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On The Need to Correct the Energy Law of M Planck and Physical Meaning of His Constant

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Abstract

Statement of the Problem: *The energy law of Planck E = hv (J) was discovered by him in 1900 while studying the energy of radiation from hot bodies. It was related to the radiation frequency v in Hz and Planck's constant h, and was in good agreement with the experimental data available then and now. This discovery is of fundamental importance for science, for which in 1919 Planck received the Nobel Prize in Physics for 1918. Since that time, this law has been included in all textbooks, reference books, encyclopedias and other scientific and technical literature, in the sections of quantum physics. On the basis of Planck's constant h, the speed of light in a vacuum c, and the gravitational constant G, Planck obtained the values of energy $E_P = 4.90313 \cdot 10^9$ J, length $l_P = 4.05135 \cdot 10^{-35}$ m, time $t_P = 13.51385 \cdot 10^{-44}$ s and mass $m_P = 5.45551 \cdot 10^{-8}$ kg. At present, the value E_P refers to the maximum quantum of energy in the material world, and all values that are greater or less than it are obtained by adding the minimum and maximum quantum's of energy. However, when laws E, E_P are applied, contradictions arise, which limits the scope of Planck's energy law. There are also problems with the interpretation of the physical meaning of Planck's constant. The purpose of this study: is to resolve these contradictions.*

Methodology and Theoretical Orientation: *The work is related to scientific discoveries, for the creation of which methods have not yet been developed. Therefore, the general principles of the theory of knowledge and the laws of dialectics were used. The starting point is the access to the initial quantum-mechanical level of the material world.*

The main results of this work: *The quantum energy E_P can be obtained at the oscillation frequency of the waves $v_P = E_P/h = 0.7399982 \cdot 10^{42}$ Hz, which should last 1 s. This contradicts the energies that arose in the Universe at the initial moment after the Big Bang, when the maximum quantum EP was formed frequency radiation in the 1st pulse, and also at the time of interaction of physical particles. The elimination of these contradictions and refinement of the physical meaning of Planck's constant constitute is scientific novelty of the work performed. For this purpose, instead of the radiation frequency v, it is proposed to use its period T, which for Planck values has meaning tP. In this case the maximum energy quantum E_P will be obtained from dependence $E_P = h/t_P = 4.90313 \cdot 10^9$ J. Similarly, all other energy values must be expressed through the period T of wave oscillations of material objects, which makes it possible to obtain a new law E = h/T (J), which more accurately reflects the state and processes occurring in the material world and covering all areas of its application. The physical meaning of Planck's constant is reduced to the energy in one frequency pulse.*

Conclusion & Significance: *Within the framework of the provision on scientific discoveries, new law can be referred to as the "Planck-Nastasenko Energy Law of Radiation" E = h/T (J).*

Keywords: Energy, Frequency and Oscillation Period of Electromagnetic Waves, Planck's Constant.

Introduction

The work relates to the fields of quantum, nuclear, atomic and molecular physics, in particular - to the study of the processes of absorption and emission of electromagnetic energy. The quantum principle of radiation and absorption of energy, substantiated by M. Planck, was adopted as the starting point. The deepening of scientific knowledge in these areas provides a more complete understanding of the foundations of the material world, which is an important and urgent task for the development of natural science.

At present, it is customary to substantiate all physical research by mathematical theories and dependencies. However, the versatility and flexibility of mathematics allows developers to vary the equations and get exactly the result they want. Therefore, all mathematical theories must be tested by physical theories based on fundamental physical constants. This article uses just such an approach, which allows you to replace complex mathematical theories and dependencies with simpler physical theories and gives the final result in numerical form. Such results have a new scientific level and can be used as a basis for further research, incl. based on traditional mathematical methods. The beginning of this approach was laid by M. Planck within the framework of the Planck quantum constants of the material world justified by him.

Statement of the Problem

The energy law of M. Planck (1) was discovered by him in 1900 while studying the energy of radiation from hot bodies [1]. It was related to the radiation frequency *v* in *Hz* and Planck's constant *h*, and was in good agreement with the experimental data available then and now:

$$E = h\nu\ (J), \tag{1}$$

where *h* is Planck's constant, the value of which is recommended by CODATA [2]:

$$h = 6.62607015 \cdot 10^{-34}\,(\text{exactly})\,J \cdot s = 6.62607015 \cdot 10^{-34}\,(\text{exactly})\,\frac{kg \cdot m^2}{s}, \tag{2}$$

This discovery is of fundamental importance for science, for which in 1919 Planck received the Nobel Prize in Physics for 1918 [3]. Since that time, the law (1) has been included in all textbooks, reference books, encyclopedias and other scientific and technical literature, in the sections of quantum physics [4]. In addition, on the basis of the found Planck's constant h, the speed of light in vacuum c and the gravitational constant G, in 1900 M. Planck also obtained the values of energy E_P (3), length l_P (4), time t_P (5) and mass m_P (6) [5]:

$$E_P = \sqrt{\frac{hc^5}{G}} = 4.90317 \cdot 10^9\,(J). \tag{3}$$

$$l_p = \sqrt{\frac{hG}{c^3}} = 4.05135 \cdot 10^{-35}\,(m), \tag{4}$$

$$t_p = \sqrt{\frac{hG}{c^5}} = 13.51385 \cdot 10^{-44}\,(s), \tag{5}$$

$$m_P = \sqrt{\frac{hc}{G}} = 5.45551 \cdot 10^{-8}\,(kg). \tag{6}$$

where c is the speed of light in vacuum, recommended by CODATA [2]:

$$c = 0.299792458 \cdot 10^9\,(\text{exactly})\,\frac{m}{s}, \tag{7}$$

G is the gravitational constant, recommended by CODATA [2]:

$$G = 6.67430(15) \cdot 10^{-11}\,\frac{m^3}{kgs^2}. \tag{8}$$

The main feature of the Planck values E_P, l_P, t_P, m_P is that within the constants *c, h, G* they are universal for the entire Universe and for extraterrestrial civilizations, which determinesя the level of their significance for the study of the material world.

At present, the value (3) refers to the maximum quantum of energy in the material world, and all values that are greater or less than it are obtained by adding the minimum and maximum quantum's of energy. However, when laws (1) (3) are applied, contradictions arise. **The purpose of this study** is to resolve this contradiction.

Methodology and Theoretical Orientation

The work is related to scientific discoveries, for the creation of which methods have not yet been developed [6,7]. Therefore, the general principles of the theory of knowledge and the laws of dialectics were used [8]. The starting point is the access to the initial quantum-mechanical level of the material world [9]. The advantage of this method is the use of fundamental physical constants *c, h, G,* which simplifies the solution of quantum physics problems without the use of complex mathematical relationships and allows you to get the final result in numerical form.

The main results of this work. The analysis performed showed that the quantum of energy (3) can be obtained at the oscillation frequency of the waves ν_P (9), which should last 1 *s*:

$$\nu_P = \frac{E_P}{h} = \frac{4.90317 \cdot 10^9\,(J)}{6.62607015 \cdot 10^{-34}\,(Js)} = 0.739982 \cdot 10^{42}\,(s^{-1}). \tag{9}$$

Such a duration of frequency means that in fact the energy law (1) of M. Planck is valid only from the 2nd second of the birth of the Universe and does not operate in the first moments and the entire 1st second. This contradicts the energies that arose in the Universe at the initial moment after the Big Bang [10] and the parameters of Black Holes [11]. when the maximum of energy and frequency quantum (3) of radiation was formed in the first impulse. In addition, at any frequency of radiation *v*, the energy (1) is its value for 1 *s*, and not the "instantaneous" value. This distorts the real picture of the material world, especially when elementary particles interact. Thus, Planck's energy law (1) has a limited scope, which does not correspond to the features of the global level laws.

The elimination of these contradictions constitutes the scientific novelty of the work performed.

For this purpose, instead of the radiation frequency *v*, it is proposed to use its period *T*, which for Planck values has meaning t_P (5). In this case, the maximum energy quantum (3) will be obtained from dependence (10):

$$E_P = \frac{h}{t_P} = \frac{6.62607015 \cdot 10^{-34}\,(Js)}{13.51385 \cdot 10^{-44}\,(s)} = 4.90317 \cdot 10^9\,(J). \tag{10}$$

Similarly, all other energy values must be expressed through the period *T* of wave oscillations of material objects, which makes it possible to obtain a new law (11), which more accurately reflects the state and processes occurring in the material world:

$$E = \frac{h}{T}(J). \tag{11}$$

With a radiation period of T_{max} = 1 *s*, the minimum energy quantum will be obtained. A longer period of radiation in the material world is impossible, since in this case the wavelength and the speed of its propagation will exceed the speed of light *c*, which contradicts the principles of Einstein's special theory of relativity [12].

The minimum energy quantum is numerically equal to the value of Planck's constant (12), but differs from it by the exclusion of time *s,* including from its dimension, which allows us to consider E_{min} as a new physical formation.

$$E_{\min} = \frac{h}{T_{\max}} = \frac{6.62607015 \cdot 10^{-34}\,(Js)}{1(s)} = 62607015 \cdot 10^{-34}\,(J). \qquad (12)$$

A longer period of radiation in the material world is impossible, since in this case the wavelength and the speed of its propagation will exceed the speed of light c, which contradicts the principles of Einstein's special theory of relativity [12].

Within the framework of general methodological principles, law (11) more accurately expresses the physical meaning of the law of radiation and absorption of energy and operates in all areas of its application, which corresponds to the laws of the global level. Therefore, he must replace the energy law (1), which shifts to the 2nd plan.

Further analysis showed that on the basis of dependencies (10), (11) the true physical meaning of Planck's constant *h* must be refined. At the current level of scientific knowledge, *h* is considered a characteristic of the microworld: physical particles, nuclei of atoms, atoms and molecules, which follow from the definition of its physical meaning given in [3, p.383]: "Planck's constant – is a quantum of action that reflects the specifics of regularities in the microcosm and plays a fundamental role in quantum mechanics." At the same time, the level of quantities with dimensions of 1 μm, or 10^{-6} *m*, belongs to the microcosm, and the level of physical particles, atomic nuclei, atoms and molecules belongs to quantum mechanics.

However, from definition [3, c.383] it is not clear enough what the "action" of this quantum is, and also what causes its "specifics". Presumably, this specific is the very change in parameters by “portions” or quanta, but a strict physical justification for the causes of the appearance of “portions” of energy, in the form of the value *h*, is not given.

Based on this definition, Planck's constant is unacceptable for characterizing the macrocosm. However, from dependence (12) it follows that its extreme level of application is associated with a wavelength that is numerically equal to the speed of light c (8), which is ≈ ¾ of the radius of the Moon's orbit at apogee R_M = $0.40540 \cdot 10^9$ *m* and this value is clearly beyond the microcosm 10^{-6} *m* [13]. Therefore, this part of the definition of the physical meaning of h, as a characteristic of the microcosm, should be canceled, which corresponds to the principles of the fundamental nature of this physical constant, since it has the same level of significance as the constants *c* and *G*, which have no restrictions in the scope of their application.

To determine the attribute "action", the property of fundamental physical constants found in was used, to be expressed in terms of Planck values l_P, t_P, m_P within their dimensions. For Planck's constant h, it is the values kgm^2/s or *Js* (2) [14].

In the first case (kgm^2/s), this is actually the *impulse of moment of the amount of movement* (13) with at the speed of light in vacuum c (7), for Planck mass m_P (6) and Planck length l_P (4):

$$h = P_m = (m_P c) l_P = \left[5.45551 \cdot 10^{-8}\,(kg) \cdot 0.299792458 \cdot 10^{9}\left(\frac{m}{s}\right)\right] 4.05135 \cdot 10^{-35}\,(m) =$$

$$= 6.62607015 \cdot 10^{-34}\left(\frac{kgm^2}{s}\right) \qquad (13)$$

In the second case (*Nsm*), this is actually the *impulse of force* (15) for Planck force *Fp* (14), Planck of Planck time t_P (5) and length l_P (4):

$$F_p = \frac{m_p c}{t_p} = \frac{5.45551 \cdot 10^{-8}\,(kg) \cdot 0.299792458 \cdot 10^{9}\left(\frac{m}{s}\right)}{13.51385 \cdot 10^{-44}\,(s)} =$$

$$1.21027 \cdot 10^{44}\,(N) = 1.21027 \cdot 10^{44}\left(\frac{kgm}{s^2}\right) \qquad (14)$$

$$h = P_F = (F_P t_P) l_P = \left[1.21027 \cdot 10^{44}\,(N) \cdot 13.51385 \cdot 10^{-44}\,(s)\right] \cdot 4.05135 \cdot 10^{-35}\,(m) =$$

$$= 6.62607015 \cdot 10^{-34}\,(Nsm). \qquad (15)$$

In the third case (*Nms*), this is actually the of *moment of force or pair of forces* (16) for Planck force *Fp* (14), of Planck length l_P (4) and Planck time t_P (5):

$$h = M_P t_P = (F_P l_P) t_P = \left[1.21027 \cdot 10^{44}\,(N) \cdot 4.05135 \cdot 10^{-35}\,(m)\right] \cdot 13.51385 \cdot 10^{-44}\,(s) =$$

$$= 6.62607015 \cdot 10^{-34}\,(Nms). \qquad (16)$$

In the fourth case (*Js*), this is actually the *impulse of energy* (17) for Planck energy E_P (3) for Planck time t_P (5):

$$h = E_P t_P = 4.90317 \cdot 10^9 (J) \cdot 13.51385 \cdot 10^{-44} (s) = 6.62607015 \cdot 10^{-34} (Js). \quad (17)$$

In the fifth case (*Js*), this is actually the impulse of energy (18) within the framework of *impulse Planck work* $A_P = E_P$ (3) for Planck time t_P (5):

$$h = A_P t_P = 4.90317 \cdot 10^9 (J) \cdot 13.51385 \cdot 10^{-44} (s) = 6.62607015 \cdot 10^{-34} (Js). \quad (18)$$

All these 5 parameters (13), (15), (16), (17), (18) are closer to the mechanical characteristics, which cannot be strictly related to the sphere of thermal radiation and absorption.

This disadvantage is eliminated by the use of dependence (12), in which Planck's constant h is the minimum energy quantum in the 1st frequency pulse, which was first proposed in [15]. But this quantum cannot be minimal or maximal, since the value h is the same for any frequency and period of electromagnetic waves and is a fundamental physical constant of the material world, which clarifies its physical meaning. However, the minimum or maximum can be the energy *E* obtained on the basis of *h* for different periods of oscillation of electromagnetic waves. The real value of this energy is determined by the oscillation period of specific waves. Thus, the physical meaning of Planck's constant *h* can be defined as an energy quantum in one frequency pulse or as the energy potential of the oscillation frequency of electromagnetic waves.

For Planck's circular constant $\hbar$ (the Dirac constant), introduced for the convenience of a number of calculations in quantum physics, which is obtained from Planck's constant by dividing it by the number 2π by relation (19), this frequency pulse expressed in radians per 1 second [16].

$$\hbar = \frac{h}{2\pi} = \frac{6.62607015 \cdot 10^{-34} Js}{2\pi} = \frac{6.62607015 \cdot 10^{-34} \frac{kgm^2}{s}}{2\pi} = \quad (19)$$

$$= 1.054571800(13) \cdot 10^{-34} Js = 1.054571800(13) \cdot 10^{-34} \frac{kgm^2}{s}.$$

The new law (11) is universal for the entire range of wave emission periods.

In this case, the original energy law of M. Planck (1) should be replaced by a new law (11) in all textbooks, reference books, encyclopedias and other scientific and technical literature related to the absorption and emission of electromagnetic wave energy. It has fundamental differences from the basic law (1), and has a significant impact on the development of science, which meets the signs of a scientific discovery [17]. Despite the simplicity of the given physical and mathematical substantiation, the obtained results are reliable, and their simplicity does not detract from the level of the scientific discovery made.

Conclusion and Significance

The law of energy of radiation and absorption of waves *E = hν (J)* within the frequency of their oscillations ν does not satisfy all possible conditions for its application in the material world, since it operates for 1 second and does not reflect the energy characteristics of the Universe in the 1st second after its birth, the concentration of energy in Black holes and the energy interactions of elementary particles.

The expression of the energy of radiation and absorption of waves through the period *T* of their oscillations excludes contradictions in its maximum and minimum values at all levels of the material world and at all periods of the birth and development of the Universe.

3. Within the framework of the provision on scientific discoveries, new physical dependence: *E = h/T (J)* can be designated as the "Planck-Nastasenko energy law of the electromagnetic waves".

Planck's constant *h* is a characteristic not only of the waves of the microworld, but also of any other electromagnetic waves, up to their maximum possible length of 0.299792458 10^9 *m*, which brings it to the same level of significance for the material world with fundamental physical constants *c* and *G*.

The true physical meaning of Planck's constant h reflects the energy of wave oscillations in one frequency pulse, it is a constant value, and the real value of wave energy is determined by the period of their oscillations.

The new energy law *E = h/T (J)* and the new physical definition of the physical meaning of the gravitational constant h should be included in all textbooks, reference books, encyclopedias and other scientific and technical literature related to quantum physics.

Conflicts of Interest

The author declares no conflicts of interest regarding of this publication paper.

The proposed work was carried out by the author independently as a personal initiative, based on personal scientific papers and used of literary sources open to the public [7, 9, 11, 14, 15]. Permission to publish them is not required.

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