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Professional paper

"ATOMISM" OF ENERGY

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Abstract

This paper presents and explains to the reader the basic difficulties that classical physics faced when it extended into the area of the microscopic world. These difficulties arose when were made the first attempts to understand and explain the mechanism of interaction between matter and radiation. This interaction, according to classical physics, was imagined as a continuous process, while modern physics supports the discrete idea of interaction between matter and radiation. According to modern physics, the process of emission and absorption, i.e. the exchange of action between matter and radiation is carried out with minimal portions of energy, with quanta, which are proportional to the frequency of the radiation: $E = h\nu$. The proportionality coefficient "h" has the dimensions of action: Energy × time. This new universal constant - the quantum of action - not only revised the classical concepts but also solved a series of problems of the atomic world, where classical physics was "blocked". The solution to these problems, which led to the birth of a new theory - quantum physics - convincingly proved the great heuristic value of Max Planck's hypothesis.

Keywords: atomism, classical physics, quantum probability, quanta of action, interaction.

1. Introduction

On the eve of the new century physics efforts were directed at resolving the two closely related problems among themselves: the true explanation of the microscopic structure of matter and the law of interaction of matter with electromagnetic radiation [1]. The first record of building material during the study were the rays that arise during the electric discharge in the so-called thin gases, beam channels, and cathodes, which appeared as electrically charged particles flow, moving with small speed or large. Thus discovered electrons (Xh.Xh.Tomson 1897) - as particles of radiation cathode, their behavior was studied in the presence of electromagnetic field theory and built a full interaction between electrons and electromagnetic waves (electronic theory of Lorentz) [2-4]. The very existence of atoms and molecules, which for a long time to examine just as comfortable working hypothesis, were accepted as objective realities.

The most convincing confirmation was the study of Brownian movement which arises due to the irregular particle striking the molecules of the surrounding environment.

It was meant to produce precise, molecular motion and is quantitatively related to statistical laws, the movement of molecules of the environment itself (Einstein, Smolluhovski 1905).

Systematic measurements of Perrenit, (1908) confirmed this hypothesis and allowed us to perform new measurements, (and that fit between them) for Avogadro's number [5]. After this critical success, physicists will not doubt the existence of atomic and subatomic particles. Were elaborated experimental methods, which allowed to look at specific phenomena at the microscopic level and to calculate specific microscopic particles (measurement of basic load of Milikeni electron in 1910, the first observations of trajectories of charged particles in the chamber in 1912 to Vilson, Gajgerit first calculator in 1913). These methods of observation "direct" were perfected even further with today constituting the most important experimental technique for the study of microscopic phenomena.

At the same time, a new chapter of physics was opened with the discovery of radioactivity (1896) - the first discovery of the properties of atomic nuclei. This discovery gave physicists in their hands a powerful tool to study the structure of the atom, namely radiation consisting of helium nuclei of atoms moving at great speed. Directing α radiation in different signs, Rutherford (1911) conducted systematic studies of the distribution of α particles with atoms and dared such a way, to build the first model of the atom-planetary model in which the center is the core of many dimensions small (10-13-10-12), around which z - electrons move, like planets around the Sun. Almost all measures of the atom are concentrated in its core. Electric charges of the nucleus are positive and equal to +z×e that exactly offsets a full load of negative electrons -z×e, so in general del an electrically neutral atom [6-10].

In parallel with the development of images of particles on the construction of the case, there was also the deepening of knowledge on electromagnetic radiation. The spectrum of electromagnetic waves known, expanded in terms of increasing wavelengths and shorter detection of Rontgen rays (Röntgen 1895) wave nature of which was decided by diffraction experiments on crystals (for Laue 1912). On completion, even mention of radioactive γ - radiation, the electromagnetic nature of which was confirmed relatively late. Complete so the rate of electromagnetic waves: radio waves, optical radiation (infrared, visible, ultraviolet), and radiation Röntgen γ-radiation [11-16].

Refined spectral analysis methods, allow an accumulation of a large amount of information about the processes of emission, discharge, and absorption of light by matter, ie about the interaction between matter and radiation at the microscopic level [17-19].

Already mentioned the Lorentz theory, namely the theory of charged particles in interaction with electromagnetic fields allows in principle to explain all these phenomena. But exactly when comparing predictions of this theory with experimental results was a first identified contradiction between classical theory and experiment. The first difficulties arose during the study of the spectral distribution of electromagnetic radiation that is in thermodynamic equilibrium with matter. A typical example is the case of a black body - the body that absorbs all radiation that falls on it. The theory of thermal radiation physics gave all of today's light, it became the cornerstone of the quantum birth of the doctrine - a doctrine which changed the classic images of the interaction of matter and radiation and led to new perceptions about the nature of light and matter.

2. Classical theory of thermal radiation

With radiation, physicists mean energy transmission through the wave process. Energy can be transported into space by waves of different physical natures, for example by elastic, electromagnetic, and gravitational waves. If the spread of elastic waves is required material environment for the spread of electromagnetic and gravitational waves this environment is not required. In this case, the spreading is carried out through physical fields. The most characteristic feature of nature is that most of the bodies radiate energy all the time in the form of electromagnetic waves. The Full Spectrum of radiation contains all types of electromagnetic radiation. Depending on the length of the wave nature of radiation changes its properties. The whole spectrum can be divided into defined areas, depending on the sources of radiation, the methods of its degradation in range, and methods of registration. As sources of optical radiation, serve the physical bodies that turn any kind of energy into energy of electromagnetic radiation of the optical range of the spectrum. Sources, whose radiation happens on account of heat, are called thermal sources and the radiation emitted by these sources is called thermal radiation. Thus, thermal radiation is associated with the thermal motion of molecules, which is characterized by body temperature T. Consequently, it comes to radiation that arises in conditions when the body maintains a certain temperature (mean, greater than the environmental temperature). This is realized when the radiation losses, are compensated by heating of the body. The fact that this radiation is related to thermal movement and his excitement is through the provision of heat from the outside, conditioned, and his name is "thermal radiation". Imagine a cavity, whose sites emit and absorb thermal rays. The experiment shows that such a cavity, after some time; establishes a thermodynamic equilibrium between the energy of radiation and matter. (emission and absorption from the pages of the cavity). For a constant temperature, the distribution of energy density of radiation (energy of radiation per unit cavity volume) according to frequency takes a constant value. For a specified frequency, more specifically, for an infinitely small interval of the frequency from ν to ν+dν, energy density is a function of frequency in this interval. This is called the spectral density of radiation and is labeled with ρν. The fundamental problem of thermal radiation was just finding the dependence of the spectral density of radiation on the frequency.

The basic directions of development of the theory of radiation at the end of the XIX century were theoretical and experimental research of the curve, which shows the distribution of energy density according to the parts of the spectrum. And these searches went through several stages of development. The first stage was Kirkof's law. He showed that the spectral density of radiation, for a constant temperature, does not depend on the nature of the bodies, which emit in a cavity with an ideally reflective page. Kirkofi found a relation between emitting ability ϵν and absorbing ability αν of the body and spectral density ρν. He introduced the concept of the black body as a body that absorbs all the energy that falls on it. The laws of radiation of a body such as black absolutely must be found. In nature, there are no black bodies, though some are radiant, for the properties are close to them. (for example. the sun could serve as such for the temperature of 5500°C). Radiance can be created artificially too close to absolutely black bodies. A sealed container that distributes almost light and tiny cracks "a "; sites vessel kept at a certain temperature T. Any radiation that falls into the container should be reflected from its pages a few times before it is released from it through a small fissure "a". As a result of multiple reflections from the division "a" appears a very small portion of the negligible flow of light. This means that the division "a" (Figure 1) brings themselves as a black body.

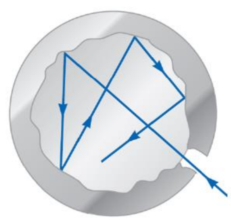

Figure 1

A laboratory model of a black body may be accomplished by graphite or other refractory material in the form of a sphere full of tiny cracks. In this way, to study the properties of absolutely black body, it is possible not only theoretically but also experimentally.

Considering these results, for the Kirkofi and Lambertit law, Laue wrote: "No one doubted the value of these discoveries. What was considered impossible was the observation of black body radiation. In 1895 Otto Wilhelm Note Lumer and Vilhemlm Vini found a way to display it, observed within the closed space through a small rift, so small that it does not change the state of radiation in the cavity closed. So, since that time, there are quantitative measurements of the intensity of radiation" [20].

In the late nineteenth century, starting from general perceptions of thermodynamics, perceptions based on the law of conservation of energy and in principle on the impossibility of building perpetual mobile of the second kind, were found experimentally two empirical laws related to radiation: Note Vin's law stating that the wavelength that corresponded to the maximum intensity was proportional to reciprocal absolute temperature λmax·T=cte: and the law of Stefan-Bolcmanit E=σ×T4: which states that the total intensity emitted by all lengths of the waves was proportional to the fourth power of absolute temperature.

The law of Vin, and Stefan Bolcmanit close second and the third stage of the classic study of a black body. In fact, all the efforts made to obtain an equation expressing the intensity in function of wavelength F(ν, T), were unsuccessful. The problem was overcome in the general limits by Relei and Jeans, with thermodynamic perceptions [21-22]. They reviewed the closed basin; whose sites were in the temperature T. Container was

filled with radiation which was in balance with the sites (the subject). Electromagnetic radiation being reflected many times from the pages, forms a stable system of waves, analogous to matter. With cord conditions for the formation of stable waves as known from the theory of fluctuation and waves is n(λ/2)=L:
where L is the length of the cord between the two fixed edges, n-integer. If, in a closed cavity traveling electromagnetic wave planes, then the conditions of formation of stable waves are also determined by the set of integers. E.g. if the waves spread in the cavity cube plans, to which the normal form angles α, β, γ with her ribs (figure 2), then the terms of the formation of stable waves have the form:

$$n_1\left(\frac{\lambda}{2}\right)=L\left|\cos\alpha\right|,\quad n_2\left(\frac{\lambda}{2}\right)=L\left|\cos\beta\right|,\quad n_3\left(\frac{\lambda}{2}\right)=L\left|\cos\gamma\right| \qquad (1)$$

The three numbers n1, n2, and n3 define the system's fully stable waves or as stated in electrodynamics, determine the mode.
Starting from the equation, (1) can be calculated mode number belonging to a small interval in the frequency from ν to ν+dν equal to:

$$\Delta z=\frac{4\pi V}{c^3}\nu^2\Delta\nu \qquad (2)$$

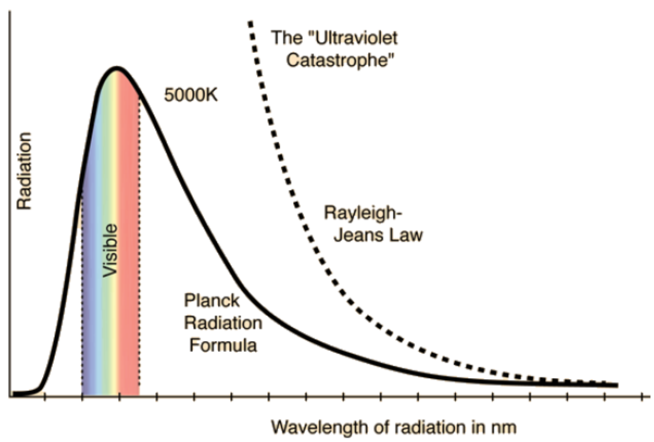

Figure 2

In this formula, V=L3 is the volume of a cube. The same result was obtained for the cavity with any other form. On equilibrium, wave energy will answer dipolar radiant energy (electrons Rocker) located in the rigid body which is composed of cavity sites. In this way, a modified average of the electricity they have a dipole oscillator. So, a mode contains average energy with the same value as a dipole oscillator. According to statistical physics for a balanced system, this average energy is equal to E=kT where k – Boltzmann's constant (k=1.38×10-16). If the calculated states of polarization of the wave potential, then that size should be doubled. Therefore the energy that the frequency interval Δνper unit volume of the cavity is (ΔZ/V)·2kT:
And the power spectral density of radiation within the cavity will be :

$$\rho_\nu=\frac{\Delta Z}{V}\cdot\frac{2kT}{\Delta\nu} \text{ ie } \rho_\nu=\frac{8\pi\mu^2}{c^3}\cdot kT \qquad (3)$$

And at the wavelength $\rho_\lambda=\frac{2}{\lambda^4}\cdot kT\lambda^{-4}$ where is the speed of light? It is understood that if we examine the cavity of a small crack, then the radiation emerges from it with the same composition as the radiation that lies within. Therefore formula (3) gives the spectral energy distribution and spectrum of the absolutely black body.

Formula (3) is known as the Relei-Jeans because Relei, along with Jeans, dealt with the issue of radiation. The conclusions from this formula are absurd. And that's why!

By comparison of experimental with theoretical curves (Fig. 3) obtained the following conclusions:

Experimental curves show the existence of a thermal equilibrium between matter and radiation. Experimental curves show that with increasing temperature of the radiation center of gravity will gradually shift to the side of short wavelength (or frequency major) to ultraviolet radiation. According to these curves, the spectrum of the black body, spectral density after it reaches a maximum (for a certain temperature) in an area of the spectrum, and falls on the ultraviolet radiation, is interrupted. The problem that arose got the name "ultraviolet catastrophe". Theoretical curves do not show a rise of infinite energy of radiation emitted from the body, nor that they balance the energy between matter and radiation. All the energy of matter transformed into radiation!? The absurdity is clear.

Why does such an absurdity arise?

First, the extrapolation of classical concepts and laws (the real case) to electromagnetic fields was a wrong move.

After the discovery of Maxwell's laws of electromagnetic processes, began to apply the laws of thermodynamics to electromagnetic fields, especially in thermal radiation. However, the phenomenological character of thermodynamics does not allow for calculating the distribution of frequencies. Therefore physicists approached the statistical method. The advantage of this task before the other was that the statistical description of the assignment was not known in detail necessary to build and emit atoms and absorb electromagnetic waves. But for every building material able to emit and absorb waves of any length thermal equilibrium must exist between matter and radiation. Since the construction of the atom was not known, then such a task should be resolved within the framework of statistical mechanics. In this case a simple model of the atom that provides the emission and absorption of waves of any length, for example, to imagine matter as a whole of linear harmonic oscillator. For this oscillator electronics ensemble, statistical images were implemented. Oscillator was assumed that they are similar to gas molecules and every one of them is energy $\frac{kT}{2}$. Calculating the number of such oscillators in the range of wavelengths between λ and λ+dλ in the function of λ leads to the conclusion that this number increases with decreasing of λ proportional $\frac{d\lambda}{\lambda^4}$. If any such oscillator, we give the energy of $\frac{kT}{2}$ so the power of radiation will be proportional to kTλ-4. So, it was obtained the law of Reley-Jeans.

Was it fair to "assume that the oscillator electronics are similar to gas molecules? The answer is negative because there is a big difference between gas and thermal radiation. Gas was supposed to be composed of an ensemble of molecules, which are not material particles but have a finite diameter. Molecules are subject to many attacks during which occurs reciprocal exchange of energy. In the case of light waves, the situation changes, because the two bundles of light that are in the way of each other do not interfere with the spread. Then how can realize the exchange of energy between stationary waves in a closed cavity? Let's imagine we have an ideal gas consisting of molecules dashboard (actually a gas such does not exist). In this case, we would not have reciprocal and therefore hook or energy exchange between them. To have this exchange of energy between molecules dashboard of an ideal gas should be introduced into the container, one or more particles with diameters of finite however small (brownian particles). Facing them, the molecules will dashboard 'was broadcast them off and in this case would happen to exchange energy. For an analogy, in the case of light waves, to have an exchange of energy between stationary waves with different wavelengths should we put them into a small container body to absorb every possible frequency, allowing an exchange of energy between all swings possible.

Ordinary black bodies, such as carbon wood, have this feature in at least a visible area of the spectrum and can imagine the "ideal black bodies" that behave in the same way with all possible frequencies of waves. By placing the cavity some carbon dust particles will thus solve the problem of energy exchange between matter and radiation. When using statistical methods, Relei assumed that "each oscillator, being similar to gas molecules belonged energy Kt, so he applied to electromagnetic radiation, the law of uniform distribution of energy according to degrees of freedom.
In what consequences the implementation of this law lead to classical thermal radiation? Russian physicist G. Gamow explains it this way [23].
The law of uniform distribution of energy according to degrees of freedom asserts that the full energy contained in a system with a large number of particles that exchange energy between them, through mutual shocks, redistributes average among all particles. If we denote by E, the full potential energy in the system and N-total number of particles, we can say that the average energy per particle is E/N. Despite the law of uniform distribution of energy, regulating the average distribution of energy among a large group of particles, this does not mean that the velocities and energies of individual particles are similar to their averages. This change in values from the average individual is named statistical distribution. In this case, the state of the system will be determined not only by specific values of physical sizes but also by the statistical distribution of these values. Distributions can be presented mathematically by Makswell-Bolcmanit formulas or graphically as in Figure 3.

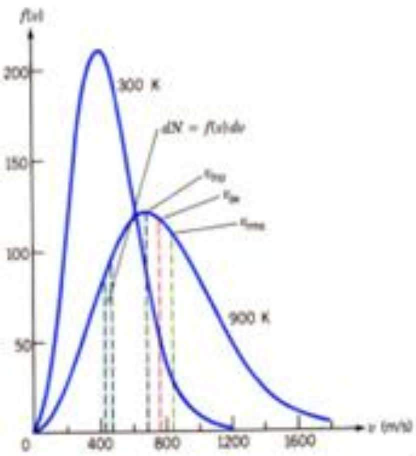

Figure 3

In Figure 3 are presented graphs that show the relative number of particles for each given temperature (in our case for three different temperatures of a gas). This distribution belongs to, molecules of gas. If we compare the curves of Figure 3 with those of Figure 2 - highlights Gamow - look at the outside a similarity: If in the first case, the temperature increase of the maximum point curve shifted to a larger molecular speed in the second case the maximum point moves towards larger frequency radiation. This similarity was suggested by Relei and Jeans, so the idea of implementing this law to thermal radiation (which had had much success in Gases) led to the conclusion that the full radiant energy was to be evenly distributed in all possible frequencies. The problem, which bore the absurdity, was that despite the similarities between a gas composed of individual molecules and thermal radiation created by electromagnetic fluctuations, there was a substantial difference.
If the number of gas molecules in a given space is always finite no matter how great to be this space, the number of possible electromagnetic fluctuations. In the same space is always infinite. To understand is necessary to remember the stable waves in a string or a cube. In the entire length of the cord can be placed an infinite number of half wavelengths where the fundamental frequencies corresponding to different harmonic oscillations will be multiple of 2, 3 ... ... 10 ... ... 102 ... .106 ... ... 1010 basic ones (Figure 4).

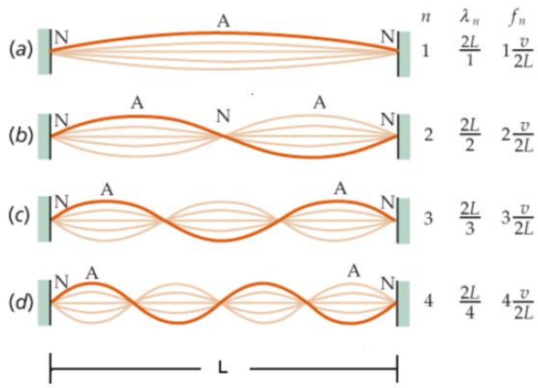

Figure 4

In the case of steady waves in the interior of a hollow three-dimensional (for example in a cube), the situation will be similar, though slightly more complicated: we will have an unlimited number of different oscillation wavelengths always smaller, and the respective frequencies always larger. Thus if E is the full amount of radiant energy available in this cavity, the law of uniform distribution of energy will lead to the existence of an infinitely small amount of energy E/∞. The absurdity of such a conclusion is obvious.

3. Solution of the problem: the hypothesis of Planck.

By the evening of 14 December 1900 classical physics, in connection with the problem of thermal radiation was located between two alternatives: the law to come and Relei law-Jeans. Neither of these two formulas, which were found until now about the spectral distribution of thermal radiation did not comply with experimental results and theoretical explanation does not give status to monitor the thermodynamic equilibrium in the experiment. The problem of black radiation seeks a solution. And the solution came from M. Planck [24-34]. At the meeting of the German Physicists Association on December 14, 1900, Planck presented his ideas, which were so far from "normal" of classical physics and so grotesque, that he did not believe (M. Planck was a physicist classic 100%). Obviously what emotions these ideas caused the audience that night and all day physical world. Planck was convinced that the problem of equilibrium between radiation and matter has fundamental value for physics and realized that it could not be resolved with the methods of classical physics. His solution should be done with a different route, either by making sacrifices for the classic images!
He intuitively felt that the study centers have moved from the relationship between temperature and energy of the oscillator ($E \approx kT$) to the link between the entropy of radiation, and energy of the oscillator.
Entropy contributes to Boltzmann's studies. He noted that the entropy of a system (like that of the oscillator cavity sites) should be maximum when the system reaches thermodynamic equilibrium. With a maximum entropy condition, he came to the law of short waves, while in another condition with a maximum entropy law Releit, he took too long waves. To achieve compliance with the experiment it melted both these conditions in a single and got a new formula of black radiation.

$$E_v = \frac{c_1 v^3 dv}{e^{\frac{c_2 v}{T}-1}} \qquad (4)$$

In his speech upon receiving the Nobel Prize, read on June 2, 1920, Planck said: "Although this formula was correct, its meaning was limited by the fact that it was only discovered as interpolate formula. Therefore since the day of its discovery in front of me, bore the duty to seek the physical sense of her secret, and this problem

led me to review the connection between entropy and probability in the spirit of developing ideas Boltzmann. It is in this way after several weeks of tense work darkness fled, and before I bore the light of new spaces"
Planck realized that, Boltzmann's claim S=k ln W where the number of states belonging to a macro state is the measure of probability of the latter applies not only to mechanical systems but also to systems consisting of a very large number of resonators with frequency ν. The macroscopic state is determined by the full power of all resonators, and microstates, from providing energy to any particular resonator. So that the number of microstates that correspond to a macro situation has been separated by finite Planck full energy in a finite number of identical elements ε. Then the logarithm of the number of ways they can be distributed to these elements' energy between the resonators determines the entropies', the value of which the method can determine the thermodynamic temperature. So in this way, no clear shape was assumed that the particular resonator can absorb and emit energy ε=hν only in quanta. And this conclusion contradicts the mechanics and electrodynamics.
Hence Planck concluded the existence of discrete energy levels of the oscillator a conclusion which overturned the foundation of all existing theories based on the assumption of the continuous progress of natural phenomena.
Then, by accepting this hypothesis Planck argued in this way: all the energy emitted or absorbed is only a complete multiple of this basic quantum:0, hν, 2 hν, 3 hν... Will examine the N oscillator that can receive energy only from these discrete values defined. In the lowest energy state are oscillators, then according to Boltzmann, the number of oscillators that are in the i-state is $N_i = N_0 e^{\frac{ih\nu}{kT}}$. If Substitute i = 0,1,2,3 ... then all the energy states will have an N-oscillator. After summing we have:

$$N = N_0 N_0 e^{\frac{-2h\nu}{kT}} + \ldots + N_0 e^{\frac{-ih\nu}{kT}}$$

or

$$N = N_0 \sum e^{\frac{-ih\nu}{kT}}$$

The total oscillator energy is equal to the production of energy for the energy level given by the number of oscillators (N):

$$W = N_0 \cdot h\nu \sum e^{\frac{-ih\nu}{kT}}$$

As the average oscillator energy, obtained the ratio between total energy and total number of them:

$$\bar{E} = \frac{W}{N} = \frac{N_0 \cdot h\nu \sum e^{\frac{-ih\nu}{kT}}}{N_0^{e^{\frac{-ih\nu}{kT}}}}$$

Hence it appears that the average oscillator energy should calculate the discrete sum and not by the integral as is done in the Reley-Jeans formula. This is a substantial difference between the two theories: that of Planck and Relei- Jeans *. Based on these arguments Planck issued the following law:

$$\bar{E} = \frac{h\nu}{e^{\frac{h\nu}{kT}-1}}$$

So we see that the average oscillator energy, the new quantum vision, is not anymore (power law distributions of the degrees of freedom). (law of irregular distribution of energy according to degrees of freedom). So Planck said no to the uniform distribution of energy according to degrees of freedom! According to the law is non-uniform distribution of energy radiation by frequency. This explained the ultraviolet catastrophe. Planck "by entering the paradoxical assumption of quantum game-stress: De Broglie built thermal equilibrium theory, and issued a new law distribution of spectral energy density of radiation of black, the law who has taken his name [35]."

Contrary to the law Releit which leads to the monotonous increase of spectral energy density of black radiation, Planck's law shows that the power spectral density initially increases with frequency and then passed through a maximum, decreasing flatly aiming at zero for frequencies that aim towards infinity. The curve of change spectral density depending on the frequency, has the appearance of a bell, and is full of the energy density of radiation of black, as shown easily emerges as a finite size and not endless as claimed by Relei.

According to Planck, the exchange picture between radiation and matter is conceived in this way: the body's radiant oscillator (cavity sites) suggests that disorderly movements are characterized by the average kinetic energy $k\bar{T}$. On the other hand cavity sites and self-emit energy quanta cavity filled with these quanta.

If we start from the image in which each wave lasts (mode) the radiated energy in the cavity is minimal ε=hν, which can then be conceived in the form $h\nu = \frac{hc}{\lambda}$, of very short wavelength (or high frequency), the minimum energy required for excitation of the wave sustainable becomes so great that this wave is not emitted by the oscillator.

In this way instead of the infinite number of stable waves (mode) $\lambda = 2l, l, \frac{2}{3}l, \frac{2}{5}l...$ take a finite number of them, starting from λ=2l and ending at such value of λ for which $h\nu = \frac{hc}{\lambda}$. So, according to Planck, if n=0, then the oscillator is located in the lowest energy state (T = 0K), its average energy is zero; between cavity walls do not form stable waves, and the cavity no quanta. When n = 1, the oscillator passes through the excited state and begins to increase its average energy kT. In this case, it can emit quanta with wavelength λ=2l for n = 2 emit quanta with wavelength λ=l, and so on.

For the case when hν<<kT (small frequencies and higher temperatures) in this area during the combination of energy exchange between matter and radiation operated a large number of light quanta (the frequency is low). Since their excitation energy is small, then they are issued with ease (with increasing temperature T), creating the impression as if these quanta are emitted in a continuum. So we line the experiment and classical images.

For the case when hν>>kT (large frequency and low temperature) in this area we are dealing with heavy quanta. Their emit required a very large energy of excitation of the oscillator and thermal energy is unable to emit such a heavy quanta belonging to ultraviolet radiation thus the contribution of these quantum complete the thermal radiation is almost negligible. This is why we also terminate exactly thermal radiation in large frequency areas (area ultraviolet). We, therefore, have consistent images of the Planck experiment.

4. Max Planck and the Quanta

In the early twentieth century, Max Planck represented an extraordinary figure. He was a theoretical physicist- and in this sense as he notes, a physicist "sui generis", 100% classic (for which he cannot be blamed; highlights Gamow.

Max Planck was born on 23 April 1858 in the German city of Chile, in an intellectual family. His father, Wilhelm Planck, was a professor of law, at the University of Chile. In 1867, he moved to Munich, where Max spent his youth as well. Here he finished Maksimilianit classic high school, where the professor of mathematics was Miler Herman, a mixer, smart and rigorous, with clear examples, simple and understandable explained to his students the laws of physics.

"I can't forget, the story of Miler- wrote Planck in his memoirs -how work bricklayer built the roof of the house with heavy bricks. The work, which he performs in this case is not lost, it is fully retained for many years, until one day this tile can be destroyed or take the wind and can drop someone in the head ". This example, at that time, strongly went into the methodology of physics. Did the best demonstration that this principle of conservation of energy"

After finishing high school, Max Planck went to university, first, in Munich for three years and then another year in Berlin. There he listened to experimental physics and mathematics. At that time there was no chair of theoretical physics. , In Munich, his professors were the physicist Philip Jolie and mathematicians Gustav Bauer and Ludovig Planck Zaidel who learned a lot and kept to the best memories. But in scientific terms they were limited. " For the first time I realized, writes Planck - in Berlin, where I expanded my scientific knowledge under the guidance of Herman and Gustav von Helmolcit Kirkofit, whose works opened new routes that were accessible to their students and accepted world. However I must admit, - goes on Planck-that for me these lessons are not seen to any great benefit. Helmolci, never prepared lessons properly, all the time spoke hesitantly, consistently erred on the board, as a result, the number of listeners was a little bit reduced, and ultimately were only three people, among whom and my friend Rudolf-Filcs Lennon, who later became Astronomer. In contrast, Kirkofi carefully read the elaborate course of lectures. No more words and no word on mahniteshim pak.Ne the lecturers and not of what they speak. "...

In such conditions, Planck satisfied their needs for his scientific training with those books that interested him, and these were works related to the law of conservation of energy. So it happened that he came across the book of physicist Bon, Claudius, particularly his work on the mechanical theory of heat. In this field also started scientific work Planck's first results of which (the second work on the principle of thermodynamics) in Munich he presented as a doctoral dissertation which he defended on 28 April 1879. After a year he was introduced to obtain doctoral work on the "state of equilibrium of isotropic bodies' " In this work he used the basic ideas of his dissertation to solve concrete problems of thermodynamic and physic-chemical.

5. Conclusion

The quantum hypothesis, which was born on the eve of the 20th century and which resolved the aforementioned contradictions, quickly became one of the leading ideas of today's physics. One of the most important results was the introduction into today's physics of the universal constant "h", which was named "Planck's constant", in honor of the founder of this theory. Along with the speed of light, the charge of the electron, and some other constants, Planck's constant became the fundamental constant of the microworld. The quantum hypothesis first of all revised the classical ideas on the exchange of energy between bodies. According to classical physics, this exchange was imagined as a continuous process, while according to quantum physics, it was imagined as a discrete, interrupted process, with hops: each body can emit or absorb energy only in portions, with quanta, the magnitude of which is $E = hv$, where v-frequency of radiation.

At that time Planck's hypothesis was viewed with suspicion and the overwhelming majority of physicists saw it only as a convenient mathematical tool, and not as an idea that would revise (including Planck himself) the classical doctrine and throw the foundations of a new doctrine of physics-the quantum doctrine.

A fundamental role in this progress of physics at that time, apart from Planck, belongs to two great physicists: Einstein and Borit. After the "path" opened by Planck, these two built "roads" towards modern physics in two fundamental directions: the first, towards the quantum chemistry of the electromagnetic field, and the second, towards the quantum chemistry of atomic systems. These became the founders of the old Quantum Theory. Regardless of the name, this theory has special importance for the foundations of modern physics, because in addition to its historical importance, as its prelude it also contains many basic ideas, which resisted time and were cemented as the basic principles of this new doctrine. Zomerfeld takes Planck's idea further. Starting from the facts that Planck's universal constant "quantum I energy" but "quantum of action" proposed to replace the hypothesis of energy quanta with a new principle, the essence of which can be expressed in this way: the necessary time of matter to receive or give an amount of energy is so much more the shorter the greater this energy.

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