Classical explanation of the Planck formula E = hv and the large magnetic moment of the electron

Yefim Bakman bakmanyef@gmail.com

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Abstract. The Planck formula was derived on a mathematical basis, and to date, the physical reason for the proportionality of the energy and frequency of a photon has not been explained. With regard to the magnetic moment of an electron, the dominant paradigm cannot explain why a small electron has a larger magnetic moment than a proton. Here, we show that the new paradigm explains both misunderstandings based on the definitions of space and mass.

Keywords: space definition, space-mass relation, photon size, Planck's equation, electron size, classical model of electron, electron magnetic moment.

1. Definition of space and mass. Application to the derivation of the Planck formula for a free photon

Modern physics does not define the concept of space, as explicitly stated in Wikipedia [1]:

> "Space is one of the few fundamental quantities in physics, meaning that it cannot be defined via other quantities because nothing more fundamental is known at the present."

The physical concept of mass has also not been deciphered—the mass is determined by the way in which it is measured.

The new physical paradigm [2] provides definitions of both concepts, but for our purposes, it is sufficient to consider that mass and space are two opposites, like light and darkness or heat and cold. The smaller the space, the greater the mass, and vice versa.

For example, one could imagine an iron kettlebell next to a huge bag of fluff.

If identical stable vortex structures of mass are compared, then their mass-energy and linear dimensions are inversely proportional.

Let us consider this relationship by using the example of a free photon. In [3], the proportions of a free photon were calculated and modeled as an elongated toroid, within which a mass density wave circulates (Fig. 1).

Let a free photon have energy E_1 and frequency ν_1. If another free photon has energy

$$E_2 = n\,E_1, \qquad (1)$$

then its linear dimensions are <u>n times less</u> than that of the first photon. Consequently, at the same speed of the vortex wave, the period T_2 of its revolution around the second photon will be n times less than that of the first photon

$$T_2 = T_1/n,$$

and the frequency

$$\nu_2 = \frac{1}{T_2} = \frac{n}{T_1} = n\nu_1. \qquad (2)$$

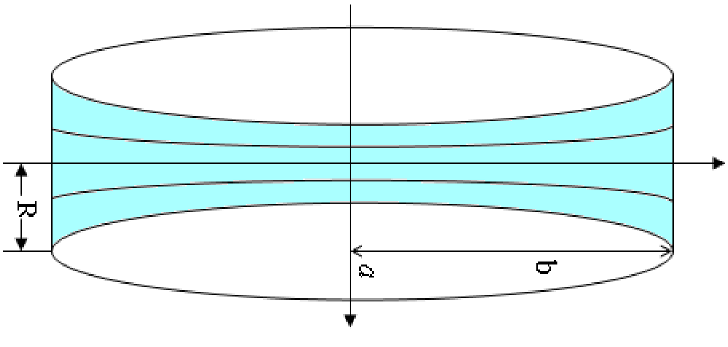

Fig. 1. The cross-section of a free photon (from [3]).

Dividing (1) by (2), we obtain

$$\frac{E_2}{\nu_2} = \frac{nE_1}{n\nu_1} = \frac{E_1}{\nu_1}.$$

That is, the ratio of energy to frequency is the same for free photons of different energies. If we denote this ratio by h, then we obtain the well-known Planck formula $E = h\nu$.

We are so accustomed to this formula that we no longer pay attention to the fact that it was derived by Planck purely mathematically as "saving from an ultraviolet catastrophe" [4]. The physical reason for this relationship has not been revealed.

The new paradigm helps indicate the physical reason for this formula.

The question "how large is a photon?" has several interesting answers on the Internet [5]. It is clear from the wide variety of responses that there is no prevailing opinion on this issue.

One unusual response came from Bill C. Riemers, who has a Ph.D. in experimental high energy physics:

> "We can measure a size for the photon and also say photon is a point particle."
>
> "This is the fun realm of quantum mechanics."

Yes, quantum mechanics has a great ability to avoid answering simple questions.

Within the framework of the new paradigm, the sizes of photons are inversely proportional to their energies. For example, an X-ray photon, because of its small size, can penetrate human soft tissues, which are opaque to visible light. However, this aspect does not enable calculation of the absolute size of the X-ray photon.

In our work [3], the linear dimensions of a free photon R, a, b (Fig. 1) were calculated in terms of its wavelength λ by solving a system of equations. In these equations, the dimensions of the photon are associated with the speed of the vortex wave and the period of its revolution. Also, the spin of the photon and its energy are used. By solving these equations, we received the length of the photon

$$2b = 1.0116\ \lambda.$$

2. Application of the relationship between mass and space to the electron-muon pair

All free photons have the same structure. An electron has only one particle with the same structure—a muon. The muon's mass is k = 206.768 times that of the electron [6]:

$$m_{muon} = k\ m_e$$

In the framework of the dominant paradigm, the muon is considered larger than the electron. Therefore, its magnetic moment should be greater than that of the electron, but in reality, it is paradoxically k = 206.768 times less than the magnetic moment of the electron.

Using knowledge from the new paradigm about the inverse proportionality of mass and size for the same vortex structures, we conclude that a muon is k = 206.768 times smaller than an electron. Because of the small size of the muon, its magnetic moment should therefore be less than the magnetic moment of the electron, and there is no contradiction with reality.

$$\mu_{muon} = \mu_e / k$$

Thus, we have confirmation that the inverse relation of size and mass is not only true for photons.

3. The large magnetic moment of the electron

In the dominant paradigm, several unresolved issues are associated with the magnetic moment of the electron. First, if the electron is pointlike, then it must have zero spin and magnetic moment, which is not true.

If the electron is not a point but is much smaller than a proton (as is commonly believed), then why is its magnetic moment 658 times greater than that of a proton with the same charge?

The inability of the dominant paradigm to help solve these problems was fully demonstrated on the Physics Stack Exchange [7], when a young forum member asked the question "where does the electron get its high magnetic moment from?"

Approximately ten participants tried unsuccessfully to answer this and other questions. In response to the question "where does that angular momentum come from?" the following answer was suggested:

"It's part of the wave function."

Quantum mechanics once again excelled in proposing a mathematical rather than a physical cause.

In light of the new paradigm, the problems can be resolved. First, the electron is not pointlike but is a toroid [2] (Fig. 2).

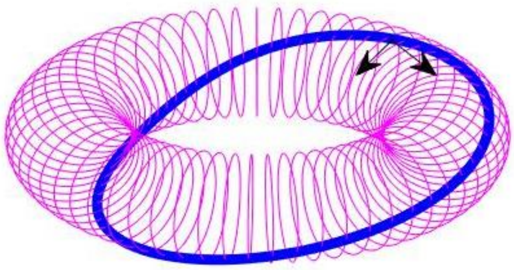

Fig. 2. The blue closed line presents the wave front circulating in an electron. The arrows show two components of the velocity of a point on the wave front: $v_{\perp}$ is perpendicular to the cross-section plane, and $v_{\parallel}$ is in the plane.

Because electrons and protons have different structures, one cannot expect an exact inverse proportionality of their masses and sizes. However, this relation can be used to roughly estimate the relative sizes. Because the mass of the proton is greater than the mass of the electron,

$$m_p = 1836\, m_e,$$

a natural assumption is that the linear dimensions of a proton are at least smaller than that of an electron. Hence, with the same unit charge, the magnetic moment of the electron (in absolute value) must be greater than that of the proton, as confirmed by the following measurements:

$$\mu_e = -1.001 \text{ μB}, \ \mu_p = 1.521 \times 10^{-3} \text{ μB},$$

where μB is the Bohr magneton.

To answer the question "what is spinning in the magnetic moment?" a model of the electric charge of an electron is necessary. We will present such a model in a future article, which will be entitled "Is the positron really an antiparticle? A classical model of the electron charge."

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