setting the right sides of these two kinetic energy equations equal to each other produces:

$$h\omega = mv_{c1}^2 \left(\frac{v_{c1} - v_{c2}}{v_{c2}} \right)$$

Then, solving for a value I call kinetic energy frequency:

$$\omega_K = \frac{mv_{c1}^2}{h} \left(\frac{v_{c1} - v_{c2}}{v_{c2}} \right)$$

The term inside the parenthesis is without units. The terms outside the parenthesis are all constants, and their combined units are inverse seconds; therefore, I will represent them by:

$$\omega_0 = \frac{mv_{c1}^2}{h}$$

I will refer to this as the rest frequency of a particle. Substituting this into the kinetic frequency equation:

$$\omega_K = \omega_0 \left(\frac{v_{c1} - v_{c2}}{v_{c2}} \right)$$

Now for kinetic energy I can write either:

$$E_K = h\omega_0 \left(\frac{v_{c1} - v_{c2}}{v_{c2}} \right)$$

Or:

$$E_K = h\omega_K$$

It follows that I can write for total energy:

$$E_T = h\omega_0 \frac{v_{c1}}{v_{c2}}$$

And for rest energy:

$$E_R = h\omega_0$$

When I introduce quantum effects, I will present a new perspective on the quantum wave-particle duality of matter. New concepts will be developed in this theory for frequency and wavelength, but their introduction is more easily accomplished when speaking of photons. This introduction will require the use of a physical model of a photon to be used as a guide.

I will next develop a theoretical model to represent photons. The photon model must be able to account for wave and particle aspects of photons. In order to develop this model I will first introduce mathematical expressions for the energy and momentum of photons.

Photon Energy

The evidence shows that when a photon leaves a particle undergoing a change of velocity, the photon carries away an increment of energy. The increment of energy originates from the particle. The characteristics of this increment of energy, all other things being constant, must have been brought into existence from the properties of the emitting particle. The properties of the photon only fix its time of duration and cause after-effects on its magnitude.

During the first stages of this derivation, I will use the term mass in connection with photons. I expect most people who trust in current theoretical physics will frown upon this practice. However, it is current theoretical physics that is challenged as being wrong. The reason I speak of mass in connection with photons is because I am trying to develop new theory that maintains a direct line with the fundamentals. The equations of relativity theory were derived from a base which is heavily dependent upon $f = ma$.

The mass term must be properly interpreted every step along the way in order to properly move forward. It cannot be arbitrarily dismissed at a certain level simply because we cannot see how it may fit with photon theory. If it is to be discarded then the reason for that action must come from the bottom up and not the top down.

In other words, the fundamentals should lead naturally to the disappearance of the mass term for photons. If this does not occur naturally in the derivation of the theory of photons then it demonstrates a reason for re-evaluating our current understanding of mass. This kind of fundamental re-evaluation does occur in this new theory.

Einstein's work in analyzing photon energy and deriving a photon interpretation of momentum does not embrace this position. I will proceed to show why this is the case. The formula derived by Einstein to describe the kinetic energy of matter is:

$$E_K = \frac{m_0 C^2}{\left(1 - \frac{v^2}{C^2}\right)^{\frac{1}{2}}} - m_0 C^2$$

Even though the formula was derived as an expression of kinetic energy, it revealed a new term describing the total energy of the particle.

The kinetic energy is expressed as the difference between the first expression representing the total energy and a second expression representing the particle's rest energy. It is the concept of total energy which leads to the idea that this equation could be used to apply to everything which has energy. Einstein then applied it to photons.

However, the energy formula given above was derived specifically to define the kinetic energy of a particle in motion. A photon carries away only an increment of this energy. This suggests that the energy of a photon should be defined using the incremental form of the kinetic energy equation of the particle. It is convenient here to use the differential form to represent the incremental.

Einstein erroneously used the particle kinetic energy equation directly to describe the energy of a photon. In spite of this he achieved useful results. I will demonstrate why this is so. I first offer a line of reasoning useful for presenting Einstein's conclusions regarding photon energy and momentum. Then I will offer an alternate approach. I will conclude with results from this new theory that give a new mathematical description of photon energy and momentum.

In analyzing the possibility of applying Einstein's energy equation directly to photon energy, a problem immediately arises. It is easily reasoned: Since photons travel at the speed of light, then his energy equation, shown above, cannot directly give a useful answer. For example, if v is set equal to C then the denominator of the first term becomes zero and the kinetic energy becomes infinite. This answer is known to be incorrect. Empirical evidence shows photons to have well defined kinetic energy of varying amounts.

A possible way out of this dilemma is to reason: Since photons are never at rest, then they have no rest mass. If this is accepted then the equation reduces to:

$$E_{Kc} = \frac{(0)C^2}{\left(1 - \frac{C^2}{C^2}\right)^{\frac{1}{2}}} - (0)C^2 = \frac{0}{0}$$

The energy equation becomes indeterminate. Mathematically there is no way to say a solution does or does not exist.

It is known empirically that each photon does have a specific kinetic energy. Einstein chose to solve this problem by defining the mass term for a photon in a manner mathematically different from that used for the mass of a particle. He determined it was only necessary to define an interim relativity mass of a photon by the expression:

$$m = \frac{E_{Kc}}{C^2}$$

This is a reduced form of the kinetic energy equation. He set the rest energy expression equal to zero, but not the rest mass. He absorbed the rest mass of the total energy expression into the new letter m. This m is replacing:

$$m = \frac{m_0}{\left(1 - \frac{v^2}{C^2}\right)^{\frac{1}{2}}}$$

The new expression absorbs the rest mass while, at the same time, denying its existence. It absorbs the term for velocity that was derived as a velocity of a body of matter, while denying matter is even involved. In other words, this step is not derived. It is assumed. It is a reasoned, subjective decision to apply the energy equation in the most general theoretical way possible.

There is no denying that the results of this decision have been extremely useful, but the irony is that, theoretically, this maneuver has accomplished nothing. To show this, I use Einstein's kinetic energy equation for photons:

$$E_{Kc} = mC^2$$

I set the right side of this equation equal to the right side of his kinetic energy equation for particles. I can do this because this represents what Einstein was actually doing:

$$mC^2 = \frac{m_0 C^2}{\left(1 - \frac{v^2}{C^2}\right)^{\frac{1}{2}}} - m_0 C^2$$

Simplifying to:

$$m = \frac{m_0}{\left(1 - \frac{v^2}{C^2}\right)^{\frac{1}{2}}} - m_0$$

This shows what Einstein was really defining as the relativity mass of a photon. Logically, if the right side of this equation is not interpretable, then the left side is also not interpretable. The problem hasn't gone away, and it must be resolved in order to understand the nature of photons.

With regard to the success of Einstein's predictions, it will be shown that no practical harm was done so long as the equation was used to make energy calculations. However, this dilemma of the mass term for photons does do harm to predictions when it is used to calculate photon momentum. This new theory can give an explanation for what was done incorrectly, and will offer new solutions for both photon energy and momentum.

The explanation begins by recognizing that Einstein made a fundamental error when defining the mass term for photons. The error occurred when he used his kinetic energy equation for a particle to describe the kinetic energy of a photon. The specific mistake was: He assumed the velocity v in his kinetic energy equation applied to photons in the same manner as it applied to matter. It is true photons must travel at the speed of light simply because they are light. This does not justify the conclusion that their kinetic energies are related to their own velocity.

It is known empirically that the energy of a photon is determined by the acceleration of the particle emitting it. Logically then, the properties of the particle define the energy of the emitted photon. The value of velocity to be used to determine the kinetic energy carried by a photon must relate to the change of velocity of the emitting particle. In other words, the energy of the photon should be defined by using an increment of change of velocity of the particle.

The photon can be considered as containing a stored increment of velocity. This incremental value can be solved for later when the incremental length of time of release of a photon has been determined. For now, I begin by defining the kinetic energy of a photon as:

$$E_{Kc} = \Delta E_{Kp}$$

This equation says: The kinetic energy of a photon equals some incremental change of the kinetic energy of a particle. I need to derive an expression for this increment of particle kinetic energy. I have already determined for a particle:

$$E_{Kp} = mv_{c1}^2 \left(\frac{v_{c1} - v_{c2}}{v_{c2}} \right)$$

I allow the kinetic energy of the particle to increase by an incremental amount and write:

$$E_{Kp} + \Delta E_{Kp} = mv_{c1}^2 \left[\frac{v_{c1} - (v_{c2} + \Delta v_{c2})}{v_{c2} + \Delta v_{c2}} \right]$$

Since:

$$\Delta E_{Kp} = \left(E_{Kp} + \Delta E_{Kp}\right) - E_{Kp}$$

I can write:

$$\Delta E_{Kp} = m v_{c1}^2 \left[\frac{v_{c1} - (v_{c2} + \Delta v_{c2})}{(v_{c2} + \Delta v_{c2})} - \frac{v_{c1} - v_{c2}}{v_{c2}}\right]$$

Simplifying:

$$\Delta E_{Kp} = m v_{c1}^2 \left[\frac{-v_{c1} \Delta v_{c2}}{v_{c2}(v_{c2} + \Delta v_{c2})}\right]$$

Yielding:

$$\Delta E_{Kp} = -m \frac{v_{c1}^3}{v_{c2}} \left(\frac{\Delta v_{c2}}{v_{c2} + \Delta v_{c2}}\right)$$

This equation gives the energy of a photon as a function of the changing local speed of light. The change in the local light speed is dependent upon both the relative speed of the particle and the incremental change of its speed.

The equation can be further simplified for most cases. Specifically, when:

$$\Delta v_{c2} \ll v_{c2}$$

Then the equation can be approximated by:

$$\Delta E_{Kp} = -m v_{c1}^3 \frac{\Delta v_{c2}}{v_{c2}^2}$$

And, if also:

$$v_{c2} \cong v_{c1}$$

Then it can be further simplified to:

$$\Delta E_{Kp} \cong -m v_{c1} \Delta v_{c2}$$

What this result reveals is that, for most cases, the approximate form of the energy equation for a photon is analogous to the approximate form of the energy equation for a particle. There is, however, a very significant difference. The form for the particle uses a change in light speed that represents the full difference from the background light speed

v_{c1}. The form for the photon uses a change in light speed that represents only the incremental change in the local light speed due to the change in the speed of the emitting particle during the fundamental increment of time.

The mass m given in the kinetic energy equation for the particle or for the photon emitted by the particle is always the mass of the particle. In other words, the photon does carry a value of mass with it, but that value is imparted by the particle that emitted it. The approximate formula given above for the kinetic energy of a photon is the form that should be used for photons in place of Einstein's energy equation.

As mentioned earlier, it happens that the use of Einstein's equation does not harm calculations involving energy; however, it leads to a clear error when he defines photon momentum. I will show that this new equation, derived, above leads to the resolution of the problem encountered when calculating photon momentum.

Compton Effect

Particles and their effects are not interactions at a point only. They are theoretically infinite. Particles of matter are members of a continuum. Their centers are peaks in the continuum of the universe. What this means for the interaction of photons and particles is that it also is continuous. Photons do not wait until they reach the point source of a particle before delivering their energy. There is nothing new at the center of the particle than there is anywhere along the path of approach to the particle's center. The differences are of degree and not of kind.

It is accepted that photons give energy to particles and particles give energy to photons. Since particles are a continuum of an effect upon the speed of light, the light will react to the whole continuum of the particle. The result of this interaction is: The photon is always giving energy to the particle and the particle is always giving energy to the photon.

The degree of this interaction is a function of relative position. For a photon following a path that misses the point source of the particle, only a partial transference of energy will occur. The Compton Effect is the measure of the partial interaction between photons and particles.

The most important implication of this effect is: It is empirical evidence that photons and particles are interacting with each other at every point in the particle's light-field. In other words, the process of exchange of energy is not discrete. I will shortly address the analysis of the Compton Effect.

Photon Momentum

It is known that photons have energy. If Einstein's kinetic energy equation is to be used to apply to photons then the mass term must be not be glossed over or ignored. Its use suggests they have a property that is connected through the fundamentals in some way to mass. If they have such a property, then they can be defined, using the fundamentals, as having momentum. In general, momentum is defined by:

$$P = mv$$

Einstein formed his photon momentum equation in this manner. He used the speed of light as the magnitude of the velocity to be substituted into the above equation:

$$P_c = mC$$

The m used was his relativity or variable mass term derived in his energy expression:

$$m = \frac{E_{Kc}}{C^2}$$

Substituting the mass equation into the momentum equation:

$$P_c = \frac{E_{Kc}}{C}$$

This definition of photon momentum predicts excessive momentum for a photon over that which a particle with equivalent kinetic energy would have. For example, in a collision involving a photon and particle, momentum is not conserved according to Einstein. Another classic case in point occurs with the apparent conversion of photons into matter, where momentum is again predicted to not be conserved. Even though the total photon energy equals the total particle energy, the total photon momentum exceeds the total particle momentum.

For this reason, Einstein's equation is interpreted to predict that for photon energy to be converted to matter, the collision must occur near an already existing body of matter. The body normally used is a heavy atomic nucleus. This additional body of matter is included for the purpose of carrying away the excess momentum from the photons. I will later offer an explanation for the evidence of the creation of matter. Having foreknowledge of this information, I continue with a new definition of photon momentum.

The prediction of excessive photon momentum does not occur in this new theory. From the perspective of this theory, a photon's momentum consists of an increment of momentum given to it by a charged particle that is accelerated an incremental amount. I will now derive photon momentum using concepts from this new theory. I have given the definition of momentum, in general, as:

$$P = \frac{dE_K}{dv_p}$$

I have used this formula to derive the momentum of an accelerating particle. The specific example used was of an accelerating particle emitting a photon in a perpendicular direction. The momentum of the particle was derived as:

$$P = \frac{dE_K}{dv_p} = \frac{mv_p}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

The released photon carries away an increment of energy and an increment of momentum. The actual size of the increment of momentum can be calculated only after I have defined the length of time of emission for the photon. This will be done during an analysis of the electromagnetic properties of the hydrogen atom. At this time the increment of momentum will be represented by:

$$\Delta P = m\,\Delta \frac{v_p}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

I treat the mass m as a constant, because in this theory, so far, it has represented only the rest mass of the particle. I simplify the appearance of the formula by defining:

$$\Delta v_L = \Delta \frac{v_p}{\left(1 - \frac{v_p^2}{v_{c1}^2}\right)^{\frac{1}{2}}}$$

Where, the subscript L denotes that the velocity is measured from the perspective of a local observer traveling with the particle. Now I can, more simply, represent the increment of momentum as:

$$\Delta P = m\Delta v_L$$

The concept of momentum is integral to the derivation of the atomic electron quantum energy levels. For this reason, I will wait until the section on quantum effects to carry out further analysis of momentum.

The incremental quantities involved in this description of the characteristics of a photon are normally very small. They have magnitudes such that they could be calculated to a very good approximation from the differential forms of equations. The fundamental increment of time and photon length can be used in conjunction with the differential rates of change to calculate the incremental values.

Taking advantage of this, I represent the increment of momentum as a differential value:

$$dP = mdv_L$$

Most theory in physics makes use of differential calculus because, in general, force is treated as if it is not quantized.

In this new theory, force is quantized; however, it is still convenient at times to approximate the application of force as a continuum. My use of this method is temporary; I will develop the quantization of force during my analysis of the electromagnetic properties of the hydrogen atom.

I have argued that Einstein's definition of photon momentum is incorrect. The analysis of the Compton Effect uses Einstein's treatment of photon momentum, and the results of this treatment are in agreement with empirical evidence. Why does this analysis appear to work?

The answer is that the analysis does not truly rely upon Einstein's theory of photon momentum. Even though it uses momentum to help define the problem, it reverts to the use of photon energy for the conclusion of the analysis. Calculations involving Einstein's definition of photon energy do not cause quantitative problems. The calculations involving photon momentum are incorrect, and if the analysis were completed using only photon momentum then the result would not be supported empirically.

Einstein's photon momentum is too large. The interaction of a photon and particle cannot conserve Einstein's momentum. The analysis of the Compton Effect works because energy is conserved. The energy values are quantitatively correct so the photon wavelength calculations flowing from them are quantitatively correct.

In order to give support to this claim, I will put my definitions of photon energy and momentum to work. These quantities are crucial to the development of a general theory of physics. If they are wrong then the theory will go astray. I will show that the definitions given here will outperform those of Einstein, and will help lead to a more successful general theory.

Now I have sufficient mathematical models for both photon energy and photon momentum. I will proceed to derive a new electromagnetic theory using the photon model of this new theory. Photon energy and momentum will play an important role in deriving formulas analogous to those of current electromagnetic field theory.

ELECTRIC EFFECTS AND THE HYDROGEN ATOM

The hydrogen atom has a nucleus of a single proton with a single electron orbiting the proton. Both of these are charged particles. They interact with each other, for any measurable amount, only through electromagnetic means. This interaction is the simplest natural environment in which to analyze the cause of electromagnetic effects.

I am not saying the action of a hydrogen atom is simple. I am saying I will examine electromagnetism from a simple atomic perspective. The origins of electromagnetism must be expected to be a part of the properties of each photon. I will use a simple model of the hydrogen atom for the purpose of theoretically isolating the properties of a single photon.

What I rely upon, for my fundamental unit of time, is the time of passage of a photon to pass a given point. In this theory, that time is a fundamental constant. I don't have a constant fundamental unit of distance. I use the length of a photon that is a varying unit of length. When I look for another natural unit of length there is the radius of the atom to consider. When this radius changes, due to an electron moving between energy levels, a single photon is involved. This length of radius and its variations are not accidental. There must be a clear physical cause for their size.

The length of a photon is directly related to the speed of light. The measurement of the speed of light is ultimately dependent upon the length of a photon. Therefore, the locally measured speed of light is a fundamental constant. The fundamental unit of time is everywhere a constant. Even the photon length has to be accepted as the local fundamental constant unit of length.

Atomic Radius

For this section the speed of light and the length of a photon are treated as constants. This has the effect of averaging their values and permitting the equations to give some numerical results in agreement with empirical measurements made from our macroscopic perspective.

The electric force due to the proton nucleus acts upon the orbiting electron, and the electron exerts an equal but opposite electrical force upon the proton. This force is predicted by the formula:

$$f_{\xi} = \frac{q_e q_p}{4\pi\varepsilon r^2}$$

The values of electric charge for the electron and proton are represented in the numerator on the right side. Both of these values are the same measure of the fundamental unit of electric charge.

The fundamental unit of electric charge is an empirically determined constant of electromagnetic theory. The value of electric charge is commonly given the units of coulombs. As I have stated earlier, anything defined in units higher than distance and time is evidence we may not have correctly determined its origin. We really have only distance and time to work with when measuring any physical event. Therefore, all empirical evidence is some measure of distance or time or both of these.

The measure of force described by the above equation is commonly given the units of newtons. Here again, there is a need to look to the demonstrable properties of photons for a physical interpretation of what is force. There is in the denominator on the right side a quantity ε called electrical permittivity. This is an empirically determined quantity having no clear explanation as to its physical origin.

There is only one term in the equation that is a measure of something physically observed. This is the letter r for the radius of the atom. Everything else in the equation needs yet to be explained by physics. However, the magnitudes of everything in the equation have been empirically determined, and I will use them to begin my analysis.

Substituting the appropriate known values, actually their absolute values, into the above force equation:

$$f_\xi = \frac{(1.602x10^{-19}\ Coulombs)^2}{4\pi\left(8.85x10^{-12}\ \frac{coulombs^2}{newton \cdot meter}\right)(5.28x10^{-11}\ meters)}$$

I am purposefully avoiding polarities for electric charge. The cause of polarities needs yet to be identified. It is accepted that the electron and proton attract each other by a force of magnitude:

$$f_\xi = 8.28x10^{-8}\ newtons$$

I wish to describe a photon coming from the proton and acting upon the electron. To attempt this, I will use the formula:

$$f_\xi = \frac{\Delta E}{\Delta x}$$

The numerator is all of, or some division of, the potential energy between the proton and the electron. The size of the increment of energy depends upon what increment of distance is used in the denominator. I will shortly decide this.

The potential energy of the electron is known to be twice the electron's kinetic energy. The kinetic energy of the electron is:

$$E_{Ke} = 13.58\ electron\ volts$$

Doubling this gives:

$$E_{pe} = 27.16\ ev = 4.35x10^{-18}\ joules$$