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The hypothesis about the nature of thermal radiation

Abstract

In modern physics, the nature of electromagnetic thermal radiation and absorption by material bodies has not yet been established. One of the reasons for this situation is to consider atoms as electrically neutral structures. In the proposed hypothesis, the source of thermal electromagnetic radiation is collisions of atoms, in which the processes of converting their kinetic energy into energy of electric fields occur upon convergence and reverse processes when they diverge as a result of the interaction of electronic shells. In this case, part of the energy of electric fields as a result of the movement of electrons is converted into electromagnetic energy of thermal radiation.

Keywords: thermal, radiation, atom, electronic, shell, layers, electromagnetic, field, electric.

The property of thermal radiation and absorption of material bodies has long been known and is considered one of the fundamental properties of the material world.

Many scientists have studied this phenomenon, including H. Lorenz, M. Planck, D. Maxwell, I. Prigozhin, L. Landau and many others [1, 2, 3, 4].

By now, it has been established that thermal radiation is the generation of electromagnetic waves in a wide range of frequencies with a continuous spectrum, in contrast to radiation accompanying the transitions of electrons from one energy orbit to another, while releasing or absorbing energy quanta at certain frequencies [5].

According to modern concepts, an electromagnetic field is a space containing electrically charged bodies that interact remotely or directly with each other, as well as with bodies having their own dipole and multipole electric and magnetic moments [6].

However, contrary to this, the processes of thermal radiation and absorption of electromagnetic waves occur in all bodies, regardless of their electromagnetic properties.

The purpose of this work was an attempt to determine the nature of thermal radiation of material bodies, unrelated to their electromagnetic properties.

To solve this problem, we have analyzed the functioning of material bodies both at the macro level from the perspective of nonequilibrium thermodynamics as the driving force of the material world around us, and at the micro level from the perspective of the interaction of atoms and their particles.

According to the modern classification, thermodynamic systems are divided according to the processes occurring in them into passive, in which energy is redistributed, tending to an equilibrium state, but never reaching it, and active, in which one type of energy is converted into another, tending to a nonequilibrium state [7]. Thus, all the bodies of the material world are in a non-equilibrium state.

For macrosystems, which are material bodies formed from systems of mostly electrically neutral atoms and molecules, the main forces that ensure their nonequilibrium thermodynamic state are gravitational forces, the property of bodies in the material world to attract each other through infinite gravitational fields formed by all material bodies [8]. In this case, the force of attraction between two bodies obeys the following Newton's law of universal gravitation:

$$F = \gamma \frac{m_1 m_2}{r^2}, \tag{1}$$

where F is the force of attraction, m_1 and m_2 are the masses of interacting bodies, r is the distance between them, and γ is the gravitational constant.

The forces of gravity, as a result of their infinity, affect all bodies at the same time, as a result of which these bodies are always in a non-equilibrium state, since they cannot be in equilibrium with all at the same time, and therefore continuously move in

space as a result of the instantaneous action of the total gravitational forces simultaneously coming from all bodies.

Considering bodies at the atomic level, we note that all atoms, as is known, consisting of a nucleus containing positrons, neutrons, protons and other particles, and electrons rotating around them, have electric charges with a + sign for positrons and a –sign for electrons. Moreover, positrons and electrons, as containing different signs, are attracted to each other, and positrons, like electrons, repel each other as having the same signs. The regularity of the interaction of these particles obeys Coulomb's law [9]:

$$F = k_e \frac{q_1 q_2}{r^2}, \tag{2}$$

where F is the interaction force, q_1 and q_2 are the charges of the interacting particles, r is the distance between the charges, and k_e is the electrostatic constant.

The interaction forces in the nucleus between positrons, neutrons, protons and other particles are defined as the strong interaction. By now, a number of parameters of these forces are known, but their nature has not yet been established [10].

The electric forces of interaction between the charges of electrons and positrons, which form infinite electric fields, also ensure the nonequilibrium thermodynamic state of atoms and molecules.This state is provided by the structure of the atoms.

Figure 1 shows an example of the atomic structure.

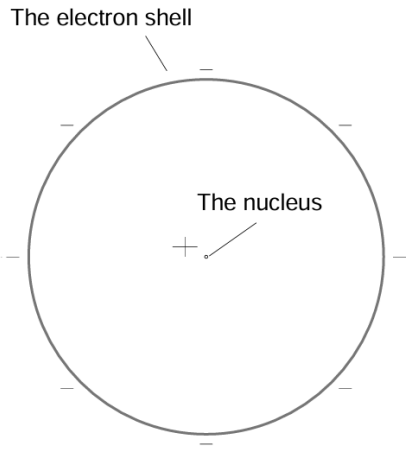

Figure 1 – Atomic structure

As can be seen from Figure 1, an atom contains a positively charged nucleus and negatively charged conditional energy electron layers (electron shell), determined by statistical and probabilistic methods of quantum mechanics, on which electrons are located in accordance with their energy potentials, the number of which and the occupied layers are determined by the magnitude of the positive charge of the nucleus [11]. The geometric dimensions of some atoms and their nuclei are shown in Table 1.

Table 1 - The parameters of the atoms of a number of substances

Parameter	Value, m
Radius of a helium atom	$1.050 \cdot 10^{-10}$
Radius of the nucleus of a helium atom	$2 \cdot 10^{-13}$
The radius of the uranium atom	$1.5 \cdot 10^{-10}$
Radius of the nucleus of a uranium atom	$8.5 \cdot 10^{-13}$

As can be seen from Table 1, the radii of atoms (electron shells) and their nuclei vary significantly. Thus, the interaction between the nucleus and the electrons through electric fields occurs at a considerable distance. The cause of this phenomenon has not yet been determined.

As atoms approach, the distance between their electron shells re becomes significantly less than the distance between the nuclei, as can be seen from Figure 2.

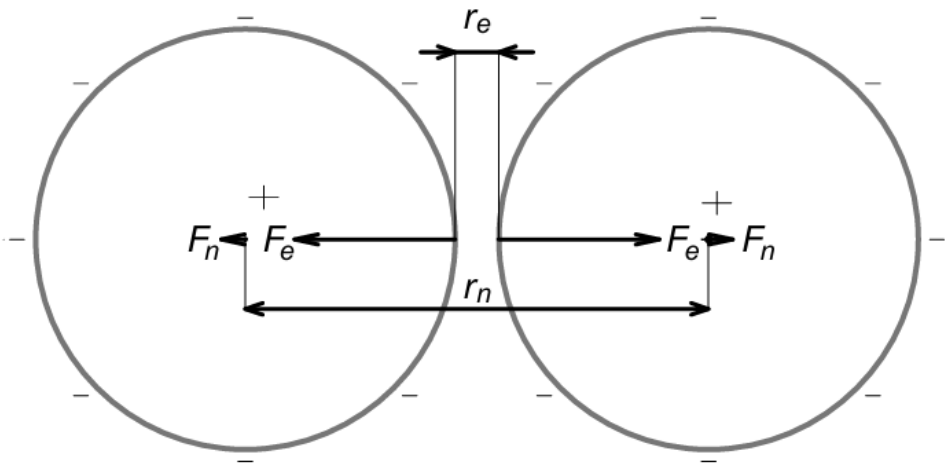

Figure 2 – The convergence of atoms

As can be seen from Figure 2, when atoms approach, the distance between their electron shells r_e is significantly less than the distance between the r_n nuclei, as a result of which the repulsive forces of the Fe electrons are significantly greater than the repulsive forces of the F_n nuclei. Thus, the main electric field strength when atoms collide is determined by the electron shells.

Thus, when atoms collide as a result of different masses of electrons and nuclei, as well as their spatial structure, a spatial local imbalance of positive and negative electric fields of atoms occurs, in which the intensity of the electric fields of the electron shells is significantly higher than the intensity of the electric fields of the nuclei. As a result, the repulsive forces of atoms are formed mainly by the fields of the electron shells.

When the approaching atoms are decelerated by the repulsive forces of the electronic shells, the kinetic energy of the atoms decreases, which is converted into the energy of the interacting electric fields of the electronic shells, and is accompanied by the generation of electromagnetic waves caused by a change in the intensity of the electric fields of the electronic shells, which is observed in the form of thermal radiation.

As a result of the joint mathematical analysis of equations (1) and (2), a pattern of changes in the electric field strength E during the collision of atoms with time t was obtained:

$$E = \frac{\mathrm{j}}{t^2}, \tag{3}$$

where j is a coefficient that depends on the conditions of atomic collision.

Figure 3 shows the dependence of the electric field strength E on the time t and the energy of electromagnetic radiation during the collision of atoms.

Figure 3 shows the pattern of changes in the electric field strength E during the convergence and divergence of electronic shells (curve 1) and the pattern of energy conversion E_e into electromagnetic waves (curve 2).

As can be seen from Figure 3, the electric field strengths E and Ee increase as much as possible with a minimum distance between the electron shells.

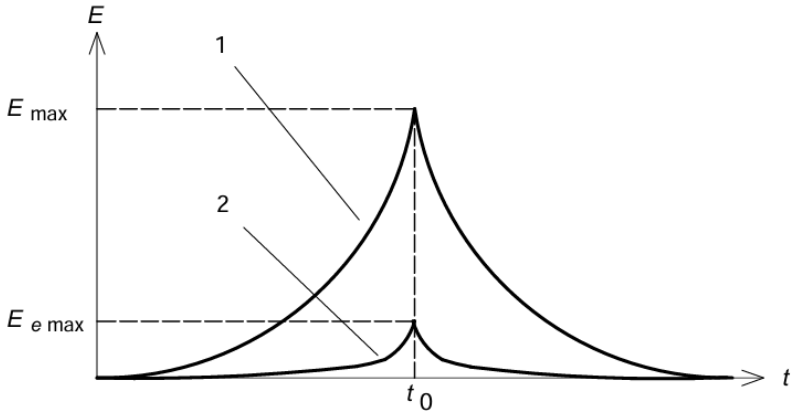

Figure 3 - Dependence of the electric field strength E and converted into an electromagnetic field Ee on the time t during the "collision" of atoms

Figure 4 shows the processes of converting kinetic energy into electric field energy and vice versa in atomic collisions ($t = t_0$) in the presence of external electric fields of equal, lesser or greater intensity created by electronic shells.

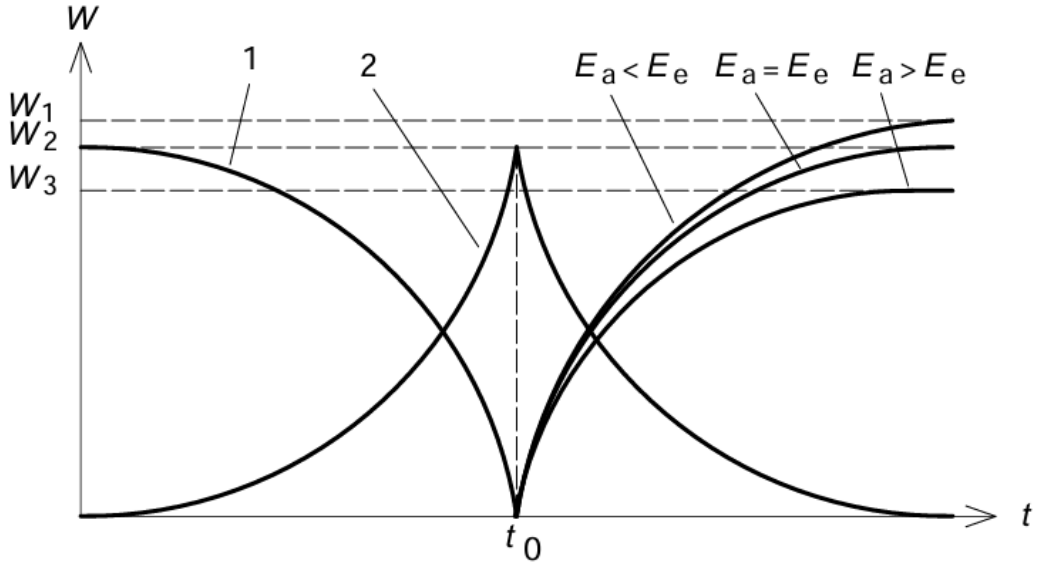

Figure 4 – Energy conversion processes in atomic collisions

Figure 4 shows graphs of the processes of converting the kinetic energy of atoms (curve 1) into electric field energy (curve 2) during the phases of atomic convergence ($t < t_0$) before the "collision", at the moment of collision ($t = t_0$) and atomic divergence ($t > t_0$) after a collision under conditions of different external electrical stresses. The number of E_e fields is relative to the electric field strength created by the collision of E_a atoms: $E_a < E_e$, $E_a = E_e$, $E_a > E_e$.

As can be seen from the graphs, at $E_a < E_e$, due to the interaction of fields, the total level of electric field strength increases, resulting in an increase in the kinetic energy of atoms – on the graph - W_1. Under $Ea = E_e$ the kinetic energy of the atoms is conserved – on the graph - W_2. Under $E_a > E_e$ the kinetic energy of the atoms decreases – on the graph – W_3.

Since the change in the kinetic energy of atoms is associated with the conversion of electrical energy into electromagnetic energy, the latter is presumably thermal radiation. Moreover, at $E_a < E_e$, the body heats up, and at $E_a > E_e$, it cools down.

Conclusions

1. Atoms, being electrically neutral in the "far" zone, when they can be represented as some kind of material point, are not actually neutral in the "near" zone, when its geometric dimensions must be taken into account, for example, when determining the electric field strength of electronic shells and nuclei far from them.
2. When atoms collide, the law of conservation of energy is fulfilled by converting the kinetic energy of the atoms into the energy of the electric field and vice versa. In this case, the energy of electric fields is partially converted into the energy of electromagnetic waves caused by changes in the intensity of electric fields.
3. Electromagnetic waves are emitted when the electron shells of atoms interact during their collision in the form of sharpened pulses.
4. In the presence of external electric fields, as a result of their interaction with the electric fields of electronic shells, both a decrease and an increase in the energy of atoms is possible.
5. The nature of gravitational and electric fields and the nature of their basic properties have not yet been established, and therefore the presented material can be considered solely as a hypothesis requiring a large amount of scientific research.

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