The Mechanism of Photon Creation

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Abstract

Physics has long assumed that electromagnetically generated photons traveling at the speed of light have no mass, partially because the Theory of Special Relativity indicates they would consequently have infinite mass. Building on the hypotheses of The New Physics, we suggest why the infinite mass conclusion does not apply to photons and compute their mass. This leads to a new value for photon momentum that should be measurable, and the conjecture that the mass of the sum of photons in the universe accounts for Dark Matter.

Introduction

Physics has long considered an electromagnetically generated photon to be massless, even though it has momentum. Because it always travels at the speed of light, if a photon had mass, then according to Special Relativity its mass would be infinite.

The core hypothesis of The New Physics is that when a particle is created, space is displaced (rather than replaced.) [2] Subatomic particles like protons and neutrons are only bubbles in space, with tiny internal fundamental particles like quarks that carry electrical charge [3]. Ignoring the very light mass of the charge carriers, protons are otherwise known to be empty: they have no mass as such. The fracturing of space that results from creating the particle partitions space into concentric nuclear quantum levels that give rise to gravitation and inertia, leading to the illusion that the particles have mass.

Relativistic Mass

A review of subatomic particles shows that the relativistic mass inflation predicted by Special Relativity only applies to particles that have internal charge elements, which have linear extents. Conversely, particles without internal charge components invariably travel at the speed of light. The New Physics hypothesizes that the internal charge components are subject to the length contraction of Special Relativity [4, §RELATIVISTIC MASS].

Importantly, a particle's gravitational field is proportional to the surface area of the first nuclear quantum level to the volume of the particle [1, eqs. (9,11)]. As the length of a particle’s charge carrier(s) is contracted in the direction of travel, the surface area of the first nuclear quantum level approaches a constant (the area of two discs), and the volume approaches zero. This results in the exponential growth of mass (viz., the particle’s gravitational field) suggested by Special Relativity. This has two immediate consequences. Conceptually, mass becomes reliant on space-time, the

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core of Special Relativity, and the reason for the mass increasing as the particle becomes smaller stands on geometric necessity.

Photon Creation

Consequently, The New Physics hypothesizes that photons are also bubbles in space that displace space when they are formed, and simultaneously adopt the speed of light. To make this process concrete, we will examine the creation of a visible light photon of average red light wavelength[2] 6.85e-7 m. (The "e-7" notation is adopted to facilitate copying these calculations into a computational tool like Excel or Sheets.)

Let's start with the accepted formula for photon creation energy, $E = hc/\lambda$, where h is the Planck constant (6.62607015e-34 Nms), c is the speed of light in a vacuum (299792458 m/s), and λ is our wavelength of 6.85e-7 m. This gives creation energy for our red light photon of 2.8999210e-19 Nm.

We turn to the creation of a *proton* (as opposed to our *photon*) to derive a key value. We are currently using creation energy for the proton (less quarks) of 1.49498954e-10 Nm. (The reason we do not include the creation energy of the quarks is that we are only interested in the energy it takes to push space aside space to create the particle bubble, not the energy it takes to create the internal charged quarks.) Using $m=E\mu\varepsilon$ (pronounced "meme" and a reformulation of $E = mc^2$, where μ is the permeability of the vacuum and ε is the permittivity of the vacuum) this is equivalent to a proton creation mass of 1.6634002e-27 kg. Using a proton radius of 8.41840e-16 m, we get a proton volume of 2.49906e-45 m^3. We can then compute the creation energy per unit mass by dividing the proton creation energy by the proton mass to yield $EnergyPerUnitMass$ = 8.98755e+16 Nm/kg.

Now, can we deduce the mass of a *photon*? If a photon is created as a bubble in space that immediately moves at light speed, two components consume energy during creation: the formation of the bubble itself, and the kinetic energy of that bubble moving at light speed.

$$E = \frac{1}{2}mc^2 + m(EnergyPerUnitMass) \qquad (1)$$

The first of these is the kinetic energy component formed by the product of the photon mass and its velocity (viz., the speed of light in a vacuum) squared. The second is the product of the mass of the photon and the energy required to produce a unit of mass. Both terms compute energy and combine to form the total energy needed to produce the photon.

We can solve this equation for the photon mass m by factoring m out of both terms and dividing the total energy by the resulting coefficient of mass:

$$m = \frac{2E}{c^2 + 2 * EnergyPerUnitMass} \qquad (2)$$

Substituting the numbers from above we obtain a red light photon mass of 2.15106e-36 kg. If we multiply this mass times the energy per unit mass, and then divide that product by the total red light

[2] We use a photon from the visible light range, but any electromagnetic photon from radio "waves" to gamma rays will do just as well. Note that while photons are generated by electromagnetic phenomena, they are not themselves electromagnetic.

photon creation energy from above, we find that the creation of the red photon mass is precisely 2/3 of the total energy of red light creation.

Photon Momentum

The previously used formula for photon momentum was $p = h/\lambda$, where p is the momentum, and the other symbols are as defined above. This gives its momentum as 9.67310e-28 kg m/s. If we instead use our derived red light photon mass and the classic formula for momentum as $p = mv$, where m is the particle mass and v is its velocity (viz., the speed of light c), we instead get a momentum of 6.44873e-28 kg m/s. This is precisely 2/3 of the result obtained by the previously used formula.

Only one of these is the correct method for computing photon momentum. A careful measurement of photon momentum should reveal which model of photon momentum is correct.

Is Dark Matter Light?

"In astronomy, dark matter is a hypothetical form of matter that appears not to interact with light or the electromagnetic field. Dark matter is implied by gravitational effects which cannot be explained by general relativity unless more matter is present than can be seen. [5]"

To date, cosmologists have generally thought light photons to be massless. But if they are not, then there is a lot more mass in the Universe than previously assumed. Could electromagnetic radiation photons be the long-sought dark matter?

We won't resolve this issue here. However, the creation energy of a photon is proportional to its frequency, and we now suspect that 2/3 of its creation energy forms its mass. So, we can determine the average frequency of a light photon if light photons were to account fully for dark matter. Is the result a reasonable value? If so, the possibility that light accounts for the elusive Dark Matter is certainly enhanced.

The amount of observable mass in the Universe is roughly 1.5e+53 kg [7]. Since this is only 5% of the matter and energy in the Universe, the full extent of matter and energy is 1.50e+53 kg divided by 5% or 3.00e+54 kg. Of this, 26.8% is dark matter, resulting in a dark matter mass of 8.04e+53 kg.

There are 4.00e+84 photons in the Universe [7]. If the average photon had a wavelength of 7.33074e-12 m and therefore (by frequency = c/λ) a frequency of 40.8952 EHz (exahertz, or 4.08952e19e+19 Hz), this would be equivalent to total photon creation energy (by $h*c/\lambda$) of 2.070975e-14 Nm and average photon mass of 2.01e-31 kg from (2) above. If we multiply this average by all the photons in the Universe of 4e+84 [7], the mass of photons in the Universe would exactly match the suspected total mass of dark matter we just computed. This required average is in fact towards the low end of the spectrum for gamma rays. How reasonable is this answer?

The frequency of our red light photon from the visible range of the spectrum is (by frequency = c/λ) 4.37653e+14 Hz. This is much lower than the above-required average photon frequency of 4.08952e+19 Hz. As we look at the cosmos, it certainly appears to us that most of the photons in the Universe are in the visible range.

Nevertheless, gamma rays might actually form the bulk of photons in the Universe. "Gamma-ray bursts are the most energetic and luminous electromagnetic events since the Big Bang and can release more energy in 10 seconds than our Sun will emit in its entire 10-billion-year expected lifetime! [8]" So it is possible that the mass of the average photon in the Universe is in the gamma-ray range, and the elusive dark matter is simply comprised of photons.

Conclusion

We have argued that electromagnetically generated photons might have finite mass and still travel at the speed of light. We have determined the mass of a given photon and derived an expression for photon momentum that differs from the previously used formula; this new prediction should be testable to determine which model is correct. The possibility that photons have mass led to a conjecture that previously elusive dark matter may be comprised of photons.

References

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