

The Compton Effect and Special Relativity

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Abstract:

The A.H. Compton scattering experiments between loosely bound electrons and x-rays provided two distinct results¹: One in which the scattered beam was the same wavelength as the primary beam (elastic collision), and the other, in which the scattered wavelength was increased (inelastic collision). Collectively, they were interpreted as being experimental proof of energy quantization and specifically, of Einstein's photon theory of light. Compton's use of relativistic equations and his apparently unqualified acceptance of the equivalence of mass and energy, also lent credence to special relativity theory, while it will be shown that it is in fact, its **experimental refutation**. While the logical anomalies in the special theory have been exposed by many authors since its publication, belief in it persists because of its presumed agreement with experiment. This paper demonstrates that **this is not the case**, and should therefore remove the last vestige of authenticity for the theory.

All arguments contained herein, including the theoretical refutations of special relativity have already been covered in a series of earlier papers². They are repeated here, in support of the above statements.

Special Relativity (SR)

Based on the assumption that light speed is a universal invariant, the theory requires that time and space be physically reduced by the factor $\beta = (c^2 - v_m^2 / c^2)^{1/2} = (1 - v_m^2 / c^2)^{1/2}$ and mass show a compensating increase by the same factor for inertial reference frames in relative linear motion along the X axis³. (where v_m is the velocity associated with momentum)

a. In one-way motion, time and space must either **expand** or **contract** depending on the direction of travel of the light beam and object, contrary to SR. This applies experimentally and by definition, regardless of difficulties in measuring one-way motion.

b. In two way motion, the contraction must account for the ratio of $2l/c$, the time of travel in the fixed frame, and $l/c - v_m + l/c + v_m$ the time of travel in the moving frame. To achieve this, special relativity inexplicably requires the **multiplication** of the contracted space and time $l\beta t\beta$, rather than their ratio, $l\beta/t\beta$. (Of course, it is the modifications that are multiplied. Space and time are used independent of one another in calculations, but combined in the four-dimensional mathematical construct.) Obviously, β must be squared in the latter, but this merely introduces a time delay for the moving frame **which must then cover the same distance in the same time as the fixed frame, precluding any relativistic change in space or time.**

c. According to the experimental or theoretical configurations of the light path (horizontal or vertical), the light beam must travel in each direction consecutively, yet the transformation equations clearly identify simultaneous motion, $(c - v_m)(c + v_m)$ in opposite directions.

d. β is the root of a second order equation, which mathematically, geometrically and physically can only apply to axes perpendicular to the direction of travel. **Presumed contraction-dilation effects must also be in these directions.**

e. According to **c.** and **d.**, the equations apply to light wave displacements and clearly duplicate

those of the Doppler effect⁴.

It should be evident that the mechanics of all sub-atomic particle interactions are interpreted through the radiation emitted and cannot be applied without modification. A frequency shift does not automatically imply a change in mass.

The Compton Effect

The basic underlying assumption in special relativity is that **motion alone** is the cause of the incremental space, time, and mass modifications. Yet in the Compton collision process, photons of electromagnetic radiation are the cause of propulsion and the effect is a transfer of energy and momentum to the electron in accordance with the standard progression of events and the conservation laws of classical mechanics. While we might allow some flexibility in assigning the cause of the mass increase in special relativity, we must remember that it required the modification of both time and space in order to maintain a universal speed for light, which necessitated a compensating change in mass. In the Compton effect, mass is presumed to increase due to an inelastic collision with a photon, and no modifications of space and time are necessary. In fact, such changes would negate the conservation laws.

The momentum p of the photon based on Planck's energy hf is,

$$p = E/c = hf/c \quad (1)$$

where E =energy, h =Planck's constant, f =frequency.

Its "mass-equivalence" becomes $p/c = m_i$ for the initial photon and $p/c = m_f$ for emission after collision. According to Einstein, the kinetic energy equation is,

$$(m - m_o)c^2 = mv_k^2/2 \quad (2)$$

where m_o = electron rest mass, v_k = kinetic speed and m = relativistic mass

While the result is correct, the calculation and interpretation are definitely not! The electromagnetic "mass-equivalence" transferred to the electron is $m_i - m_f = \mu$. The relativistic mass is then $m_o + \mu = m$. Therefore, the proper mathematical representation of the collision process is,

$$m_i - m_f + m_o = u + m_o = m$$

and,

$$(m_i - m_f)c^2 = \mu c^2 = mv_k^2/2 \quad (3)$$

The form of (3) is important for the following reasons:

a. Although $u + m_o = m_o / (1 - v_m^2/c^2)^{1/2} = m$ the speed of light is associated with the photon's energy and **does not in any way relate to a rest energy associated with the mass of an electron** as required by special relativity. It is equally unrelated to the electron's kinetic or total energy other than being a component of the motive force. A field quantity is implied. A mathematical interpretation has been selected with no consideration given to the actual physical event.

b. The equation provides no evidence of a conversion from electromagnetic energy to mass. Nor at this point, is there any justification for assuming a photon contains mass, or that its energy is converted to mass. Regardless of whether or not the famous equation, $E = mc^2$ is correct, there is no basis for it in special relativity, it is not evident in the Compton effect, and cannot be derived from either.

There is a difference between the velocity of the momentum equation and the speed related to kinetic energy (v_m and v_k). Equation (2) leads to

$$m_o/m = 1 - v_k^2/2c^2 = (1 - v_m^2/c^2)^{1/2}. \quad (4)$$

This denotes the “relativistic” masses in momentum and energy are equal, and the relationship between velocity and speed is,

$$v_m^2/v_k^2 = 1 - v_k^2/4c^2 \quad (5)$$

The classical definition of kinetic energy is that it represents the energy of motion. Here, special relativity arbitrarily redefines it. In order to resolve the dilemma, we consider the momentum and energy of a one-dimensional Compton collision with a photon whose mass-equivalence is equal to that of the particle (electron):

$$\begin{aligned} (m_i - (-m_j))c / (m_i - m_j)c^2 &= 2mv_m / mv_k^2 \\ (m_i + m_j) / 2(m_i - m_j) &= v_m c / v_k^2 \\ (m_i + m_j) &= 2(m_i - m_j) \text{ and } v_m c = v_k^2 \end{aligned} \quad (6)$$

The results of equations (3) and (6) indicate that the velocity of the “mass” increment and that of the particle are components of a **total** energy. Since the speed of light is involved with the “relativistic” increase, it appears that we should maintain a distinction between it and mass, until an appropriate explanation for it can be found.

The change in wavelength of the scattered radiation is given by the Compton equation,

$$\begin{aligned} \Delta\lambda = \lambda_f - \lambda_i &= \lambda_c(1 - \cos \phi) \\ \text{where } \lambda_c &\text{ is the Compton wavelength, } h/m_o c \end{aligned} \quad (7)$$

However, $h/m_o c = 4\pi m_o v r / 2m_o c$, and the appearance of light speed in the denominator confirms that it is a component of the electron's intrinsic magnetic moment; a field attribute. The photon absorption provides a **cause for the appearance of the induced magnetic field** rather than merely attributing it to motion. Indeed, the opposite is true. Accordingly, equation (3) should read,

$$\begin{aligned} E_i - E_f c^2 &= \mu c^2 = E_e v_k^2 / 2 \\ \text{where } E_{i,f,e} &\text{ are the initial, final photon and electron, electromagnetic energies} \end{aligned} \quad (8)$$

A limit is implied in eq. (8), which signifies the speed of light is achieved when the induced magnetic component equals the electric; the classic description of an electromagnetic wave. This infers either a dissolution of, or a counterbalance to mass. If this suggests the transfer of mass to energy, it is in an opposite sense to that proposed by special relativity.

Furthermore, it is claimed in special relativity that mass approaches infinity as its velocity approaches the speed of light. The Compton effect clearly identifies any presumed changes to be entirely dependent on the accelerating force, and the velocity of the electron resulting from such a collision is determined solely by the **ratio of the initial masses** (or more accurately, mass-equivalents. A photon, presumably, has no mass). They may be multiplied or divided by any constant without affecting the resulting velocities. Therefore, relativistic mass is not indicative of, nor dependent on velocity. Rather than infinite, the “masses” may be infinitesimal, yet will approach light speed if the ratio allows. By

relegating relativistic increase to field induction, there is no necessity for mass or field to change, since frequency is the determining factor. If there is indeed a limit on momentum, it is due to inertia and the emission of radiation following the collision process.

In order to resolve the mass-energy question, we return to the classical one-dimensional elastic collision between an electron and a mass-equivalent photon. $m_x = m_o$. This would result in a Newtonian velocity v_n of,

$$2m_x c / (m_o + m_x) = v_n = c \quad (9)$$

A similar configuration in a Compton collision gives, $cv_m = vk^2$ (see eq, (6)). If the mass ratio is modified and/or a two-dimensional collision is introduced,

$$2m_x cv_m \cos \phi / (m_x + m_o) = v_n v_m = vk^2 \quad (10)$$

The Newtonian velocity v_n is implicit throughout. Its existence confirms the entire range of mechanics which **has not in any way been supplanted by relativistic considerations.**

$$v_m / v_n = (1 - vk^2 / 4c^2) \quad \text{see eq. (5)} \quad (11)$$

Furthermore, the speed associated with energy is explicitly defined in the product $v_n v_m$ which is the square of the angular velocity v_k .

It is simple to prove that mechanics and electrodynamics are independent representations of mass and field respectively. It can also be shown that their total energies are the same, by pointing out another mathematical misrepresentation. Newtonian physics assigned only one relative motion for momentum and energy. In the case of energies associated with orbit, an expression for the total is derived (circular):

$$m_p m_s V^2 / 2(m_p + m_s) - m_p m_s G / r = -m_p m_s G / 2r \quad (K - P = T) \quad (12)$$

where V = sum of speeds of the sun and planet relative to centre of mass, m_s and m_p = masses of the sun and planet respectively.

In resolving eq. (12) according to convention, the "proper" sum of velocities is,.

$$V^2 = G(m_s + m_p) / r \quad (13)$$

However, we see that eq. (13) is incorrect. The velocities have been **initially defined** and their sum **cannot be changed**. Small macrocosmic velocities do not show appreciable differences, but if we increase the velocities of Newton's equations so that they are comparable to electromagnetism, we will find the resulting speed to be precisely that of the total energy, v_k .

Equation (11) conforms to Dirac's relativistic treatment of the energy levels of the hydrogen atom and more importantly, provides an ontological basis for fine structure splitting of spectral lines. The fine line splitting observed in electron orbits are attributed to spin-orbit interactions, but analysis suggests a different explanation. Dirac's equation (CGS System) is:

$$E = -ue^4 / 2h^2 n^2 [1 + a^2 / n (1 / (j + 1/2) - 3/4n)] \quad (a)$$

where u = reduced mass, and n and $j + 1/2 = 1$ (1st Bohr orbit), a = fine structure constant. Using the Bohr equivalence, equation (1) reduces to

$$E = -um_e^2 v^4 r^2 / 2m_e^2 v^2 r^2 [1 + a^2 (1 - 3/4)]$$

$$E = -uv^2/2 (1+v^2/4c^2) \quad (b)$$

where m_e = mass of the electron, v = velocity in the first Bohr orbit. Removing $u/2$ from both sides and re-arranging,

$$v^2 = v^2 - v^4/4c^2 \quad (c)$$

Obviously, **there must be a difference in the velocities**. Replacing the left with the relativistic linear velocity v_m and on the right with the angular (total) velocity v_k , we have

$$v_m^2 = v_k^2 - v_k^4/4c^2 \text{ and } v_m/v_n = 1 - v_k^2/4c^2 \quad (d)$$

Fine structure splitting is then the duality of field and mechanical orbit interactions. Note that the theoretical basis for Dirac's energies as well as the mathematics is greatly simplified by the inclusion of the mechanical velocity.

Finally, it is quite evident that the **basis** for photon invariance ($h=mv_r$) must itself be invariant. Not only does mass remain constant, but a direct correspondence between photon and mass is implicit and leads to a new interpretation of both.

Summary

It is astounding that simple mathematical and logical errors, easily resolved by anyone, remained undiscovered (effectively) for over a hundred years. Relativistic doctrine contributed to a metaphysical tangent in physics, spawning theories that have no basis in logic or reality. In view of the above, it is patently obvious that the generalization of mechanics and electromagnetic theory could have been resolved at the turn of the last century and although available today, is not acknowledged by the physics community.

Addendum: May 12, 2015:

Although contained above, but not specifically stated, the famous equation $E = mc^2$ is erroneous. The above arguments confirm that it has no basis in the Compton effect since the speed of light is not directly related to mass, but to its motive force. Further, it is a representation of kinetic rather than total energy. In relativity theory, it was derived from eq. (2) independent of any causal influence other than velocity, which renders it tautological and therefore meaningless.

$$(m-m_0)c^2 = mv_k^2/2$$

$$(2mc^2 - mv_k^2) = 2m_0c^2$$

and by eq.(4)

$$(2m_0c^2 - m_0v_k^2) = 2m_0c^2 (1 - v_k^2/c^2)$$

$$(2m_0c^2 - m_0v_k^2) = (2m_0c^2 - m_0v_k^2)$$

End

- 1 A. H. Compton: A Quantum Theory of the Scattering of X-Rays by Light Elements, Phys. Rev, 21, May 1923, p. 483
- 2 Walter Babin: <http://gsjournal.net/Science-Journals-Papers/Author/103/Walter,%20Babin>
- 3 A. Einstein: On the Electrodynamics of Moving Bodies, The Principle of Relativity, Dover Publications, 1952, p. 37
- 4 Walter Babin: <http://gsjournal.net/Science-Journals/Research%20Papers-Relativity%20Theory/Download/3731>, July, 2000