the general science journal

A Theoretical Analysis of Sub-Atomic Particle Interactions

"Fundamental Problems of Natural Sciences and Engineering"

Presented At: St. Petersburg State University, St. Petersburg, Russia

Abstract:

The logical contradictions evident in the kinematics of Special Relativity have been independently identified by a number of individuals since the original publication of the paper. Despite this, the theory remains operative through a perceived correspondence with experiments that pre-date, or were subsequent to its publication. However, a rigorous analysis of the experiments leads to a new theory based on classical electrodynamic principles independent of the precepts of SRT.

Introduction:

A. Einstein's special relativity theory incorporated the contraction of space and the dilation of time as basic arguments towards maintaining universal constancy for the speed of light. Consideration of the classical conservation laws led to equivalent modifications in the concept of mass. Experimental corroboration; notably that of Kaufmann, 1901, Bucherer in 1908 [1] and Compton in 1923 [2] lent credence to the theory despite opposition and criticism from the outset. [3]

An independent analysis of relativistic kinematics was made in a previous paper [4] where it was proven that arguments supporting contraction and dilation of space and time were tautological. The analysis will not be repeated here, other than to demonstrate that presumed modifications between equivalent frames of reference must be reciprocal and therefore undetectable in strict accordance with the first postulate.

A comparison is made of equal measured lengths, (x and x'), in two frames of reference, (S and S') in uniform relative motion. The length x' as "viewed" by an observer in S would be contracted by the factor, $\beta = (1 - v^2/c^2)^{1/2}$ as required by special relativity. Conversely, x would be contracted by the same factor to an observer in S'. We then have the relationship:

$x' = x\beta$ and $x = x'\beta$

$x'/x = x/x' \therefore x' = x$ (1)

Note that no limitation is placed on the underlying metric by this assessment other than it must be universally applied. Since the same arguments hold true for both time and mass, any deviations in their magnitudes must also be universal.

We must also conclude from the common metric and the reciprocal aspects of the kinematics of relativity theory that clocks separated by a distance can be synchronized either by mechanical means, or if we affirm the constancy of the speed of light, [5] by the transmission of light signals. Furthermore, if the clocks are related by a consistent formula, then synchronism may be achieved regardless of the underlying space-time geometry.

Lorentz Transformation Equations

We may presume the above arguments were considered by many, and presume further that they were disregarded because of the perceived agreement of relativity theory with experiment. Also, it was known that Maxwell's equations

for the propagation of electromagnetic waves were not invariant under a Galilean transformation, but remained so under a Lorentz transformation. [6]

There is no doubt that this invariance was viewed an impressive contribution towards confirmation of the theory in general. However, it cannot be attributed to relativistic space-time modifications for the above reasons. Furthermore, an asymmetry between the two reference frames is indicated. A comparison between Galilean and Lorentz transformations reveals the only fundamental difference to be the constancy of the speed of light. By eliminating β since it is common to both frames of reference, the transformation equations reduce to:

$x = x' + vt'$ $\quad x' = x - vt$

$t = t' + vx'/c^2$ $\quad t' = t - vx/c^2$ (2)

Since $x = ct$, and $x' = ct'$, the equations for time become:

$t = t'(1 + v/c)$ $\quad t' = t(1 - v/c)$ (3)

The ratios of (3) indicate that compound times have been substituted for compound velocities. This cannot be justified by the dilation of time or asynchronous clocks. By inverting the equations in (3), the Lorentz time transformations become light frequencies and the space transformations of (2) become wavelengths.

$f' = f/(1 \text{ [+ or -] } v/c)$

$\lambda' = \lambda (1 \text{ [+ or -] } v/c)$ (4)

The equations apply equally to motion of source or observer in accordance with the second postulate. If relativistic modifications of wavelength and frequency are indeed an experimental fact, they must necessarily be attributed to the cause of emission or contained in the nature of light itself.

The Compton Effect

The Compton effect was widely hailed as corroborative evidence for special relativity. Yet the basic underlying assumption in relativity is that motion alone is the cause of the incremental space, time, and mass modifications. In the collision process, electromagnetic radiation is the cause of propulsion and the effect is a transfer of energy and momentum to the electron in agreement with the progression of events and the conservation laws of classical mechanics. If the mass of the electron is in fact increased, the result is a compensating decrease in velocity as effect rather than cause. No additional contribution is required.

The scattered radiation of a wave-particle interaction was considered by Compton to be the quantum result of an elastic collision between an electron and a photon. The wavelength of the scattered radiation is found experimentally to be:

$\lambda' = \lambda + h(1 - \cos\phi)/m_e c$ (5)

Where h = Planck's constant and m_e is the rest mass of the electron.

The energy, E' of the scattered radiation may be derived from the Compton relationship:

$1/E' = 1/hf + (1-\cos\phi)/m_e c^2$ (6)

Where f is the initial frequency of the wave. The energy value of the scattered radiation may be used in the relativistic energy equation along with the initial energy value E, of the photon:

$E + m_e c^2 = E' + m_{ef} c^2$ (7)

Since the total relativistic energy, ($m_{ef}c^2$) equals the sum of the kinetic energy (K) and rest energy of the electron,

$$m_{ef}c^2 = m_e c^2 + K \qquad (8)$$

Substituting the right term of equation (8) in equation (7) provides:

$$E - E' = K \qquad (9)$$

Which simply states that the photon energy loss equals the kinetic energy of the electron as expected in an elastic collision.

$$m_{ef}\, c^2 = m_e c^2 + \tfrac{1}{2}\, m_{ef} v_k^{\,2} \qquad (10)$$

By re-arranging terms and dividing by the total energy we find the ratio of the rest and "kinetic" masses to be:

$$m_e /m_{ef} = 1 - v_k^{\,2}/2c^2 \qquad (11)$$

This is neither the mass ratio, nor the magnitude of the velocity required by relativity, although it is derived naturally from equations, (7) through (9). By substituting the mass and the energy of the scattered radiation in the momentum equation (180 degrees), we have:

$$E/c + 0 = -E'/c + m_{ef} v_m \qquad (12)$$

Although it might be expected that kinetic energy would not be conserved in the collision, it is surprising that the mass ratio of (11) is a squared term equal to β . Also, the ratio tends to a mass limit of 2 as v_k approaches c, or the kinetic energy equals the rest mass energy. In support of the denominators of the latter terms of the equations, (10) and (11) we note that as non-relativistic velocities are approached, the ratio v_k/v_m tends toward zero.

Since experiments in particle acceleration indicate that mass increases are virtually unlimited, it must be assumed that the ratio pertains to a structural configuration that becomes manifest with the application of an external force. However it is not certain whether it applies to the electron or the distribution of electrical and magnetic effects.

As it has been known from the earliest experiments in electromagnetism that charges have inertial properties [7], it appears no further explanation is required for the presumed mass increases of relativity. This may be supported by numerous arguments; the most obvious being that magnetic effects are ignored in the collision, they vary directly with velocity and that energy is necessary in their creation. Further evidence of an electromagnetic explanation may be provided by comparing β and equation (11).

$$m_e^{\,2}/m_{ef}^{\,2} = (1 - v_k^{\,2}/2c^2)^2 = 1 - v_m^{\,2}/c^2$$

$$\therefore\ v_m^{\,2}/c^2 = v_k^{\,2}/c^2 - v_k^{\,4}/4c^4 \qquad (13)$$

The third term of equation (13) has the squared magnitude of an induced field. It may also be related to emitted radiation as required by classical electromagnetic theory. However, we must assume the latter does not apply since there was no evidence of it in the Compton experiments. Also, the inertial effects are retained and energy conservation can be satisfied totally within the interaction.

A New Theory of Dynamics

Regardless of whether the Compton effect is viewed as a collision between particles or a field coupling, it is amply evident that the total particle-wave aspect of the electron is involved and that total energy is conserved. As indicated, the increase in "mass" may apply either to the electron or the electromagnetic field. The probable answer would be that the symmetry evident between electrical and magnetic properties also exists in a dual form of matter and is a property of electromagnetic radiation as well. This is obviously confirmed by pair production, and the generation of electromagnetic fields and particles.

In relativistic dynamics we have an invariant value in the rest energy of the electron and a variable in both the kinetic and total energies. Alternately, there is an invariant in the charge on the electron, and variables in magnetic and total energy properties. Both instances have a parallel in classical mechanics in the law of conservation of energy:

$$-U + K = I \qquad (14)$$

Here (-U) is the potential energy, (K) is kinetic and (I) the invariant. It is obvious that the dynamic equations of relativity are a re-statement of the energy conservation law.

Since Bohr's theory of atomic structure allows the orbits to be treated mechanically or as the result of a coulomb attraction, there must be a proportional factor between electromagnetic and mechanical effects. The momentum of electromagnetic radiation is E/c. Therefore, there is an inertial effect associated with radiation in the magnitude (E/c^2). Conversely, the energy equivalent for mass is $E = mc^2$. It is obvious that the proportionality constant is the speed of light and that one is the inverse of the other! Furthermore, it must apply to the charge on the electron.

We will represent the potential energy by P, the electrostatic mass by M_e, the mechanical rest mass by M_m, and add a subscript (f) for final masses. The ratio becomes:

$$M_e /(1 - v_k^2/2c^2) = M_e c^2 = P - M_{ef} v_k^2/2$$

$$M_m(1 - v_k^2/2c^2) = M_m c^2 = P + M_m v_k^2/2 \qquad (15)$$

As the internal speed increases through the application of an external force, there is an increase in the internal electromagnetic potential and an increase in inertial effects represented by the magnetic component. (Note that the potential may be represented as a negative or positive by changing the order of equation (11)). At the same time, the mechanical potential is reduced and kinetic energy is increased. At an internal speed of (c) the electric and magnetic energies are equal but a residual mass ($1/2M_m$) remains.

By reversal, a formula for the increase in inertia or the creation of mass is achieved, thereby providing a complete symmetry between the creation and dissolution of matter.

$$M_m /(1 - v_k^2/2c^2) = M_m c^2 = P - M_{mf} v_k^2/2$$

$$M_e(1 - v_k^2/2c^2) = M_e c^2 = P + M_e v_k^2/2 \qquad (16)$$

Note that the mechanical direction in equation (15) is from an inertial state to kinetic. In (16), the direction is from a kinetic state to inertial. At the energy of pair creation, the speed is absorbed and the charge is retained. A partial increase in inertia may be effected by any interaction with fields or matter as in the bending of light. The result is a combined and completely antithetical arrangement comprising a single entity. There is no change in the magnitude of the combined energy, only in its distribution.

Internal energy provides a theoretical basis for electron spin and eliminates the possibility of infinite mass, which was the principle concern with the interpretation of the Stern-Gerlach experiment.

The radial and spherical character of light demands an equivalent configuration for matter. The picture would be of an extremely dense magnetic core with the binding energy of $M_e c^2$. This is concluded through symmetry although the core aspect is a noted characteristic of the atomic nucleus.

With the addition of the core, the antithetical arrangement is complete. Where electromagnetic radiation has a constant speed and a variable inertial component, matter is constant and the speed varies. At an extreme, light is converted to matter whereas matter converts to electromagnetic energy at the opposite extreme. The magnetic core is localized and the electrical is contained. In radiation, electromagnetism is dispersed in a radial and spherical manner.

It should be noted that if the magnetic core has spin, it is not the measured spin of the electron. This would suggest that by merely inverting an electron it becomes a positron, which is assuredly not the case. This suggests a more complicated internal/external structure, which will not be explored within the context of this paper.

Although the theory combines electromagnetism and classical mechanics there is no expression provided that represents the total. This may be found in A. Einstein's momentum and energy relationship, which is presented in its original form:

$$(K + m_o c^2)^2 = (pc)^2 + (m_o c^2)^2 \qquad (17)$$

[Note: The internal and external mechanics involve vector relationships probably at two levels. For example, the basic interaction includes expressions for internal energy - $m_{ef} v_m c \cos \phi / m_{ef} v_k^2/2 = 1/m_p c^2 + 1/m_e c^2$ where the latter terms are the inverse of the initial energy of the photon and rest energy of the electron respectively. Also, spin couplings are not clear. The internal energy suggests spin and a v_k velocity yet the magnetic moment appears to incorporate the linear momentum velocity, v_m]

The equation must be given much broader significance than a mere comparison since it contains the vector relationships that are required for the internal energy transfers. The fact that β is a geometric mean and the internal/external energies equate at the 4^{th} level unequivocally establishes the fundamental structure as four-dimensional.

Pair production and symmetry considerations point to the existence of an equivalent amount of matter and anti-matter in the universe. The antithetical character of charge and matter and the inverse relationship with the proportionality constant of [c^2] inevitably identifies the field and particle as the anti-matter and matter pair. This theory provides a major simplification in the unification of electrodynamics and mechanics. If not patently obvious, it must at least be considered far more probable than the quantization of the "vacuum" and negative energy states of P.A. M. Dirac and the time-reversability theory of R. P. Feynman.

The Nature of Light

Excitation of an electron creates instantaneous and proportional fluctuations in electrical and magnetic amplitudes. Since all aspects are dimensionally equivalent, propagation cannot be attributed to an electromagnetic ratio at the source or at any point along the line of propagation. The virtual particle aspect of the photon immediately suggests a contribution from the particle's inertial characteristics. A ballistic explanation for convection is suggested and with it, an associated space and time continuum (wavelength and frequency).

As indicated above, the complexity of light is equal to that of the structure of the electron. Regardless of the whether generation is viewed as a statistical summation of collisions or the result of harmonic oscillations, it is evident that both magnetic poles are accelerated and decelerated. This suggests a coupling of spin, anti-spin pairs that would emulate the sinusoidal fluctuations of a wave train and account for the spin of one.

We see that the energy of a photon is directly proportional to its frequency from the relationship $E = hf$. The variable aspect of the energy density immediately suggests an explanation for the constancy of its speed. As the frequency is reduced or increased, the particle or wave aspects become less localized or more so with respect to a uniformly moving observer and the inertial effects will vary accordingly. The mass characteristics are only evident with impact (braking), which contradicts the prevalent view. Indeed, if a photon in flight has mass, its speed must necessarily be less than [c] in accordance with relativistic doctrine.

The variable aspect of inertial effects also resolves the necessity for multiple waves since the single wave exhibits different inertial characteristics for observers in relative motion. In an accelerated frame of reference such as a rotation, light traveling in the direction of spin would exhibit less inertia than in the opposite direction. This would result in the compound velocities characterized by the de Broglie matter wave, orbitals, and the Sagnac effect.

Generalization of the Compton Effect

The Compton equations involve interactions between particles and electromagnetic waves and as such must either implicitly or explicitly encompass Rayleigh scattering, photoelectric effect, pair production and coulomb interactions.

If we gradually reduce the energy of the photon, or increase the mass of the target as in a tightly bound atomic configuration, the calculations indicate that the result of the collision approaches a Rayleigh scattering. Also the ratio

v_k/v_c becomes progressively smaller until classical limit of virtual equality is reached.

The photoelectric effect is equivalent to the Compton effect as applied to electrons in a bound state when the work function is incorporated. The scattered radiation must be present unless the wavelength is equal to or a multiple of the de Broglie wave and contributes to the excitation of an electron from one orbit to another.

Arbitrarily increasing the energy of the photon in a Compton formulation indicates that an energy balance cannot be achieved for a free electron or proton. This has been amply proven in particle accelerator experiments and can be considered one of the reasons for their stability. In pair production, charge dependency is indicated for the separation to take effect. Otherwise a Rayleigh scattering would result.

Replacing the collision process with the Coulomb attraction between particles provides an important analogy that will not be pursued in this paper. At this point, we will only observe that a sufficiently energetic electron will exhibit the potential energy-mass of a muon at an approximate radius of 2.8 fermi from a proton. At the classical electron radius, the speed is that of light and the transformation is from mass to an electromagnetic wave.

Summary

The above theory, although for the most part qualitative, is entirely consistent with the known data and should provide a strong theoretical framework for future development in physics. Of significance is the combining of mechanics and electrodynamics into one comprehensive theory. It also explains the equivalence of inertial and kinetic masses regardless of the direction or mode of propulsion. The transformation of mechanical to electromagnetic energy and the reverse gives an a priori explanation for anti-matter, reduced masses, tunneling, etc. without improbable probabilities, negative states and interaction with the vacuum.

When viewed from an inertial/kinetic standpoint the theory provides an ontological basis for superconductivity. By reducing the temperature to that approaching absolute zero, a cessation of all activity results in an unimpeded magnetic effect. At higher temperatures, the combination of a conductor and an amorphous material to absorb kinetic activity produces the same effect. At the opposite extreme, a suppression of all inertial or magnetic properties will result in superluminal speeds reaching to infinity. Also, if dark matter is proven to exist, it will likely have the proportion of the electron as related to its charge.

June 30, 2000

References

1. Science Abstracts 11, 687, 1908.
2. A. Compton: The Quantum Hypothesis of Scattering, Physical Review, 21, 207, 1923
3. Information on the many critics of SRT is available on the following sites: G. Walton: http://www.btinternet.com/~sapere.aude and M. Coleman: The Trouble with Relativity, http://wbabin.net/physics/marcus.htm
4. W. Babin: An Analysis of the Theoretical Foundations of Special Relativity, http://wbabin.net/babin/webdoc1.htm
5. P.T. Pappas, A.G. Obolensky: Proceedings of the International Tesla Conference, Colorado Springs, 1988. H.W. Milnes: Faster Than Light Signals, Radio Electronics, V. 54, No. 1, p.55, 1983
6. H.A. Lorentz: Electromagnetic Phenomena In A System Moving With Any Velocity Less Than That Of Light: Academy of Sciences of Amsterdam, 6, 1904.
7. Einstein's Theory of Relativity: Max Born, Dover Publications, p.210. V.F. Weiskopf, Physics in the 20th Century, MIT press, p.99.