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Hypothesis: Heat Transfer and Elementary Carriers of Heat Energy

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Energy is one of the basic concepts of natural science and is inextricably linked with the idea of the transformation of one form of motion of matter into another. In turn, technological advances encourage science to make new discoveries that make it possible to use all types of energy efficiently: master the energy of the subsoil, the sun's rays, tides, sea waves, control thermonuclear energy, etc. All this requires fundamental knowledge of the mechanism of energy transfer. Currently, it is argued that the "phlogiston theory" is over, but in a hidden form it is widely used in practice to explain the heat transfer as Fourier's equation:

$$\Phi = -\lambda\ (\partial T / \partial x)\ S$$

where Φ is the heat flux; λ is the coefficient of thermal conductivity; ∂T/∂x is the temperature gradient; S is the cross section of the conductor through which the heat flux flows. Here «heat flow» is accepted as a form of motion. It is well known that there are three types of heat transfer, which are carried out by thermal conductivity or conduction; convection or heat transfer by moving particles of matter and radiation. However, the true nature and nature of the manifestation of heat requires a more careful approach to the mechanism and essence of the heat transfer process. The present work is devoted to elucidation of the nature of heat carriers on the basis of dialectical, thermodynamic, molecular-kinetic and quantum - electrodynamic methods of cognition. To do this, first consider the heat of formation mole of water ΔH_f^0 ($H_2O_{liq.}$), which is equal to the heat of combustion ΔH_c^0 (H_2) for mole of hydrogen:

$$H_2 + 0{,}5O_2 \rightarrow H_2O \quad \Delta H_c^0(H_2) = = \Delta H_f^0(H_2O_{liq.})) = -285.8\ kJ/mol$$

According to the reference data during the combustion of hydrogen in oxygen the temperature reaches 3173K and 285.8 kJ/mol of heat equal to the heat of formation of water is released. Formed water vapor is cooled from 3173K down to 298K. Specific heat capacity of water $C_P(H_2O_{liq}) = 4.218$ kJ/kg, and of steam $C_P(H_2O_g) = 2.02$ kJ/kg; $\Delta H_{tr}^0(H_2O) = 2260{,}0$ kJ/kg. Believe that the processes occur at standard conditions: T = 298K and $P = 1{,}05 \cdot 10^5$Pa. This process is carried out back, equilibrium and heat balance for heating water from 298K to 3173K is as follows:

$$Q = C_P(H_2O_{liq})\ (T_{bp} - 298) + \Delta H_{tr}^0(H_2O)) + C_P(H_2O_g)\ (T_{fin} - T_{bp}) + P\Delta V$$

The heat expended on the work of water expansion PΔV is calculated by the of Mendeleev-Clapeyron's equation $nR\ (T_2 - T_1)$ in the temperature range from 373K to 3173K. In this case, for one mole of water the value of heat is described by this equation:

$$Q = C_P(H_2O_{liq})\ (373-298) + 2260 + C_P(H_2O_g\ (3173-373) + R\ (3173-373)$$

Here, the sum of $C_P(H_2O_{liq})$ (373-298) + 2260 + $C_P(H_2O_g$ (3173-373) represents the change in internal energy (ΔU):

$$\Delta U = 4{,}21 \cdot 18 \cdot\ (373-298) + 2260{,}0 \cdot 18 + 2.02 \cdot 18 \cdot\ (3173-373) = 148{,}16 \cdot 10^3 J.$$

Work of the expansion of steam (PΔV) from 373K to 3173K requires energy:

$$P\Delta V = nR\ (T_2 - T_1) = 8{,}314 \cdot 1 \cdot (3173-373) = 23{,}28 \cdot 10^3 J.$$

For the process it took $148{,}16 \cdot 10^3 + 23{,}28 \cdot 10^3 = 171{,}4 \cdot 10^3$J of heat. Under the given conditions, the formation of water mole produces $285.8 \cdot 10^3$ J of heat. The system is closed, the amount of water is constant and eliminates the transfer of heat by water molecules. Consequently, the number of scattered heat - TΔS - is $(285{,}8 - 171{,}4) \cdot 10^3 = 114{,}4 \cdot 10^3$J. [1].

Regardless of the various forms of manifestation of energy, the generally accepted formulation in the scientific literature is as follows: "energy is a scalar physical quantity, which is a single measure of the various forms of motion and interaction of matter, a measure of the transition of the movement of matter from one form to another." Consequently, a certain thermal material object equivalently characterizing heat energy about $114.4 \cdot 10^3$J left the system. In this regard, the system is considered to be open and with an infinitely small change in the internal energy (dU) is:

$$dU \leq TdS - PdV + \sum \mu_i dn_i$$

where TdS - the amount of energy transferred to the system (to the substance, body, etc.) in the form of heat; PdV - the value of the expansion of the system; $\sum \mu_i dn_i$ - the total amount of arrival and consumption of energy due to the energy carriers of the system. From the characteristic properties of the state functions, an infinite small change in the number of particles carrying thermal energy in this case, with the constancy of other parameters, should determine the i-th particle's chemical potential related to heat:

$$\mu_i = (\partial U/\partial n_i)_{S, V, nj} = (\partial H/\partial n_i)_{S, p, nj} = (\partial A/\partial n_i)_{T, V, nj} = (\partial G/\partial n_i)_{T, p, nj}$$

Chemical, biochemical and electrochemical transformations occurring at the atomic-molecular level with a decrease in the change of chemical potentials, it is an indisputable fact that the number of electrons and nucleons in the system are preserved. However, in this case emitted or absorbed heat, light and other manifestations indicates the change in internal energy of the system. I. e. according to the definition of "energy", this means a corresponding change in the "certain material" object moving in a nuclear- electronic system that characterizes "energy", in other words, it is necessary to consider the genesis of the micro-macrostructure of matter. It is well known that the transfer of heat by solar rays, the accumulation of their energy in material objects and the reverse extraction of heat and light is an axiom. These facts clearly suggest that the elementary energy carriers are directly related in combinations with the elements of the atomic - molecular structure, with the loss of their original characteristics. The loss of individual characteristics of elementary energy carriers gives reason to believe that their combinations with electrons are formed. A good example is the release of heat, light in the redistribution of electrons in chemical bonds in combustion reactions. The combination of monochromatic rays is sunlight. Similarly, hydrogen and oxygen in a chemical combination forms water and in it hydrogen and oxygen do not show their initial properties. If necessary, the decomposition of light and water can produce the appropriate components. In nature, such analogies of transformation of material objects exist both in macro-and in the micro world [2-4].

Thus, based on the analysis of theoretical and experimental results published in the scientific literature in the field of atomic and molecular structure of substances and energy manifestations, according to the dialectical laws of nature, we proposed the presence of elementary energy carriers combined in the nuclear-electronic structure in the form of dipoles. In this case, the opposite magnetic poles of the dipoles are attracted to each other, where micro electric currents appear as a result of the movement of the charged parts. Emerging micro electric currents in the movement of the poles, have opposite directions, which causes them to repel and do not allow the poles to approach. As a result, alternating electrical and magnetic manifestations within the particle itself in the environment of charged particles of the nucleus and electrons leads them to pulsation, which allows them to be called pulsating "electromagnetic particles" [5,6].

In relation to the energy manifestations, M. Faraday concludes that regardless of the thermal, light, chemical, physiological, magnetic or mechanical source of energy, they can all be manifested in the form of the same electricity. This conclusion of M. Faraday means the identity of the nature of elementary energy carriers, which differ only in the nature of their movement, representing different forms of energy transfer depending on the nature of the process.

According to statistical thermodynamics at a given temperature, the total energy of the kinetic motion of an elementary particle is $\sum x_i kT$, i.e. the energy of the particle is equal to:

$$\varepsilon = \sum x_i kT$$

where k is the Boltzmann's constant ($1{,}3806 \cdot 10^{-23}$J/K); T is the thermodynamic temperature of the system, K; $\sum x_i$ is the total number of contributions of kT to the translational, rotational-vibrational and pulsational motion of elementary particles in the thermal energy of each i-th type of motion. To determine the value of $\sum x_i$ in the equilibrium of thermal radiation, we use the spectroscopic data of IR radiation. For the same particle, the following equation holds:

$$\sum x_i kT = h\nu, \text{ where } \quad T = h\nu/\sum x_i k.$$

According to the scientific literature, heat transfer in vacuum is carried out by thermal radiation of the source, which is referred to the infrared, representing the process of "propagation in space of the internal energy of the emitting body" by electromagnetic waves. In our opinion, a wave is a trajectory of motion of certain material particles (sea waves - movement of water, sounds - vibrations of specific material objects, etc.) in space. Consequently, electromagnetic waves are a picture of the motion of pulsating "electromagnetic particles" with different values of the pulsation frequencies, including carriers of heat, light, etc. Without violating the principles of wave optics, use its known equations and characteristic values of the infrared wave, which are given in the reference materials. From the equation $T = h\nu/\sum x_i k$ to the infrared radiation of the middle range at temperatures of 4000K and 3620K:

$$4000 = 4{,}7994 \cdot 10^{-11} \cdot 4 \cdot 10^{14}/\sum x_i \qquad \sum x_i = 4{,}79$$

$$3620 = 4{,}7994 \cdot 10^{-11} \cdot 3{,}8 \cdot 10^{14}/\sum x_i \qquad \sum x_i = 5{,}03$$

Similarly, for the middle range at temperatures of 2070 and 600K, as well as for the far range of 290 and 90K, the values of $\sum x_i$ are 5.10; 4,79; 4.96 and 5.33, respectively. Average value for $\sum x_i$:

$\sum x_i$ = (4,79+5,03+5,10+4,79+4,96+5,33)/6=5.0.

The total kinetic energy of the thermal motion of an elementary particle in thermal equilibrium with the emitted particles into the environment is true: 5 kT = hv. Hence T = hv/5 k =$0.959\cdot10^{-11}\cdot$v, you can make a conclusion revealing the physical meaning of temperature:

- the temperature of the system is determined by the pulsation frequency "electromagnetic particles" carriers of heat "the plotron" [6,7].

For burning hydrogen at maximum temperature 3173K from the formula T = $0,959\cdot10^{-11}\cdot$v the pulsation frequency of heat carrier was determined:

v =T/ $0.959\cdot10^{-11}$. v = 3173/$0,959\cdot10^{-11}$ =$3,31\cdot10^{14}$Hz

Similarly, Planck's formula ε = hv, and the total kinetic energy of the thermal motion of elementary particles ε = 5kT, we calculate the energy of elementary particles -at the temperature 3173K and frequency of $3.31\cdot10^{14}$ Hz:

$$\varepsilon = hv \quad \varepsilon = 6,6261\cdot10^{-34}\cdot3,31\cdot10^{14} = 2,189\cdot10^{-19}J$$

$$\varepsilon = 5kT \quad \varepsilon = 5\cdot1,38\cdot10^{-23}\cdot3173 = 2,189\cdot10^{-19}\ J$$

Using the coefficient of transition from mass to energy, we calculate the masses of elementary particles of the heat carrier:

m = = $2,189\cdot10^{-19}/8,98755\cdot10^{16}$ =$2,435\cdot10^{-36}$kg

Besides it using the well-known equation $\varepsilon = mc^2$ the same mass of the particle heat carrier is determined:

$$m = \varepsilon/c^2;\ m = 2,189\cdot10^{-19}/(3\cdot10^8)^2 = 2,432\cdot10^{-36}kg$$

Taking into account the intensive property of the temperature and pressure values, which do not depend on the amount of substances, we write the Clapeyron's equation for the particle in the form [7]:

$$pV_m = k\cdot0,959\cdot10^{-11}\cdot v$$

where V_m - the volume of a combined particle creates a pressure p; k - Boltzmann's constant; $0,959\cdot10^{-11}$-temperature coefficient; v-the oscillation frequency of the "electromagnetic particle". Analysis of the equation allows us to find out the physical meaning of "p" for the elementary particle, which is a "force of elasticity - p" necessary for the pulsation of the elementary particle in the volume it occupies V_m; T - thermodynamic temperature of the system, which is an indicator of thermal equilibrium with the environment. The change in V_m and p under compression causes an opposing force according to Newton's third law and the manifestation of the internal pressure of the system.

Thus, the above allow us to put forward a hypothesis about the existence of pulsating "electromagnetic particles" in the nuclear- electronic system, which

- Participates in their binding to the structure of the molecule and the "chemical individual"-the elementary link of macroscopic formation;

- Participate in the implementation of the Coulomb electric interaction and to prevent the annihilation;

- creates an electric and magnetic field of the conductor under the influence of an external voltage source;

- Are in combination with electrons and the nature of their motion determines the thermal, optical, magnetic, electrical and other properties;

- The frequency of pulsations of "electromagnetic particles" determines the physical meaning of the temperature and the internal pressure of the system;

- The pulsation of the particles creates a standing wave, and their directed collective movement of the seeming traveling wave, which is taken as an "electromagnetic wave".

The almost perfect coincidence of the calculated masses of elementary heat carriers according to the proposed equation and the traditional formula gives reason to believe the above conclusions are reliable.

All these data will expand the information in the field of energy manifestations and in-depth approach to the atomic structure of micro-macroscopic formations.

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