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Energy of the Photon or Energy of Radiations: The Specified Type of the Formula of A. Einstein

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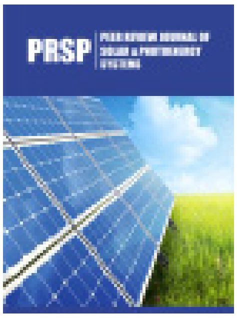
Abstract

Widely known formula of Einstein of $E=mc^2$ contains the paradox which isn't noticed still. Essence of this paradox in mixing of the concepts "radiation" and "photon". On basis of the analysis of the primary source authors show new interpretation of a formula of Einstein with additional coefficient. The conclusion of a formula of communication of energy and Einstein's mass belongs to radiation, but not to separate photons.

It is impossible to confuse these concepts. In order that from energy of radiation to receive energy of a single photon, it is necessary energy of radiation which enters Einstein's formula, to divide into quantity of photons in radiation. As at a conclusion Einstein used radiation at the same time of two waves (photons), energy of one wave (photon) will make exactly a half of full radiation. Einstein's formula, paradox, new coefficient, radiation, photon, energy, substitution of concept, two waves, two directions, additional coefficient, weight.



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Introduction

Einstein's famous formula $\acute{A} = mc^2$ contains a paradox that has not yet been noticed. The essence of this paradox is the mixing of the concepts of "radiation" and "photon". To notice this, you need to refer to the original source. For the first time, Einstein deduced this famous formula in 1905 in the work "does the inertia of a body Depend on the energy contained in it?". On the second page of his article Einstein writes the following verbatim: "Let there be a resting body in the system (x, y, z), whose energy assigned to the system (x, y, z) is equal to E_0. Let a body send a plane light wave with energy L/2 [measured relative to the system (x, y, z)] in the direction of the angle φ with the x axis and simultaneously send the same amount of light in the opposite direction.

In this case, the body remains at rest relative to the system (x, y, z). coordinate systems. If we denote by E1 the energy of the body after light emission when measuring it relative to the system (x, y, z)" [1].

He also gives the formula:

$$\acute{A}_0 = \acute{A}_1 + (L/2 + L/2)$$

Proposal of a solution to the paradox [2-6].

Let's analyze what was said in more detail. The body emits two waves, one in the forward direction and the other in the reverse direction. Each of these two waves carries energy (in Einstein's notation) L/2. Later, Einstein no longer mentions that the body actually emits two waves, but States that the body emits energy:

$$L/2 + L/2 = L$$

and at the end Einstein writes: "The kinetic energy of a body decreases when light is emitted by an amount that does not depend on the nature of the body:

$$\hat{E}_0 - \hat{E}_1 = L/c^2 * v^2/2$$

It follows directly from this equation that if a body gives off energy L in the form of radiation, its mass decreases by L/c^2. At the same time, it is obviously immaterial that the energy taken from the body directly passes into the radiant energy of radiation, so we come to a more General conclusion. The mass of a body is a measure of the energy contained in it; if the energy changes by the value L, then the mass changes accordingly by the value L/

(9 *1020), and here the energy is measured in ergs, and the mass - in grams". L (according to the original source) is the total energy of two waves emitted by the body simultaneously and moving in opposite directions [7,8].

$$p = \frac{dE_ê}{dv}$$

Moving from EM waves to photon radiation, following the logic of Einstein's famous formula, we cannot say that a body emits a single photon that moves in two opposite directions.

It should be said that the body emits two photons that move in opposite directions and have a total energy

$$Å = mc_0^2$$

In this case, each photon has an energy

$$Å = m_0c^2 / 2$$

where m_0 is the mass of the photon,

c is the speed of light.

Conclusion. In other words, the real formula for the relation of the photon's energy to its rest mass is not $Å = mc^2$, as is commonly written in modern literature [8-11], but

$$Å = m_0c^2 / 2$$

Discussion of the Result

Now we can tell where the error occurred in determining the energy of the photon. It occurred due to the confusion of the concepts of "radiation energy" and the concept of "photon energy". We must understand that Einstein derived his formula for radiation. And radiation can consist of several photons. For example, when deducing the formula, Einstein stipulates that two waves are emitted simultaneously, which is analogous to the expression "two photons are emitted".

Therefore, the derivation of Einstein's formula for the relation of energy and mass refers specifically to radiation, and not to individual photons. These concepts should not be confused. In order to get the energy of a single photon from the radiation energy, the radiation energy that is included in the Einstein formula must be divided by the number of photons in the radiation.

Since Einstein used the radiation of two waves (photons) at the same time, the energy of one wave (photon) will be exactly half of the total radiation. The proposed conclusion about the actual value of the energy of a single photon solves another paradox that is hidden in modern science, namely, the ratio of the kinetic energy and momentum of the photon.

In mechanics, the following relations between energy and momentum are known:

Expression of kinetic energy through a pulse:

$$E_ê = \frac{ð^2}{2m}$$

here $Å_ê$ is the kinetic energy; p is the momentum; m is the mass.

Expression of momentum through kinetic energy in Lagrangian mechanics:

here - speed.

If you substitute the values of the energy and momentum of the photon in the present form into the given formulas, you will get an incongruity.

Since, according to modern science, the momentum of a photon is p = mc, and the energy of a photon is E = mc², the first formula follows:

$$E_ê = \frac{ð^2}{2m} = \frac{(mc)^2}{2m} = \frac{mc^2}{2}$$

Again, half-meaning, which does not coincide with modern scientific literature. And from the second given formula it turns out:

$$p = \frac{dE_ê}{dv} = \frac{dmc^2}{dc} = 2mc$$

For the pulse, the value is doubled. Which again does not correspond to modern literature.

It is impossible to imagine that these discrepancies are not noticed by anyone, however, in the modern scientific literature, these facts of inconsistencies are not explained in any way. The suggestions of the authors of this article completely remove these inconsistencies.

Let's continue further. It may seem that by removing some inconsistencies, the authors introduce others. For example, in modern scientific literature, two formulas that Express the energy of a photon are equated:

$$Å = mc^2 \text{ and } Å = h\nu$$

here E is the photon energy; c - light speed; h - Planck constant; ν is the radiation frequency.

Equating the right parts of both equations in the form of in modern science determine all the parameters of the photon.

If you substitute the coefficient ½ in the first equation, it will inevitably appear in the second equation. This means that you must either admit that the value of the Planck constant is overestimated by two times, or in some other way transform the formula.

This issue is easily resolved if you admit the other hypothesis of the authors expressed in the article "a formula of communication of energy and frequency in macro - and micromechanics" [7] in which the authors present the classical derivation of Einstein about the relationship of photon energy and frequency of radiation, in the form:

$$Å = \frac{h\nu}{2}$$

In this case, the coefficient ½ is present in both equations expressing the photon energy:

$$Å = \frac{mc^2}{2} \text{ and } Å = \frac{h\nu}{2}$$

Thus, almost nothing changes except the correction of formulas that Express the energy of the photon. So when we equate the two right hand sides of the two equations we get

$$\frac{mc^2}{2} = \frac{h\nu}{2}$$

When reducing the coefficient in both parts of ½ we get the usual form of the equation for the photon

$$mc^2 = h\nu$$

The next question that needs to be considered is: how many photons are emitted by an atom when it goes from an excited to a stationary (non-excited) state? This question is important because Einstein in his work clearly pointed out that when an atom is radiated, it loses energy mc^2, suggesting explicitly that two photons must necessarily be radiated.

The answer to this question was verified experimentally by Walter Bothe in 1924. The essence of the experiment was that Bothe irradiated a thin foil with a weak stream of x-rays. Under the influence of x-ray radiation, the foil became a source of secondary radiation, which was detected by two Geiger counters installed on both sides of the foil. Two counters from different sides (right and left) were needed to determine whether the secondary wave is radiating in one direction or in two directions simultaneously. The results of Bothe's experiment clearly showed that secondary waves radiate only in one direction, either to the right or to the left, but never in both directions simultaneously [12].

The results of Bothe's experiments clearly show that the emission of photons in reality occurs in individual photons. Einstein's assumption that two photons are simultaneously radiated in opposite directions is a purely methodical technique that Einstein needed to justify the thesis that after the act of radiation, the atom remains in a state of inertial motion. Since special relativity, on the basis of which Einstein deduced the connection between energy and radiation, does not imply a transition from uniform to accelerated motion, Einstein introduced the postulate that radiation goes in two opposite directions, although this is not relevant to reality.

Conclusion

1. Einstein's article " does the inertia of a body Depend on the energy contained in it?" [1, p.36-38] contains a methodological error. Thus, the article clearly States the relationship between radiation energy and mass. Moreover, Einstein explicitly says that the formula Å $= m_0c^2$ does not concern the mass of a single photon, but the mass of radiation in the form of two photons. However, in the modern scientific literature, it is customary to say that the formula m_0c^2 concerns a single photon.

2. Bothe's Experiments in 1924 clearly show that an atom actually emits a single photon, not two, as is customary in Einstein's paper.

3. Thus, the formula for the connection of the photon's energy with its rest mass should not be written in the form Å $= m_0c^2$, as it is customary to write in modern literature [8-11], but in the form Å $= m_0c^2/2$.

References

1. Einstein A. Collection of scientific works in ch-x 1: S36-S38.
2. Kochetkov AV, Fedotov PV (2012) General theory of relativity and parametric post-Newtonian formalism // Online magazine "Science of Science" No. 4. http://naukovedenie.ru_45tvn313
3. Kochetkov AV, Fedotov PV (2013) Assessment of the manifestation of the historical mentality in modern mechanics and physics. Space and Time 2(12): S62-S71.
4. Kochetkov AV, Fedotov PV (2001) Manifestations of Historical Thinking in Modern Physics (Lectures for Amateurs). Saratov: Sarat State Tech Unt: p. S176.
5. Kochetkov AV, Fedotov PV (2013) The classical law of quantum radiation. Lap Lambert Academic Publishing. p. S104.
6. Kochetkov AV, Fedotov PV (2015) Problems of Harmonization of Radical Contradictions in the Axiomatics of Natural Sciences. Mechanical Engineering. p. S320.
7. Kochetkov AV, Fedotov PV (2014) The derivation of energy and communication frequencies in macro- and micromechanics. Internet magazine "Science of science". http: //naukovedenie.ru_90TVN314
8. Okun LB. Einstein's formula: $E = mc^2$. "It is not the Lord laughing". UFN. 2008.178. p. 541-555.
9. Okun LB. Concept of mass (mass, energy, relativity) (Methodological Notes). UFN. 1989. T. 158. Pp. S511-S530.
10. Pauli W (1991) Theory of Relativity. with it. and Eng. 3rd (edn), Rev/ED Ginzburg and VP Frolov. M Nauka Ch Ed Sci Lighted. p. 328.
11. Taylor EF (1971) Wheeler JA and physics of space time. M Mir. p. 320.
12. Sivukhin DV (1986) The general course of physics of atomic physics. Nauka, p. 426.

