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THE LAW OF THE RADIATION OF THE PERFECT BLACKBODY IS THE LAW OF CLASSICAL PHYSICS

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Abstract: The notion "Quantum Physics" has appeared due to the fact that Max Planck failed to find the connection of mathematical model of the law of radiation of the perfect blackbody with the laws of classical physics. Now this task is solved, and we are faced with the problem of systematization of fundamental scientific notions and axioms, on which modern physics is based.
Keywords: classical physics, blackbody, electromagnetic radiation, Planck's constant, photon, frequency.

INTRODUCTION

The deduction of mathematical model of the law of the radiation of the perfect blackbody made by Max Planck at the beginning of the 20th century was based on notions and ideas, which are considered to contradict the laws of classical physics [1], [2]. Planck introduced constant h with dimensionality of mechanical action into the mathematical model law of the radiation of the perfect blackbody. This contradicts to the electromagnetic nature of radiation. Nevertheless, his mathematical model described experimental dependencies of this radiation. The constant introduced by him pointed out fact that radiation place not continuously, but in packets. It was in contradiction to Reyleigh - Jeans law, which was based on notions concerning the continuous wave nature of electromagnetic radiation, but described experimental dependencies in the low frequency range only [2].

As the mathematical model of Reyleigh - Jeans law is present in the mathematical model of the law of the radiation of the perfect blackbody, it means that Planck law of the radiation of the perfect blackbody is based on the mutually exclusive wave and corpuscular notions nature of radiation [2], [3], [4], [5].

Continuous wave process of radiation with portal process was a safe basis for acknowledgement of the crisis classical physics. Since that time, physicists began to think that the application field of the laws of classical physics restricted by the macro-world. They think that other, quantum laws operate in the micro-world, that's why physics, which describes the micro-world, should be called quantum physics. It should be noted that Max Planck tried to understand the mixture of such physical notions and return them to the classical way of development, but failed [3], [5]. For the first time, a mathematical model of the law of the radiation of the perfect blackbody by thermodynamic ideas was expressed by Yu.M. Ageev [10], [13].

Years later, we have to admit that the border between the law of classical physics and quantum physics has not been established yet. Still it is difficult to solve many problems of the micro-world, and many problems are considered to be unsolved within the framework of the existing notions and conceptions, why we have to return to an attempt Max Planck to derive a mathematical model of the law of the radiation of the perfect blackbody on the basis of classical notions [6], [7], [8], [10], [11].

THEORETICAL PART

First of all, let us give Reyleigh - Jeans formula, which describes satisfactory experimental behaviour of a low frequency range of radiation. Taking into consideration the wave conceptions on electromagnetic radiation they have found out that energy E_{RJ} being available in volume V of the perfect blackbody is determined by the dependence [2]

$$E_{RJ} = \frac{8\pi\nu^2}{C^3} V \cdot kTd\nu, \tag{1}$$

where ν is frequency of radiation;
V is volume of space of the perfect blackbody;
C is the speed of light;
k is Boltzmann constant;
T is absolute radiation temperature.

If we divide the left part and the right part of the relation (1) by volume V, we get volumetric density ρ_ν of electromagnetic radiation

$$\rho_\nu = \frac{8\pi\nu^2}{C^3} \cdot kTd\nu. \tag{2}$$

The deduction of this formula is based the notion a number of standing waves of electromagnetic radiation with frequency ν in the closed space of the perfect blackbody [2].

In order to get the mathematical model, which could describe the whole range of electromagnetic radiation of the perfect blackbody, Max Planck postulated that the radiation is not continuous but it is in packets, and energy E of each radiated packet is equal to $E = h\nu$, and the formula for the calculation of density ρ_ν of electromagnetic radiation of the perfect blackbody is as follows [1], [2]

$$\rho_\nu = \frac{8\pi\nu^3}{C^3} \cdot \frac{h\nu}{e^{h\nu/kT} - 1}. \tag{3}$$

Value h is a constant with mechanical dimensionality of the action. The essence of this action was completely unclear at that time. Nevertheless, the mathematical model obtained by Planck gave a satisfactory description of the experimental laws of the radiation of the perfect blackbody.

As it is clear, the expression $\frac{h\nu}{e^{h\nu/kT} - 1}$ in (3) significant addition to Reyleigh - Jeans formula (2), $h \cdot \nu$ energy of one radiated photon.

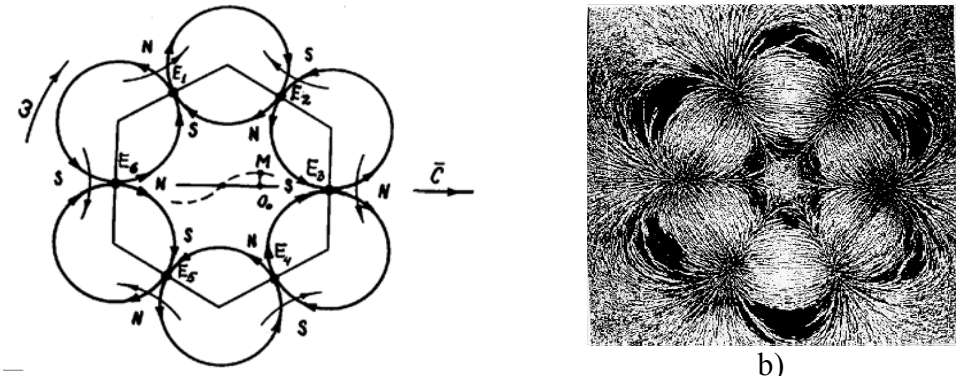
In order to understand the physical essence of Planck addition, one should have a notion of electromagnetic structure of the photon, because the physical essence of Planck constant h is in this structure. As the product $h \cdot \nu$ describes energies of the photons the whole scale of electromagnetic radiation, electromagnetic structure of the photon is concealed in dimensionality of Planck constant. The detailed description of the formation process of electromagnetic model of the photon and the process of its movement dozens of pages of the book text [4], [5], [6], [8]. That's why we give only a scheme of this model and show constant is realized in it [8].

We have found out that the photon has rotating electromagnetic structure, the center of mass describes the λ, which is equal to radius r of its rotation. As a result, of constant is as follows [8]

$$h = m\lambda^2\nu = mr^2\nu\left(\frac{kg \cdot m^2}{s}\right) = const. \tag{4}$$

As it is clear, Planck constant has clear mechanical dimensionality of angular momentum, which has another name – moment of momentum. It is known [11] that the law of conservation of angular momentum governs constancy of angular momentum, and the reason clear. First of all, the notion "the law of conservation of angular momentum" is notion classical physics, to be more precise, classical Newtonian mechanics. It means that **if no external force influences a rotating solid body, angular momentum of such body remains constant.**

The photon is not a solid body but it has mass m, and we have every reason to believe photon an electromagnetic substance (i.e. electromagnetic field) rotating in relation to the axis plays the role of mass. It results from the mathematical model (4) of Planck constant that the electromagnetic model of the photon should be such that simultaneous change of mass m, radius r and frequency ν of the rotating electromagnetic fields of the photon would retain their product reflected in the mathematical expression of Planck constant [8]. The diagram of the rotating electromagnetic fields of the photon is in Fig. 1 below.



a) b)

Fig. 1. Diagrams of electromagnetic models of the photon
a) the theoretical model b) the simulated one by Walter Krauser [17].

It is known that if mass (energy) of photon is increased, its wavelength is decreased. This change is implemented with the help of Planck constant (4) in the model of the photon (Fig. 1) [8].

As the law of conservation of angular momentum ($h = mr^2\nu = const$) governs constancy of constant, density of their electromagnetic fields is increased when the mass m of the photon (Fig. 1) is increased, and due to the electromagnetic forces which are balanced by an equal the centrifugal forces of inertia compressing the photon. This leads to the reduction of radius r of photon rotation, which is always equal to its wave length λ. But as radius r in the expression of Planck constant is squared, oscillation frequency ν should be increased in order to preserve constancy of Planck constant (4). Due to this fact, a small alteration mass of the photon changes its rotation radius and frequency automatically in such a way that angular momentum (Planck constant) remains constant. Thus, the photons of all frequencies preserving their electromagnetic structure change mass, frequency and rotation radius in such a way that $mr^2\nu = h = const$. It means that **the law of conservation of angular momentum governs the principle of this alteration** [7], [8].

Why the photons of all frequencies move in vacuum with equal speed? The answer is alteration of frequency ν of the photon is a consequence of the alteration of the mass, which changes the density of the electromagnetic fields of the photon and the electromagnetic and centrifugal forces of inertia leads to the change radius of its rotation, which is always equal to its

wavelength. The above-mentioned changes take place in such a way that the product of frequency ν and wavelength ($\lambda = r$) is constant for the photons of all frequencies and is equal to $\lambda \cdot \nu = C$. The speed of the center of masses M of the photon (Fig. 1) is changed in such a way that its average value remains constant and equal to C [8], [9], [11].

Thus, the law of conservation of angular momentum, one of the fundamental laws of classical physics (to be more precise, classical mechanics) governs constancy of Planck constant h. In modern physics in classical mechanics it is called the law of conservation of moment of momentum [11]. It is a purely classical mechanic law, not a mystical mechanical action as it has been considered previously. That is why the appearance of the Planck constant in the mathematical model of the law of the radiation of the perfect blackbody does not give the reason to consider that classical physics is unable to describe the process of this body. On the contrary, the law of conservation of angular momentum, the most fundamental law of classical physics, takes part in the description of this process [7], [8], [9]. Thus, Planck's law of the radiation of the perfect blackbody is a law of classical physics. The derivation of this law is based on classical notions given below [4], [5], [6], [7], [8], [10], [11], [13].

CLASSICAL DERIVATION OF THE LAW OF THE RADIATION OF THE PERFECT BLACKBODY

Use Reyleigh - Jeans ideas in the calculation of a number of packets of electromagnetic radiation in the space of the perfect blackbody, describe a separate packet of electromagnetic radiation not as the standing wave, but as the photon [4], [5], [6], [7], [8], [11]. As radii of the closed electrical fields of the photon are $0.5r$ and radii of the center mass of electromagnetic fields are r the photon does not have a spherical form, but a flat form is nearly one fourth of the sphere with radius r. Thus, the volume of the localized space, in which the photon can be present, will be nearly $\frac{4}{4 \cdot 3} r^3$. Volume $\frac{4}{3} R^3$ of the spherical space of radius R of the perfect blackbody will many orders of magnitude greater than the volume of the photon. Maximal quantity N of the photons in this space (as well as maximal quantity of standing waves in Reyleigh - Jeans formula) will be determined by a dependence

$$N = \frac{4 \cdot R^3}{r^3}. \tag{5}$$

Taking into consideration that $C = \lambda \nu = r \cdot \nu$, we'll have

$$N = \frac{4 \cdot R^3 \cdot \nu^3}{C^3}. \tag{6}$$

The interval of frequencies from ν to $\nu + d\nu$, the number will be

$$dN = \frac{3 \cdot 4 \cdot R^3 \cdot \nu^2}{C^3} d\nu. \tag{7}$$

As the photon moves linearly and rotates round its axis in three-dimensional Euclidean space, it will have six grades of freedom. Taking this into consideration and dividing the left and the right parts (7) by volume R^3, we get the volumetric density $d\rho$ of the photons in the spherical plane of the perfect blackbody as shown below:

$$d\rho = \frac{3 \cdot 6 \cdot 4 \cdot \nu^2}{C^3} d\nu. \tag{8}$$

We integrate, we get

$$\rho = \frac{24 \cdot \nu^3}{C^3} \tag{9}$$

Thus, we have volumetric density (9) of the photons in the spherical space of the perfect blackbody. If spherical space has a small hole, energy that is emitted via this hole, will depend energy of each photon $h\nu$, to be more precise, on its frequency ν. Then the photons, which have passed via hole in the spherical space, will be absorbed. As energy of each photon on the plane of its polarization is realized by two grades of freedom, the value of heat energy of the absorbed photons will be equal to kT. It means that volumetric density of the radiation of the perfect blackbody will depend on energy $h\nu$ of each radiated photon and energy kT of the whole set photons.

As the radiation of the perfect blackbody is a set of the photons, each of which has only kinetic energy, we should introduce kinetic energy $h\nu$ of the photon and heat energy kT of the set of the radiated photons into the mathematical model of the distribution [9], [12]

$$y = e^{-h\nu / kT}. \tag{10}$$

We should take into account that the photons are emitted by the electrons of the atoms during their energy transitions. Each electron can make a series of transitions levels 1,2,3...n emitting the photons of various energies. The complete distribution of volumetric density of energy emitted photons will consist of a sum of the distributions, which take into account energies of the photons of all energy levels. With due regard for the above - mentioned facts, Maxwell law, which takes into account energy distribution of the photons all (n) energy levels of the atom, be put down in the following way

$$y = e^{-h\nu / kT} + e^{-2h\nu / kT} + e^{-3h\nu / kT} + \cdots + e^{-nh\nu / kT}, \tag{11}$$

where n is the main quantum number determines of the position of electron in the atom.

It is known that sum of row (11) is equal to [2]:

$$y = \frac{1}{e^{h\nu / kT} - 1}. \tag{12}$$

If we multiply the right part of volumetric density of the photons (9) in the space of the perfect blackbody by a mathematical expression (12) of the law of this density and by the energy of one photon $h\nu$, we get the volumetric density ρ_ν of energy which is radiated by the perfect blackbody

$$\rho_\nu = \frac{24 \cdot \nu^3}{C^3} \cdot \frac{h\nu}{e^{h\nu / kT} - 1}. \tag{13}$$

It is the law of the radiation of the perfect blackbody (3) as obtained by Max Planck. Expression (13) differs from the expression (3) coefficient 24. According to E.V. Shpolsky [2], the value of this coefficient depends on the character of electromagnetic radiation and can vary from 4π to 12π. But within the framework of the above-mentioned notions, the coefficient

$$k_f = \frac{24 \cdot \nu^3}{C^3} \tag{14}$$

acquires a precise physical sense. It characterizes (as it should) density of the photons in the cavity of the perfect blackbody. The value 24 does not change the law of the radiation of the perfect blackbody, why more precise value of this coefficient can be determined by experiment.

CONCLUSION

Thus, we have derived the law of the radiation of the perfect blackbody on the grounds of purely classical notions and ideas, and we see no reason to believe that this law contradicts classical physics. On the contrary, it follows from the laws of this physics.

Now we have the way of the development of the theoretical physics, which allow us to describe the behaviour of the photon [14], electron [15], nuclei of atoms [16], atoms, and molecule [8] in more detail with what modern theoretical physics.

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