REST MASS OF PHOTON CANNOT BE EQUAL TO ZERO

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Currently, the rest mass (m_0) of photons has been assumed to be = 0. Otherwise, according to Einstein's postulate of theory of relativity, since the velocity of photons (v) has been assumed to be = c (constant), the moving mass (m_{mov}) of photons becomes infinite according to expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$. Since the moving mass (or any type of mass) of photons (or of any particle) cannot be infinite, their rest mass has been assumed to be = 0. But presently, giving plausible arguments and evidences, it has been tried to prove that the rest mass of photons cannot be equal to zero. Giving plausible arguments, a justified solution has also been determined such that the moving mass of photons may not become infinite despite having their rest mass to be finite.

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1. INTRODUCTION

Currently, the rest mass (m_0) of photons has been assumed to be = 0. Because, according to Einstein's postulate of theory of relativity, since it has been assumed that the photons move with constant velocity c and nothing can move with velocity > c, if some rest mass m_{ph} is assigned to photons (i.e. $m_0 = m_{ph}$), their moving mass (m_{mov}) becomes infinite according to expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$. Since their moving mass cannot be infinite because practically it can never be possible, the rest mass of photon (m_{ph}) has been assumed to be = 0.

2. EVIDENCES AND PLAUSIBLE ARGUMENTS TO PROVE THAT THE PHOTONS POSSESS REST MASS

2.1 Evidences to prove that the photons possess rest mass

1. No escaping of light from the black holes verifies the truth of rest mass m_{ph} of photons. Black holes have very strong gravitational force and they do not let even the photons to escape from them, it means, photons have rest mass and they are attracted by the black holes due to their very strong gravitational force. For further confirmation that the photon possesses rest mass, we can see also Sec. I D, Ref. 1.
2. Photons possess rest mass $\approx 3.38 \times 10^{-36} Kg$ (for its mathematical proof, see Sec. IV B, Ref. 1).

2.2 Plausible arguments to prove that the rest mass of photons cannot be equal to zero

1. Since the photons travel with velocity c, scatter electrons colliding with them in Compton scattering and eject electrons in photoelectric effect penetrating into metals etc., for photons two things are necessary: 1. A bundle of radiation energy that provides physical existence to photon as, e.g. a bundle of charge (-e), which (-e) happens to be actually the

electric energy, provides physical existence to electron. 2. Some energy, that enables photon to travel with velocity c etc. as, e.g. some energy is needed for electron to enable it to travel etc. [For experimental verification of the necessity of the mentioned above two things for photon to travel with velocity c, scatters electron colliding with that in Compton scattering etc., we can see starting from line-25, column-2, page-53 to line-15, column-1, page-54, Sec. I D, Ref. 1.] Further, according to mass-energy equivalence principle of theory relativity, since the matter is transformed into energy in equivalence to that's mass, that's mass is not being transformed into energy, if the mass of the transformed energy somehow is measured, that shall be found to be equal to the mass of the matter. Therefore, the bundle of radiation energy of photon too should have some rest mass m_{ph} as, e.g., the bundle of charge (-e), which is a bundle of electric energy, possesses rest mass m_e.

3. DETERMINATION OF SOLUTION SUCH THAT THE MOVING MASS OF PHOTON MAY NOT BECOME INFINITE DESPITE HAVING THEIR REST MASS TO BE FINITE

In order that the current interpretation of photon (see Sec. 2.1, Ref. 2) may explain the phenomena of Compton scattering etc., the moving mass $h\nu / c^2$ has been assigned to photons. In $h\nu / c^2$, since every term h, ν and c has finite value, $h\nu / c^2$ should also be finite, while on the contrary, if substituting the rest mass of photon (m_0) to be = 0 in expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$, the moving mass m_{mov} of photon is obtained to be indeterminate. It means, there is some error either in the Einstein's postulate or in expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$ or in $h\nu / c^2$. But where and what is error, in order to determine that, let us try to examine the expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$ [see Sec. 3.1] and the Einstein's postulate [see Sec. 3.2]

3.1 Examination of expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$

The expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$ is true. But in it, m_{mov} is not the moving mass of the particle having rest mass m_0 and moving with velocity v, as currently being defined. It is actually the effective mass of particle generated due to superposition of the effect of spin motion of that particle on that's rest mass.

Since electrons (for which the truth of expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$ has been verified), protons etc. all the matter particles possess spin motion along with their linear motion, they possess spin energy (E_s) corresponding to their spin motion as they possess kinetic energy (E_k) corresponding to their linear motion, and hence possess motional energy $E_m = E_k + E_s$. And as E_k of any particle generates linear momentum (p_{lin}) in that particle along the direction of that's linear velocity (v), similarly, if that particle possesses E_s, that's E_s generates spin momentum (p_s) in that particle along the direction of that's spin angular momentum (L_s). [For verification of the truth of generation of p_s in electron along the direction of its L_s, see Sects. I C and I D, Ref. 1.] So, the particles possess motional momentum $p_m = p_{lin} + p_s$. In the expressions $E_m = E_k + E_s$ and $p_m = p_{lin} + p_s$, if superposing the effects of E_s and p_s of the particle on its E_k $(= m\mathrm{v}^2 / 2)$ and p_{lin} $(= m\mathrm{v})$ respectively (where m and v respectively are the mass and the linear velocity of the particle) we try to write down the expressions for E_m and p_m of the particle in terms of its kinetic energy and linear momentum respectively, the expression shall be as: $E_m = m_{eff} \mathrm{v}^2/2$ and $p_m = m_{eff}\mathrm{v}$ respectively. The energy $m_{eff}\mathrm{v}^2/2$ and the momentum $m_{eff}\mathrm{v}$ shall produce the same effects as the energy E_m and the momentum p_m respectively shall produce. The term m_{eff} is the effective mass of the particle. The effect of spin motion of the particle in fact does not increase the mass of the particle but increases the effect of that's mass m to $m_{eff} = m_{mov}$. The relativistic kinetic energy $\mathrm{E_k} = [\mathrm{m}c^2/\sqrt{(1-\mathrm{v}^2/c^2)}]$ - mc^2 and the relativistic linear momentum $p_{lin} = m\mathrm{v}/\sqrt{(1-\mathrm{v}^2/c^2)}$ of electrons are actually their $E_m = m_{eff}\mathrm{v}^2/2$ and $p_m = m_{eff}\mathrm{v}$ respectively obtained as the consequence of superposition of the effects of E_s and p_s of electrons on their E_k, and p_{lin} respectively. [How these are obtained, see starting from the last but one paragraph (column-1, page-69) to the end of Sec. IV C, Ref. 1.]

3.2 Examination of Einstein's postulate

If we look at the graph of Bertozzi[3] between v^2/c^2 and $kinetic\,energy/mc^2$ (= E_k/mc^2) of electron, Fig.1, on the basis of which the truth of Einstein's postulate has been confirmed, no doubt, the rate of increase in v^2/c^2 goes on decreasing as E_k/mc^2 increases. After E_k/mc^2 = 5, the tendency of the rate of increase in v^2/c^2 becomes very slow, and after E_k/mc^2 = 25, the tendency becomes very-very slow, and beyond that, the tendency may become extremely slow, can say $\rightarrow 0$. But it does not lead to confirm that v^2/c^2 can never be > 1. It (v^2/c^2) can be > 1. Because the rate of increase in v^2/c^2 can never be = 0 as long as E_k/mc^2 goes on increasing. It is possible that v^2/c^2 may become > 1 at very-very large or can say at extremely large E_k / mc^2, but the possibility of becoming $\mathrm{v}^2 / c^2 > 1$ cannot be ruled out.

Secondly, electrons and photons both possess spin motion and their velocity varies as their frequency of spin motion varies (for verification of its truth for electrons, see Eqn. 1.2, Sec. I, Ref. 1; and for photons, see Sec. IV B, Ref. 1). And hence, as after attaining relativistic velocity by the electrons when the rate of increase in their v^2 / c^2 starts decreasing, their frequency of spin motion starts increasing in order to conserve E_m, p_m and L_S of electrons, not their mass in order to conserve their E_k and p_{lin}, because electrons possess E_m, p_m, L_S and hence E_m, p_m, L_S of electrons should be conserved, not only their E_k and p_{lin} (for detail, see Sec. 4.1.4, Ref. 4), similarly, in order to conserve E_m, p_m, L_S of photons, their frequency of spin motion (ν) should start increasing. (ν is frequency of spin motion of photons, not frequency of their wave nature. For its confirmation, see Sec. I A, Ref. 1.) Since, as we know, the frequency of spin motion of photons increases, and hence, in order to conserve E_m, p_m, L_S of photons, the velocity of photon cannot remain constant, i.e. v^2 / c^2 cannot be = 1. It should increase, though the tendency of the rate of increase may be extremely slow, can say $\rightarrow 0$. The increase in v^2 / c^2 can be possible, because c is the velocity of photons of visible light, and the velocity (v) of photons of ultraviolet rays, X-rays and γ-rays may be greater than c. The tendency of the rate of increase in v^2 / c^2 of their photons may be extremely slow, can say $\rightarrow 0$.

3.3 Determination of solution

When m_{mov} is not the moving mass but it is the effective mass, secondly, the velocity of photons varies with the frequency of their spin motion (see Sects. IV A and IV B, Ref. 1.), and thirdly, the velocity of photons of ultraviolet rays, X-rays and γ-rays may be greater than c, in the expression $m_{mov} = m_0 / \sqrt{(1 - \mathrm{v}^2 / c^2)}$, c can be replaced by c_1, where c_1 is hypothetically assumed highest possible value of velocity of any particle, very-very close to c but > c and also > the velocity of photons of γ-rays. If c is replaced by c_1, all the problems are resolved.

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FIGURE CAPTION

Fig. 1: Variation of v^2/c^2 of electrons with respect to their $kinetic\,energy/mc^2$.

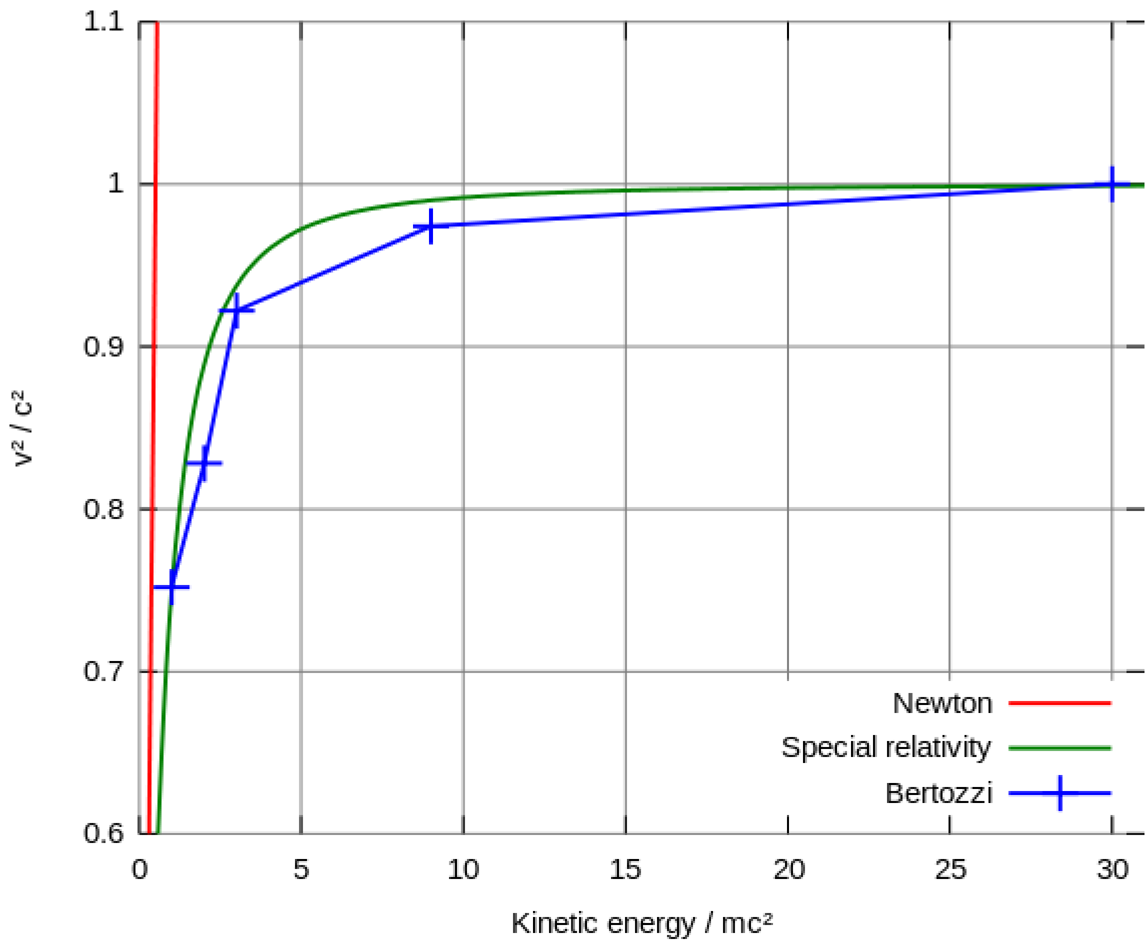
1.1
1
0.9
0.8
0.7
0.6
v² / c²
0
5
10
15
20
25
30
Kinetic energy / mc²
Newton
Special relativity
Bertozzi

Fig. 1