SOFIA TECHNICAL UNIVERSITY

Prof. PETAR RASHKOV PENCHEV, Doctor of Technical Sciences

DOCTOR HONORIS CAUSA OF SOFIA TECHNICAL UNIVERSITY

WE NEED A NEW WORLD VIEWPOINT, WHICH SHOULD UNITE INTO ONE WHOLE EVERYTHING, WHICH IS KNOWN AS EXPERIMENTAL FACTS, BUT SO FAR HAS NOT BEEN INTERPRETED ON THE LINES OF A UNITARY WORLD

FROM A UNITARY ELECTROMAGNETIC MATTER TO A UNITARY SCIENCE OF NATURE

THERE IS NO NATURAL PHENOMENON WHICH IS NOT A RESULT FROM MOTION OF ELECTROMAGNETIC MATTER

THERMAL ENERGY IS ONLY ELECTROMAGNETIC ENERGY, CARRIED BY THE PHOTON GAS

The fact that matter and energy in the World are homogenous (unitary) in nature is accepted in physics – in mechanics. And electrodynamics proves the fact that matter and energy in the World are only of electromagnetic nature. These two facts entail the inference that matter and energy in the World are only and solely of electromagnetic nature. This inference is grounded on the idea that the concept of matter and energy of unitary nature precludes any possibility for the presence of matters and energies of natures different from the electromagnetic one.

"A crucial prerequisite for the power of knowledge is not the belief in a reputedly infallible authority, but the irresistible power of experimental facts which irrefutably reveal the most reliable authority, Nature itself."

Sofia
2012

ANNOTATION

Proceeding from the following crucial experimental facts: a) that through the sun rays, which are formed by photons, thermal energy is carried from the sun to the earth at velocity *c*, and photons are essentially carriers of electromagnetic energy, which is transferred without atoms or molecules and b) that electromagnetic thermal energy *dQ* of light rays, carried by photons, go through substantial wall, according to the law of Fourier $dQ = -\lambda \frac{dT}{dr}$, (where: λ is coefficient of thermal conductivity; T – temperature; r – distance) of 1822, without being carried by atoms or molecules. But it is carried only by photons (for example, thermal energy of water in a heating radiator (carried by photons) goes through the solid alls of the radiator, carried by photons, without a single atom or molecule. Taking into account that experimental facts have irresistible evidential power, the conclusion follows that photons, which are a field form of electromagnetic matter and are carriers of electromagnetic energy. And according to the law of Larmor of 1897 they are emitted by the electrons of the atoms, which are a substantial form of electromagnetic matter in the form of electric charges q_e, at acceleration $\vec{a}$, with power

$$N = \frac{dW}{dt} = \frac{2}{3} . \frac{q_e^2 . a^2}{c} .$$

The energy *dW* is released by the magnetic (kinetic) energy of the electrons, which move at velocity v_e along orbits in the atoms (molecules). Because of this, atoms (molecules) should be considered as potential carriers of thermal energy, since part of the magnetic (kinetic) energies of the electrons are transformed into energy of photons.

In this aspect, the theory of thermal energy is electromagnetic theory. And thermodynamics is specific electrodynamics, i.e. is thermoelectrodynamics.

Thermal energy is only electromagnetic energy carried by the photon gas.

ISBN 978-954-8655-37-8
Sofia, 2012
Publisher „Krisan-C”
3A, Ivan Borimechkata St, Sofia
E-mail: economist@abv.bg

Author and producer: Prof. P. R. Penchev, Dr Tech Scs
Addresses for contact with the author, Prof. P.R. Penchev

Sofia Technical University
Electrotechnical Department
8, Kl. Ohridski Blvd
Sofia, 1756
e-mail: iliana@tu-sofia.bg
yatchev@tu-sofia.bg

Mladost 1,
bl. 90, entr. 9
Sofia 1797
Home phone: +359 2 870 68 05
+359 885 13 83 09
e-mail: iliana@tu-sofia.bg
e-mail: iliana@tu-sofia.bg
yatchev@tu-sofia.bg

THERMAL ENERGY
IS ONLY ELECTROMAGNETIC ENERGY

CONTENTS:

PART ONE.
PREMISE

1. GENERAL FORMULATIONS

For long centuries, the principle of unity of nature (the world) has been taken shape in human mind and together with it – also the idea of something that must be the unitary (homogenous) carrier (substrate) of nature, which is known as matter. In this sense, matter is synonymous to the notion nature (world) and is referred to as material continuum.

At the very beginning of emergence of human scientific research, *the notion matter (under various terms) became a logical means for reflection on the universal unity of the world picture.* **In this form and sense, the notion matter is the sole basic and initial (starting) basis (idea) for making up (building up) of a scientific viewpoint on natural entities – the World.**

In this sense, it should be unconditionally accepted that matter is the only initial and primary resource (quantity), which is the carrier, motivation and source (generator) of all physical realities, i.e. of all natural entities (fragments, objects, bodies, phenomena, processes and so on) in Nature (the World). At the same time, in scientific aspect matter is also its invariant quantity.

In this sense, nature is one whole with internally motivated continuity of perpetual (eternal) interaction between fragments with varying internal structures. Because of this, natural entities do not possess eternal and unequivocal external manifestations (properties), but are constantly changing states of their structures, which circumstance determines their incessantly changing properties, which humanity perceives through their organs of senses.

In essence, matter itself is the cause (reason) of its own diverse manifestations. And essentially, all natural manifestations (entities) are expression of various structural-organizational and dynamic states of respective quantities of matter (masses), which in respective initial conditions have been transformed (restructured) into new (other) states.

In essence, science studies manifestations of matter or more specifically, the various states of the structures of motions of matter, since essentially that is what the manifestations of matter in the form of natural entities actually consist of. Science forms scientific facts by respective notions, properties and regularities (laws or principles)**.**

In view of a better clarification f the mechanism of forming new scientific truths (laws) about natural entities, it is necessary more specifically to clarify the meaning of some scientific terms, such as:

1. The place (meaning) of experimental fact (experiment) in scientific research is that it, being an empirical (experimental) law, has irresistible (categorical) evidential power, which can be disproved (refuted) only by other experimental facts. It is exactly for this reason that experimental fact is the criterion of truth.

2. Logic, the logical laws, are generalizations of empirical laws or logic is generalization of practice (practical work or real work of man), i.e. the notion practice is treated in the aspect of a synonym to the notion of experience.

This means that a person, from the moment of his/her birth, begins to accumulate experimental (practical) laws – logical laws – logic.

3. For the formation of new (scientific) knowledge of nature, it is proceeded from the principle that new truths (knowledge) are logical consequences of the system of truths already known, which are accepted as known (a priori) truths, which play the role of initial experimental facts. The facts (notions) ascertained by daily routines are considered to be unconditional truths, called by E. Kant, a priori truths. This approach is called method of formal logic (MFL)). The scheme of MFL is

premise ⇒ analysis ⇒ synthesis (conclusions) ⇒ experimental confirmation; (A)

Here the premise is a system of previously known truths (which were first called axioms in geometry) – axiomatic system. Because the premise as a whole (system) has new properties, which its parts do not have (the whole has more properties than its parts). A logical analysis determines the new properties of the premise and synthesizes them into new inferences (laws), which must be confirmed through experiments; not until an inference has been confirmed by experiments can it be declared a law (a reliable truth), but it is only a hypothesis, an assumption. ***In this sense a postulate is not a law, but only a hypothesis, which has no experimental confirmation yet.***

4. The descriptions thus obtained of the scientific truths about natural entities (NE) are not mirror or universal images of specific natural entities, but are only models (schemes) of the idealized (abstracted, simplified) notions, according to the objective of the studied reality. Therefore, one object can have several models.

5. The criterion for selection of the perfect explanation (theory) is the principle of simplicity (Occam's razor). *According to this principle, of two theories, which explain a phenomenon equally well, the more perfect, and with this the more reliable is this theory (this explanation), which on the one hand assumes fewer starting points in its premise, and on the other, explains a wider range of natural entities, i.e. contributes to a greater unity in the knowledge of nature.*

It is known, from I. Newton's methodology (1687) that science does not construct images mirroring natural entities (reality), but it constructs models of them which are simplified (idealized, abstracted) by means of simplified (idealized, abstracted) notions in conformity with the purpose (task) of a specific scientific research. In this way a model is created containing only the most essential (important) major properties (manifestations) of reality (natural entities, objects) depending on the purposes of study.

The notion of a unitary science should not be understood (interpreted) that it must be reduced to a formula or a system of equations, but it should be understood that it must have an initial principle, since nature as a whole is a system structured by material elements (realities) in the form of material bodies, manifestations and processes which are interdependent because they are mutually linked with force (structural) connections, i.e. it is one material whole (material continuum). *Therefore, without matter there is no reality – there is no matter, or the notions of matter and nature are essentially synonymous.* **Because of this condition, we can contemplate a unity of sciences only in homogeneity (uniformity) of matters of diverse natural entities (realities)**. ***That is to say that the unity of science is predetermined only on condition that matter in nature (the World), as a whole is homogeneous in essence, i.e. it is manifested in various parts which are object different in structure and organization, but with a homogeneous genetic essence, because they are formed from a single homogenous resource.***

Science has the ultimate and primary goal to unite facts in a hierarchical causal and genetically uniform system of independent logical elements, a system of diverse forms of manifestation of a substantial nature (essence), known as a unitary material continuum of fragments of natural resources - the World. And there is no place in it for matter without a material or field form, as it is the one and only carrier and generator of its own manifestations – in accordance with Spinoza's idea of "Causa Sui" (matter is the cause of its own manifestations). These manifestations, generated by reason of matter itself (without any eternal interference), are the subject of scientific study to obtain experimental evidence, ***which after interpretation becomes scientific evidence, which is the initial resource (basis) and logical foundation of science.***

In this sense each item of scientific knowledge is based on empirical experiment, because the mental process, through which knowledge is formed (created) is always based on the resource of reflections (imprints) of the natural entity in human mind.

The physical science is **not** *a priori*, but is an empirical science, and the validation of the authenticity of its claims as truths **becomes only by means of appropriate validating experimental facts.** In this sense, since *the experimental fact (the empirical regularity)* is **its supportive point for evidence and inferences of physical truths,** *as laws, principles and postulates.*

Because of this, it is agreed that the experiment (the empirical regularity) has a **STATUTE OF LOGICAL NECESSITY.** Id est, the material experiment is an expression of the meaning of logic or it is **THE LOGICAL FOUNDATION OF THE CLAIM** (law, principle and so on).

In the above sense, there follows the conclusion that: each scientific truth in its root must have a specific, direct or indirect, empirical basis, since **"THE EXPERIMENT HAS IRRESISTIBLE EVIDENTIAL POWER".**

2. ON THE UNITARY ELECTROMAGNETIC MATTER

2.1. Introduction

Newton's reflections that the substantial form of matter is of homogenous nature were presented in [8] of 1687, and that the nature of homogenous matter is electromagnetic manifesting itself as a substantial and field forms was experimentally proven in [9] of 1704.

In addition to this, he stated in [8] that the notion mass is an abstracted point-like notion, expressing the real volumetric notion quantity of matter concentrated in one volumeless point.

In the preface of [8] (p. 5) Newton wrote: *„They argued that substance in universe was homogenous…"* And on p. 23 in [8] he wrote: *„this quantity [of matter] that I mean hereafter everywhere under the name of body or mass. And the same is known by the weight of each body; for it is proportional to the weight."* On p. 504 in [8] he wrote: *„Experiments as well as astronomical observations have proved that bodies around the Earth are attracted to the Earth by force, which is proportional to the quantity of matter of each of them. Based on this, there should be established a rule that all bodies attract to each other."* On p. 518 in [8] it is written: *„Hence it follows that attraction between all planets is proportional to their quantities of matter, which are contained within them."* There are more texts in [8] in this sense, that quantity of matter was called mass by him.

By considering the fact that Newton gave the formula of gravitational force F between two bodies with masses m_1 and m_2 (the idea of the field form of matter did not exist then) and the gravitational constant γ, as follows

$$F = -\frac{m_1.m_2.\gamma}{r^2}; \tag{2-1}$$

it is apparent that Newton defined that masses m_1 and m_2 of bodies are abstracted notions without the volume of the real notions quantities of matter, which have volumes $V_1 > 0$ and $V_2 > 0$. ***I.e. Newton introduced the point-like idea of objects (bodies) through the abstracted notion mass,*** which he placed in the center of gravity of the bodies in order to enable mathematical operations – via differential and integral calculus, created by him.

Essentially, science studies the manifestations of matter, and in particular, it studies the various states of the structures, organization and movements of matter since they are essentially manifestations of matter occurring as natural phenomena. ***And matter is something, out of which is formed the system of natural entities, objects (bodies, phenomena, processes, etc), whose manifestations are studied by science and then scientific facts are defined through respective notions, called properties and regularities (laws or principles).***

Proceeding from the described by I. Newton in [9] „Opticks…" of 1704, which was set fourth in the queries from 1 to 31, as consequences, in a synthesized form, are described the following experimental facts:

"Are not the Rays of Light very small Bodies emitted from shining Substances"
"The changing of Bodies into Light, and Light into Bodies ...."
"... is very conformable to the Course of Nature, ..."
" […] it is manifest that Light consists of Parts. Light […] spends about seven or eight minutes […] from the Sun to the Earth."

} K

In modern terminology, these Newtonian laws of the system K would state:

"All substantial forms of electromagnetic matter emit and absorb field forms (electromagnetic waves – photons) of electromagnetic matter."
"Substantial forms of electromagnetic matter convert into field forms of electromagnetic matter, and its field forms (electromagnetic waves – photons) convert into substantial forms of electromagnetic matter."
"These are normal natural phenomena (processes)."
"Light is a flow of elementary particles, photons, which move incessantly at the velocity of light c."

} K'

THESE EXPERIMENTAL FACTS, DESCRIBED BY NEWTON, ARE IRRESISTIBLE EXPERIMENTAL EVIDENCE THAT MATTER IN NATURE IS ONLY ELECTROMAGNETIC IN A FIELD AND SUBSTANTIAL FORMS.

This Newton's evidence was confirmed by Kirchhoff in 1860, who, without quoting Newton, postulated his experimental law of Kirchhoff, which states:

"All bodies emit and absorb radiant energy, whereby the ratio of the emitted to the absorbed energy depends on the frequency and temperature of the bodies, but it does not depend on the kind of the bodies."

I.e. the experimental facts, described by Newton and Kirchhoff prove in a most irrefutable way, ***for experiment has irresistible evidential force,*** **and experimental (empirical) laws are logical laws,** *that matter (mass) of all natural entities (objects, phenomena and processes) is only of electromagnetic essence – it is electromagnetic matter (mass m), which constantly changes both in quantitative respect, i.e.* $m \neq \text{const.}$, *and in respect of its structural states from substantial into field form and vice versa.*

In this case we assume that matter is a structure of a homogeneous initial (primary) resource whose nature (properties) is unknown. The nature of the resource is unknown, it is not experimentally established, because it can not be established experimentally, because it cannot be manifested as an independent reality without assuming some kind of spatial structure, which is in some kind of natural phenomenon of matter. And the matter with the smallest amounts of initial resource is called an elementary particle, elementary particles, respectively. Elementary particles in physics, according to the proposal of W. Heisenberg, are accepted to be a) of homogenous nature; b) in the form of substantial and field states and c) can convert from substantial into field forms and vice versa.

Since matter and energy are inseparable from each other, it follows that energies are only of electromagnetic nature, i.e. there is only electromagnetic matter and electromagnetic energy in various structural states.

2.2.1. Initial formulations for electromagnetic matter and its dynamics

1. The smallest independent quantitative values of the matters of objects (elementary particles) are in the form of negative e^- and positive e^+ electric charges, with values $q_e = \mp 1{,}9.10^{-19}$ C. These bipolar charges are a substantial form of electromagnetic matter and for them it is agreed and it follows that indirectly experimentally has been proven that they are formed out of unknown in its essence, but homogenous in essence initial (starting) resource of electromagnetic matter in the form of elementary particles electrons. These substantial elementary particles are of electromagnetic nature, i.e. they are electromagnetic particles, called electron $\left(e^-\right)$ and positron $\left(e^+\right)$, they are ***the smallest experimentally established independent quantities (quanta, portions) negative*** $\left(q_e < 0\right)$ ***and positive*** $\left(q_e > 0\right)$ ***electric charges.*** Often, when both charges are meant together $\left(e^-\ \text{и}\ e^+\right)$ they are referred to only as electrons. And in the terminology of elementary particles the electron and the positron are respectively referred to as particle and antiparticle.

It should be emphasized here that a thesis can be considered that in a certain indirect aspect, as the initial material resource could be argued that the elementary independent electric charge of the electrons is the initial resource as it is known that the effect of interaction between electrons e^- and positrons e^+ can be the generation of other elementary particles (protons, neutrons, photons and so on) and also there is not an electrical charge that does not generate electrical, magnetic or gravitational fields.

2.2.2. Michael Faraday in 1843 proved that there exists a law of electric charges conservation – LECC. This LECC is essentially the basic law of electromagnetic matter conservation. This general fact (law, principle) is motivated by the circumstance that it holds true not only for the substantial electromagnetic elementary particles of matter, but also for all natural entities, which are only various quantities and structures of restructured electrons and positrons, respectively of negative and positive electric charges. **THEREFORE ALL LAWS OF CONSERVATION IN PHYSICSARE DIRECT OR INDIRECT RESULT FROM LECC. IN THIS ASPECT, THE LAW OF CONSERVATION OF ENERGY OF J. ROBERT MAYER (1842) IS ALSO A RESULT FROM THE BASIC LECC.**

2.2.3. It has been experimentally proved that electrons $\left(e^-\ \text{и}\ e^+\right)$ ***generate:***

1. At rest $\left(v = 0\right)$: a) electrostatic fields $\vec{E}$, energies W_{E0} and masses m_{e0}; b) gravitational fields $\vec{G}_{E0}$, energies W_{GE0} and masses m_{GE0}.

2. At velocity $v \neq 0$ they also generate, apart from $\vec{E}$ and $\vec{G}$, a magnetic fields $\vec{H}$ and magnetic energies W_{He} and mass m_{He}.

3. In the process of acceleration (change of speed) they emit electromagnetic waves (photons), which are of $\vec{E}$, $\vec{H}$ and $\vec{G}$ fields, energies and masses.

4. The energies and masses of electrons can get restructured (transform): a) from one into another (say, from electrons into protons, neutrons and photons) substantial or field forms of electromagnetic matter; b) from one structure of one kind of fields and energies into other kinds (structures) of fields and energies (say, from electric fields $\vec{E}$ and energies W_E into magnetic fields $\vec{H}$ and energies W_H) and vice versa.

However, these kinds of restructuring (transformations) of electromagnetic matter, are always accompanied (according to the presented in item 4 above) by inseparable from them gravitational fields, energies and masses. ***I.e. there is no electromagnetic natural entity (object, phenomenon, process and so on) that is not***

accompanied (is not a carrier) also of gravitational fields, energies and masses. *Or* **in other words, there are no independent gravitational fields, energies and masses without the electric or magnetic energies and masses that generate them, respectively without their** $\left(\vec{E} \text{ или } \vec{H}\right)$ **fields. THIS IS ALSO THE EXPLANATION WHY SO FAR NO INDEPENDENT GRAVITATIONAL WAVES HAVE BEEN ESTABLISHED EXPERIMENTALLY.**

3. THEORETICAL FOUNDATIONS OR DEDUCTIVE PRINCIPLE OF THE SCIENCES OF NATURAL ENTITIES – NATURE

Since science studies the manifestations of electromagnetic matter and out of the empirical (experimental) laws of the manifestations, which are a reflection of realities, forms their electromagnetic laws, and the foundations of the electromagnetic laws, without the laws of gravitational phenomena, are given by Maxwell in the form of the Maxwell equations, which were further developed by Einstein and others, and now the foundations of these further developments are obtained directly from the described experiments of Newton in his books „Principles...“ of 1687 and “Opticks...” of 1704. Moreover, out of them and of his book “Principles...” of 1687 are also obtained the gravitational laws.

Under these conditions, since the theoretical basis of electromagnetic energies and masses are given by Maxwell’s equations, without the gravitational fields, while according to S. Poisson, Newton’s gravitation was described in 1813 by the following differential equations

$$\text{a) } \text{rot}.\vec{G} = 0;\ \text{b) } \text{div}\vec{G} = -\rho_m.4.\pi.\gamma; \tag{3-1}$$

where according to the condition that matter is electromagnetic, it follows that ρ_m is

$$\text{a) } \rho_m = \frac{dm}{dV} = \frac{\varepsilon_0.E^2}{2.c^2} = \frac{\mu_0.H^2}{2.c^2} = \frac{d\left(Q_T\right)}{dV};\ \text{b) } \rho_E = \frac{\varepsilon_0.E^2}{2.c^2};\ \text{c) } \rho_H = \frac{\mu_0.H^2}{2.c^2}; \tag{3-2}$$

where ρ_m is density of the mass of electromagnetic matter in substantial or field form. And their respective gravitational fields generated by electromagnetic matter are

$$\text{a) } \vec{G}_{\rho_m} = -\frac{\rho_m.\gamma.\vec{r}_0}{r^2}; \tag{3-3}$$

It is apparent that the electric $\vec{E}$ and magnetic $\vec{H}$ fields (or rather the densities of their masses) generate gravitational fields, which are described by the equations of Poisson (3-52) through the densities of their masses.

This circumstance is the reason to consider the equations of Poisson (3-1) as gravitational part of the theory of electromagnetic matter. And in this sense there follows the inference that they, being part of the theory of electromagnetic matter, should be united into one system, as a second part after the equations of Maxwell, ***which are the first part, which system, described with observance of the laws: a) of conservation of the electric charge, b) the three laws of Newton and c) their corollaries, form the deductive principle (the theoretical foundations of the theory of electromagnetic matter,*** **which system because it is a leading theoretical principle, which is in the basis (root) of all theories about the manifestations of electromagnetic matter.** ***Out of these foundations (principles) of the laws of electromagnetic matter is formed the deductive principle (theoretical foundations) of physics, which is the leader of natural sciences, and which in this study is called***

PRINCIPAL

$$\left.\begin{array}{ll} \text{a) } \text{rot}\vec{E} = -\dfrac{\partial \vec{B}}{\partial t}; & \text{b) } \text{div}\vec{D} = \rho_E;\ \text{c) } \vec{D} = \varepsilon.\vec{E}; \quad \text{I} \\ \text{a) } \text{rot}\vec{H} = \dfrac{\partial \vec{D}}{\partial t} + \vec{j}; & \text{b) } \text{div}\vec{B} = 0;\ \text{c) } \vec{B} = \mu.\vec{H}; \quad \text{II} \\ \text{a) } \text{rot}\vec{G} = 0' & \text{b) } \text{div}\vec{G} = -\rho_m.4.\pi.\gamma; \quad \text{III} \end{array}\right\} \tag{3-4}$$

where these designations are new: $\vec{D}$ and $\vec{B}$ are electric and magnetic inductions; ρ_e - density of the electric charge; $\vec{j}$ - density of current, if there is any; ρ_m - density of electromagnetic matter (gravitational charge), the mass.

These inferences follow from (3-4):

1. they describe the unity of the regularities both of field and of substantial forms of electromagnetic matter;

2. they prove the unity and inseparability of electromagnetic and gravitational fields, i.e. their genetic unity;

3. they show that at $\rho_e = 0$ the unity and inseparability of electromagnetic waves is described as well as the generated by them electric, magnetic ($\vec{E}$ and $\vec{H}$) and gravitational field $(\vec{G})$ through the respective densities of their matters (masses) $\rho_E + \rho_H = \rho_m$.

4. that the gravitational field has electromagnetic nature, i.e. that it is a secondary electromagnetic field.

Emphasis

Here the fact should be emphasized that the differential equations practically have unlimited number of real solutions, which depend on the unlimited number of boundary conditions, determined by the unlimited number of situations, which occur in nature. This property of differential equations enables them to describe the natural diversity, i.e. they satisfy the requirement of unlimited number of solutions for description of natural diversity.

In ***The Principal*** *all quantities are genetically homogenous. I.e. the Principal describes the homogeneity (the unity) of: a) the substantial and field forms of electromagnetic matter and that they can convert (restructure) from one into the other forms; b) the electromagnetic and gravitational fields, and that there is no object (phenomenon) which does not generate simultaneously both (electromagnetic and gravitational) fields and* **c) this is the embryo as an initial deductive principle, which directly or indirectly is in the root of all sciences studying natural phenomena.**

4. RELATIONSHIP BETWEEN ENERGY AND MASS AND THE MEANING OF THE NOTION FORCE

1. J. C. Maxwell in his book "Treatise on electricity and magnetism" of 1873 wrote:

a) in paragraph 638: "We should consider both magnetic and electromagnetic energies as kinetic energies.…";

b) in paragraph 792: „In a medium, where electromagnetic waves propagate, there is pressure in direction perpendicular to the waves and numerically equal to the energy contained in a unit of volume".

If by ρ are designated respectively the densities of mass m and energy W, falling at the velocity of light c, for a unit of time upon surface S and located within volume $V = S.c$, then it follows that $\rho = m/V$ and $w = W/h$. Under these conditions, according to Maxwell, the pressure on a unit of surface $(S = 1)$ obeys these regularities (according to paragraph 792).

$$\text{a) } p = \rho.c.c = \rho.c^2 = w; \rightarrow \quad \text{b) } \rho = \frac{w}{c}; \rightarrow \quad \text{c) } c^2 = \frac{w}{\rho}; \tag{4-1}$$

The pressure P on a surface, different from one $(S \neq 1)$ is

$$\text{a) } P = p.S = m.c = \frac{W}{c}; \rightarrow \quad \text{b) } m = \frac{W}{c^2}; \rightarrow \quad \text{c) } W = m.c^2; \tag{4-2}$$

2. In 1883 the Italian A. Bartoli in an article in "Nuvo cimento. 15. p. 195, 1883" gave a deduction of (4-2)a based on thermodynamic regularities.

3. In 1900, H. Poincare in "Lorentz-Festschrift, 1900, 252" derived formula (4-1)a, which was defined by Maxwell in paragraph 792 of the treatise.

4. In 1901, P. Lebedev in „Ann. d. Plys, 6, p. 433, 1901", and in 1903 the Americans Nickols and Hool in „Ann. d. Plys, 12, p. 225, 1903" independently of each other, as they wrote, gave experimental proof to Maxwell's formula of the pressure of light $P = W/c$. And since (4-2)a is proven, the deduction of (4-2)c is elementary.

5. It is an interesting fact that Einstein also published an article about $W = m.c^2$ in the same magazine „Ann. d. Plys", but in 1905, only 4 and 2 years after Lebedev and Nichols and Hool, who had already proved experimentally the formula $W = m.c^2$. $(m.c = W/c = P)$, which he offered as a new discovery.

Emphasis

In his article "Ist die Trägheiteines Körpers von seinem Energienhalt Abhengig?" in "Ann. Phys" 1905, 18, 639 -641, Einstein wrote: „This equation $W \equiv m.c^2$ immediately entails the inference that is the body releases energy W in the form of radiation, then its mass decreases by W / c^2. It is insignificant that the energy, which the body releases, is directly transformed into radiant energy of emission."

Apparently, Einstein derived formula (4-2)c for electromagnetic waves (photons), and after that he wrote that it holds true for bodies as well, as it is with Maxwell. This generalization is grounded on the experimental fact that the field form of electromagnetic matter can be transformed in substantial (fermion) and vice versa.

All natural phenomena are various structural-organizational and dynamic states of respective quantities of electromagnetic matter (mass), which have passed from one state into another as a result of shift (motion) of certain quantities of matter.

And essentially, in order that such motion of matter can be realized, force $\vec{F}_a = m.\vec{a}$ ($\vec{a}$ is acceleration) should act. By definition, force has dimensionality N (ньютон) $= kg.m.s^{-2}$ or energy [J] or mass [kg] per a unit of distance, or

$$F = \frac{\text{energy}}{\text{distance}} = \frac{W}{r} = \frac{m.c^2}{r} = \frac{\text{mass}}{\text{distance}}.c^2; \qquad (4\text{-}3)$$

I.e. the action of the force means imparting energy (W / r) or $\left(m/r.c^2\right)$ to the matter (mass) of the object – alteration of its energy and mass.

This process of the action of the force on the object (mass) is called interaction (exchange of energy for mass), without which no new natural phenomenon can occur.

The process of interaction was called by Newton a mechanical process. With electromagnetic matter, the forces, energies and masses are only electromagnetic, but the name of the interaction was given even by Maxwell in some places of „The treatise" as mechanical . I.e. essentially, since the interaction is always associated with „mechanical " shift (motion), therefore it is always mechanical shift (motion).

5. ALTERATION OF THE QUANTITY OF MATTER OF BODIES AS A RESULT OF THE ACTION OF FORCE

5.1. Generation of magnetic energy and matter (mass) and respective gravitational field

Experimentally has been ascertained that during motion of electric charge $\mp q_e$ at velocity $v < c$ around it and inseparably from it a magnetic field $\vec{H}_e$ is generated with density of magnetic energy w_{He} and density of its mass ρ_{He}, as well as the mass m_e of the electron at velocity v, as follows

$$\text{a) } \vec{H}_e = \varepsilon_0.\left[\vec{v}.\vec{E}_E\right]; \text{ b) } w_{He} = \frac{\mu_0.H^2}{2}; \text{ c) } \rho_{He} = \frac{w_{He}}{c^2}; \text{ d) } \mu_0 = \frac{1}{\varepsilon_0.c^2}; \qquad (5\text{-}1)$$

where: μ_0 is magnetic constant of vacuum.

At point M at distance r the electron generates densities of energy w_{He} and of mass ρ_{He} of the magnetic field $\vec{H}_E$, which are variable quantities, depending on velocity v, and the respective quantities of electrostatic field $\vec{E}_E$ are constant

$$\text{a) } w_E = \text{const.}; \text{ b) } \rho_E = \text{const.}; \text{ c) } q_e = \text{const.}; \qquad (5\text{-}2)$$

In these conditions the resultant densities of energies w_M and masses ρ_M at point M are

$$\text{a) } w_M = w_E + w_{He}; \text{ b) } \rho_M = \rho_E + \rho_{He}; \qquad (5\text{-}3)$$

Therefore the differentials of w_M and ρ_M from (5-9) are

$$\text{a) } dw_M = 0 + dw_{He}; \text{ b) } d\rho_M = d\rho_{He}; \qquad (5\text{-}4)$$

i.e. at point M, w_M ***and*** ρ_M ***are altered depending on velocity v only the components of the magnetic***

field $H = f(v)$ ***and its respective densities of energy and mass (5-4), and thence (or because of this) the magnetic energy*** W_{He} ***and mass*** m_{He} ***of the electron are also altered.***

To density of mass ρ_M corresponds momentum $\vec{P}_M$ and force $\vec{F}_M$

$$\text{a) } \vec{P}_M = \rho_M.\vec{v};\ \text{b) } \vec{F}_M = \frac{d\vec{P}_M}{dt} = \frac{d\rho_M}{dt}.\vec{v} + \rho_M.\frac{d\vec{v}}{dt}; \tag{5-5}$$

Since point *M* is at a random distance *r* from the electron, the relationships $\vec{P}_M = \vec{P}$ and $\vec{F}_M = \vec{F}$ hold true for all points of the volume outside the electron from its radius r_{e0} to infinity (∞). Under this condition the differential of the full energy (of the electrostatic and magnetic fields) of the electron with density of mass ρ_M (5-9)b is

$$dW_e = \vec{F}_M.d\vec{r} = \frac{d(\rho_M.\vec{v})}{dt}.\vec{v}.dt = d\rho_M.v^2 + \frac{1}{2}\rho_M.d(v^2); \tag{5-6}$$

And the density of mass ρ_M of the energy of the electron at velocity

$$\text{a) } v < c;\ \text{b) } \beta = \frac{v}{c} < 1;\ \text{c) } \beta \to 1; \tag{5-7}$$

is

$$\rho_M = \frac{dW_e}{c^2} = d\rho_M\left(\frac{v}{c}\right)^2 + \frac{1}{2}\rho_M.d\left(\frac{v}{c}\right)^2 = d\rho_M\left(1-\beta^2\right) + \frac{1}{2}\rho_M.d\left(1-\beta^2\right);\quad \beta = \frac{v}{c}; \tag{5-8}$$

After processing equation (5-8) we have

$$\frac{d\rho_M}{\rho_M} = -\frac{1}{2}\frac{d\left(1-\beta^2\right)}{\left(1-\beta^2\right)}; \tag{5-9}$$

With solution of equation (5-9) under the following conditions

$$\text{a) } v = 0;\to\ \text{b) } \rho_M = \rho_E;\ \text{c) } v \neq 0;\ \text{d) } \rho_M = \rho_M \neq \rho_e; \tag{5-10}$$

we have density of mass ρ_e of the electron at velocity $v < c$, and from it we have the density w_e of its energy, which are

$$\text{a) } \rho_e = \rho_E\left(1-\beta^2\right)^{-1/2};\ \text{b) } w_e = \rho_e.c^2 = \rho_E.c^2.\left(1-\beta^2\right)^{-1/2}; \tag{5-11}$$

Whence, after integrating ρ_e and w_e in the volume of r_{e0} to ∞ we have the full mass m_e and the energy W_e of the electron at velocity *v* according to the condition about the velocity (5-7), which are

$$\text{a) } m_e = m_{e0}\left(1-\beta^2\right)^{-1/2};\ \text{b) } W_e = m_e.c^2 = m_{e0}.c^2\left(1-\beta^2\right)^{-1/2} = W_{e0}.\left(1-\beta^2\right)^{-1/2}; \tag{5-12}$$

Since m_e and W_e also include m_{e0} (5-2)a and the energy W_{E0} (5-1)c at rest $(v = 0)$, it follows that they are sums of two parts

$$\text{a) } m_e = m_{e0} + m_{He} = m_{e0}\left(1-\beta^2\right)^{-1/2};\ \text{b) } W_e = W_{E0} + W_{He} = W_{E0}\left(1-\beta^2\right)^{-1/2}; \tag{5-13}$$

In this inference, a significant fact (law) is that since during motion of the electron at velocity *v*, magnetic (kinetic) energy is generated around it, which is inseparable from the electron; therefore, the mass of the magnetic (kinetic) energy is inseparable from the mass of the electron at rest m_{e0}. That explains why the mass and full energy of the electron at velocity *v* increase according to (5-13), while the theory of relativity does not offer any explanation of the physical meaning of the mass growth according to (5-13). This circumstance explains why, according to Maxwell, kinetic energy is magnetic (electromagnetic) energy.

Therefore the mass m_{He} ***of the magnetic field (of the magnetic energy) of the electron and the magnetic energy*** W_{He} ***of the electron are inseparable from the electron and have these values***

$$\text{a) } m_{He} = m_e - m_{e0} = m_{e0}\left[\left(1-\beta^2\right)^{-1/2} - 1\right];\ \text{b) } W_{He} = W_e - W_{E0} = m_{e0}.c^2\left[\left(1-\beta^2\right)^{-1/2} - 1\right]; \tag{5-14}$$

To m_{He} corresponds gravitational field $\vec{G}_{He}$ of electromagnetic nature, inseparable from it

$$\vec{G}_{He} = -\frac{m_{He}.\gamma.\vec{r}_0}{r^2} = -m_{e0}\frac{\left[\left(1-\beta^2\right)^{-1/2}-1\right].\gamma}{r^2}.\vec{r}_0 = -q_e^2.\frac{k_m.\left[\left(1-\beta^2\right)^{-1/2}-1\right].\gamma.\vec{r}_0}{r^2} < 0; \quad (5\text{-}15)$$

It is apparent from here that the gravitational field, generated by the mass of the magnetic field of the electron is of electromagnetic nature, but since it is generated by the magnetic (electromagnetic) field, it should be called a secondary electromagnetic field, which is generated by the square (the mass) of the electric charge $\left(\mp q_e\right)^2$, ***or, respectively, by the mass of its magnetic energy.***

Emphasis

Magnetic (kinetic) energy $W_{He} = W_{Ke}$ ***(5-14)b and magnetic (kinetic) mass*** $m_H = m_{Ke}$ ***(5-14)a, are here obtained as quantities, which are product of electromagnetic matter, whose theory was developed by J. C. Maxwell in his book "Treatise on Electricity and Magnetism" in 1873, where Maxwell specified that in the theory of electromagnetic matter the role of kinetic energy is played by magnetic and electromagnetic energies, whereby:***

a) in paragraph 636 Maxwell wrote **"...kinetic energy exists wherever there is magnetic field, i.e. in all parts of the field where there is magnetic field. Quantitatively, the density of magnetic (kinetic) energy is**

$$W_K = W_H = \frac{\mu_0.H^2}{2};$$

where: μ_0 is magnetic permeability of vacuum; H – magnetic field."

b) and in paragraph 638 Maxwell wrote:

"THEREFORE WE SHOULD CONSIDER BOTH MAGNETIC AND ELECTROMAGNETIC ENERGIES AS KINETIC ENERGIES." (emphasis added by P.P.).

This solution of Maxwell was missed (not taken into consideration) at the time when Maxwell's electrodynamics was studied. Probably this omission was made by the author who first presented the complete electromagnetic theory of Maxwell in a systemized way, in the form known today as Maxwell equations, for this system of equations, named after him, was not given by Maxwell in his treatise.

At present this omission should be corrected and instead of kinetic energy it should be written (used) the notions of magnetic or electromagnetic energy. i.e. all energies are only electromagnetic energies (electric, magnetic and gravitational).

At velocity of the electron v much lower than c, i.e. at

$$\text{a) } v \ll c;\ \text{b) } \beta = \frac{v}{c} \ll 1;\ \text{or c) } \beta \to 0; \quad (5\text{-}16)$$

the expression $\left(1-\beta^2\right)^{-1/2}$ is expanded in a power series

$$\left(1-\beta^2\right)^{-1/2} = 1+\frac{1}{2}\beta^2-\frac{3}{8}\beta^4+\frac{15}{18}\beta^6...; \quad (5\text{-}17)$$

And by taking only the first two terms of (5-14), magnetic energy W_{He} (5-14)b and mass m_{He} (5-14)a are notated in reduced forms

$$\text{a) } W_{He} = \frac{m_{e0}.v^2}{2};\ \text{b) } m_{He} = \frac{W_{He}}{c^2} = \frac{m_{e0}.v^2}{2.c^2} \ll m_{e0}; \quad (5\text{-}18)$$

These magnetic energy W_{He} and mass m_{He} incorrectly, according to Maxwell, are called kinetic energy W_k and mass m_k.

5.2. Protons and neutrons are restructured accelerated squares of electric charges – electrons

It is necessary to emphasize that it is known that there exists a law in physics that magnetic (kinetic) energy can be turned into substantial elementary particles.

For example, the interaction of accelerated electron e^- and positron e^+ may result, depending on the condition: a) proton p and antiproton $\overline{p}$ or b) neutron n and antineutron $\overline{n}$. The accelerated to velocity $v < c$ electron and positron have masses m_e and energies W_e, according to (5-13). Then

$$\text{a) } e^- + e^+ \to e_0^- + e_0^+ + (p + \overline{p}); \text{ b) } e^- + e^+ \to e_0^- + e_0^+ + (n + \overline{n}); \tag{5-19}$$

where, if equation (5-25)a is written through the energies of the electrons and protons and if we take into consideration the fact that the energies and the masses of the electron and positron are equal in values $\left(W_{e_0^-} = W_{e_0^+}; W_{e^-} = W_{e^+}\right)$ as well as to proton p_0 and antiproton $\overline{p}_0$ at rest, and by analogy, for the neutron. Under these conditions, from (5-13) and (5-19)a, written through the respective energies, we have

$$2.W_{e0} = 2.(W_{e0} + W_{He}) = 2.(m_{e0} + m_{He}).c^2 = 2.(m_{e0} + m_p).c^2 = 2.m_{e0}\left(1-\beta^2\right)^{-1/2}.c^2; \tag{5-20}$$

from (5-20) after processing, follow the formulae of the masses of the proton and antiproton

$$m_{p0} = m_{\overline{p}0} = m_{He} = \frac{W_{He}}{c^2} = m_{e0}\left[\left(1-\beta_p^2\right)^{-1/2} - 1\right] = q_e^2.\left[\left(1-\beta_p^2\right)^{-1/2} - 1\right].k_m = Q_{p0}^2.k_m; \tag{5-21}$$

where, since the expression $\left[\left(1-\beta_p^2\right)^{-1/2} - 1\right]$ is a dimensionless quantity, and k_m is a physical constant, we have no grounds to assume that

$$Q_{p0}^2 = q_e^2.\left[\left(1-\beta_p^2\right)^{-1/2} - 1\right]; \tag{5-22}$$

is effective square of the electric charge of the proton at rest, which is so with the antiproton too.

By analogy we can obtain the masses of neutron n_0 and antineutron $\overline{n}_0$

$$m_{n_0} = m_{\overline{n}_0} = m_{He} = \frac{W_{He}}{c^2} = q_e^2\left[\left(1-\beta^2\right)^{-1/2} - 1\right].k_m = Q_{n0}^2.k_m; \tag{5-23}$$

Since W_{He} and m_{He} are respectively the magnetic (kinetic) energy and mass of the electron, it is evident that they can convert (get transformed) into a substantial form of electromagnetic matter. I.e. protons and neutrons are electromagnetic elementary particles.

Whence the masses of the proton and neutron generate respective gravitational fields, as follows

$$\vec{G}_{p0} = -\frac{m_{p0}.\gamma}{r^2}.\vec{r} = -\frac{q_e^2.\left[\left(1-\beta^2\right)^{1/2} - 1\right].\vec{r}_0}{r^2} = -\frac{Q_{p0}^2.\gamma.\vec{r}_0}{r^2}; \tag{5-24}$$

$$\vec{G}_{n0} = -\frac{m_{n0}.\gamma}{r^2}.\vec{r}_0 = -q_e^2.\left[\left(1-\beta^2\right)^{1/2} - 1\right].\vec{r}_0 = -\frac{Q_{n0}^2.\gamma.\vec{r}_0}{r^2}; \tag{5-25}$$

It is apparent that these gravitational fields are product of the squares of electric charges. Therefore they are:

a) of electromagnetic nature – they are secondary electromagnetic fields, and

b) unipolar, since

$$\left(\mp q_e\right)^2 > 0; \tag{5-26}$$

This proof was not given either in Newton's mechanics or in Einstein's theory of relativity.

And since atoms and molecules are formed (structured) from electrons, positrons and neutrons, the inference follows that atoms are structures of electromagnetic elementary particles, i.e. they are only structures of electromagnetic matter – they are substantial electromagnetic matter, which is obtained from field matter and can convert into field matter.

For the purposes of analyzing the masses of protons and neutrons, for convenience, we introduce the notion effective square of electric charge Q^2 of a body (object) of electromagnetic matter with mass m.

Essentially these squares of electric charges Q^2, are an external expression of the sum of the squares of electric charges of the electrons, from which are formed the respective quantitative values of objects (quantities of electrons, protons and neutrons) of electromagnetic matter, respectively of electromagnetic (magnetic – kinetic) energy. And here (in this article) they are called squares of effective electric charges of objects (bodies).

And in the most general case, to each quantity of electromagnetic matter (body), which corresponds to electromagnetic energy (including also to thermal energy) *W*, corresponds mass $\left(m_T = W_T / c^2\right)$, and to its mass m_T corresponds a square of the effective electric charge.

$$\text{a) } Q_T^2 = \frac{m_T}{k_m};\ \text{b) } m_T = Q_T^2.k_m; \tag{5-27}$$

It is essential to emphasize that Q_T^2 is not equal to the real square Q_R^2 of the sum of electric charges of the electrons of the object with mass m, but is equal to the sum of squares of the individual charges of the electrons, which correspond to the object.

From the interaction of the electron e_0^- and positron e_0^+ at rest are generated photons γ, which move at velocity of light *c*, as follows from the following experimental facts

$$\text{a) } e_0^- + e_0^+ \rightarrow 2.\gamma;\rightarrow \text{ b) } 2m_{e0}.c^2 = 2.W_f = 2.h.\nu = 2.\gamma;\ \text{c) } \nu = \frac{m_{e0}.c^2}{h}; \tag{5-28}$$

where: *h* is Planck constant; ν - frequency of photons γ.

In the case of photon γ, the energy $W_f = h.\nu$, which is electromagnetic energy in the form of electromagnetic waves of electric $\vec{E}$ and magnetic $\vec{H}$ fields, but this energy W_f is obtained from the energy $m_{e0}.c^2$ of the electron, which can be written in the form

$$\text{a) } q_e^2.k_m.c^2 = W_f = h.\nu;\rightarrow \text{ b) } q_e^2 = \frac{W_f}{k_m.c^2} = Q_f^2; \tag{5-29}$$

In this sense, to the energy of electromagnetic waves of photon corresponds effective square of the electric charge Q_f^2 of the photon. It is exactly in this sense that this charge is the source of energy W_f. In this aspect, to each electromagnetic (electric W_E, magnetic W_H or sum of W_E and W_H) energy corresponds some effective square of electric charge.

5.3. Conclusion

In the above meaning the interaction results from the action of forces and generates exchange of energy and mass (quantity of matter), as a result of which the matter of the object changes. And along with it changes also its structural-organizational and dynamic state, and hence its properties, including its force property.

PART TWO.
THERMODYNAMICS IS THERMOELCTRODYNAMICS

1. INTRODUCTORY THOUGHTS

The beginning of the studies of thermal manifestations, i.e. the manifestations of electromagnetic energy, was laid in times long before electromagnetic energy was discovered and used in practice.

This circumstance justifies the development of a science dedicated to thermal processes and named thermodynamics. More specifically, the term „thermodynamics" was introduced in 1854 by W. Thomson, who changed the original name of this section of physics, which had been called „mechanical theory of the heat". In general, the development of modern equilibrium thermodynamics is erroneously believed to have started in 1824 with the article "Reflections on the moving force of fire" by S. Carnot, where he proposed Carnot's cycle, instead of starting in 1822, when Fourier postulated his law of thermal energy.

On the development and the archaisms in thermodynamics, Prof. N. A. Kvasnikov[*] wrote in 2002:

"For historical reasons thermodynamics was created not by one generation of scientists, but by several generations, so there are a lot of viewpoints in it, various approaches, different formulations of the same questions, variety of designations, etc. This accounts for certain heterogeneity of material" and further (on p. 35) he wrote: **"Thermodynamics is not a unitary and universal theory. Its sphere of application and its capacities are limited." On p. 192 he also wrote: *"The problems of thermodynamics can be solved without the notion of entropy… by using only immediately measurable quantities." And further on, he also wrote:***

In § 1 (p. 17) he wrote: "As it was noted in the foreword, thermodynamics and statistical physics are not universal theory. Their sphere of application is strictly limited to the study of so-called thermodynamic systems."

*In § 3 (p. 36) he wrote: "Thermodynamics discusses only quasi-static processes. They are defined as infinitely slow processes, which consist of inexhaustible number of successive equilibrium states which hardly differ from one another; clearly, these processes **are not real processes, but a special unreal boundary case**, the main advantage of which is that they are reversible, i.e. that there are no losses."*

In § 9 (p. 192) he wrote: "... we have shown that the problems of thermodynamics can be solved without using the notion of entropy, or chemical potential and so on, but by operating only with immediately variable quantities. The latter circumstances make these versions of solutions very illustrative, and thus to some extent is compensated their artificiality, which at first is associated with the need to seek appropriate Carnot's cycle, etc., and also with the feeling of "oddity" in the sense of style of presentation."

This citation of Prof. Kvasnikov shows that:

- the solution of thermodynamic problems without entropy is much simpler and more illustrative;

Here we must emphasize one of the requirement on scientific reliability, which states: for a certain quantity to be recognized as a scientific one, first of all it must be measurable, i.e. without being able to measure quantitative values of a concept (notion), as is with the notion of entropy, there is no scientific truth in it. *This requirement is necessary so that we can compare the quantitative values estimated for entropy with the ones measured in experiments (practice). Since this is the procedure for proving the reality of the laws of entropy. And as it is known, the quantitative values of entropy cannot be measured, nor is there a full algorithm for calculation of its quantitative values, according to Boltzmann's formula, respectively, the thermodynamic probability. This is the reason why here entropy is treated as a flawed term, instead of as a second law.*

Another feature (essential weakness - flaw) of present-day thermodynamics is that it ignores the experimental fact, which has been known to humanity for centuries, that the electromagnetic waves - the photons (light from the sun) are the expression of heat (thermal energy) i.e. that photons are heat energy, which is something material according to the modern idea that photons are a field form of electromagnetic matter (electromagnetic elementary particles), and which can be converted into a substantial form of electromagnetic matter.

In the edition of "Opticks…" of 1718, on p. 323 and 324, I. Newton[**] wrote:

---

[*] N. A. Kvasnikov. Thermodynamics and Statistical Physics. v. 1. Theory of Equilibrium Systems. Thermodynamics. (in Russian) Publ. Editorial URSS. Moscow. 2002.

[**] Newton I. Opticks or a treatise of the reflections, refractions, inflections and colours of light (in Russian). "Gostehizdat". M. 1954. Translated from Isaac Newton. Optics or Treatise of the Reflection's, Refractions, Inflections and Colors of Light. London, 1718.

Qu. 18. If in two large tall cylindrical Veſſels of Glaſs inverted, two little Thermometers be ſuſpended ſo as not to touch the Veſſels, and the Air be drawn out of one of theſe Veſſels, and theſe Veſſels thus prepared be carried out of a cold place into a warm one; the Thermometer *in vacuo* will grow warm as much, and almoſt as ſoon as the Thermometer which is not *in vacuo*. And when the Veſſels are carried back into the cold place, the Thermometer *in vacuo* will grow cold almoſt as ſoon as the other Thermometer. Is not the Heat of the warm Room convey'd through the *Vacuum* by the Vibrations of a much ſubtiler Medium than Air, which after the Air was drawn out remained in the *Vacuum*? And is not this Medium the ſame with that Medium by which Light is refracted and reflected, and by whoſe Vibrations Light communicates Heat to Bodies, and is put into Fits of eaſy Reflexion and eaſy Tranſmiſſion? And do not the Vibrations of this Medium in hot Bodies contribute to the intenſeneſs and duration of their Heat? And do not hot Bodies communicate their Heat to contiguous cold ones, by the Vibrations of this Medium propagated from them into the cold ones? And is not this Medium exceedingly more rare and ſubtile than the Air, and exceedingly more elaſtick and active? And doth it not readily pervade all Bodies? And is it not (by its elaſtick force) expanded through all the Heavens?

This experiment, conducted by Newton in 1718, entails the inference that gas molecules are not carriers of the dynamic form of thermal energy, but carriers of thermal energy is the photon gas, which has density of electromagnetic (photon) energy

$$w_f = \sum W_{fij} = h. \sum_{i=1;\ j\neq 0}^{i=n.\,j<10^{20}\ \mathrm{Hz}} \nu; \tag{1-1}$$

where: h is Planck constant; ν_{ij} - frequency of the photons, whereby ν_i is number of photons in general, and ν_j - is number of the photons with different frequencies j.

The pressure P_f, which is exerted by w_f is

$$P_f = \frac{1}{3}.w_f; \tag{1-2}$$

And the thermal energy W_{fV} and the pressure $\vec{P}_{fV}$ of the photon gas in volume V_{fV} are

$$\text{a) } W_{fV} = w_f.V_{fV};\ \text{b) } \vec{P}_{fV} = \frac{w_{fV}}{c}.\vec{c}_0;\ \vec{c} = \frac{\vec{c}}{|\vec{c}|}; \tag{1-3}$$

The experimental fact presented above, described by Newton, reject in a most categorical way the assumption that only molecules are carriers of the dynamic form of thermal energy and reinforce (by experimental facts) the law that thermal energy is also carried by the photon gas, which has a density of thermal energy w_f and generates pressure $\vec{P}_f$, which is generated when the energy of the photon $W_f = h.\nu$ is absorbed for time τ and momentum $\overline{p}_f = \frac{W_f}{c}.\vec{c}_0$ and force

$$\text{a) } \vec{F}_f = \frac{\vec{P}_f}{\tau};\ \text{b) } \vec{F}_{fT} = \frac{\vec{P}_{fT}}{\Delta t} = \frac{w_f}{\Delta r}.\vec{c}_0;\ \text{c) } \Delta r = c.\Delta t; \tag{1-4}$$

This force from the photon gas sets molecules of the gas with mass m_M in motion at temperature T to velocity v, which is the same in the photon gas as the one in the probability of Maxwell for the gas molecules

$$v = \left(\frac{3.k_B.T}{m_M}\right)^{1/2}; \tag{1-5}$$

where: k_B is Boltzmann constant.

Here is should be specified that all atoms (molecules) continuously, but periodically emit and absorb photons with energy $W_f = h.\nu$, time τ whereby during the emission forces of recoil occur, and during the absorption of a photon a force of pressure occurs. These forces provide the motion of molecules. and they are proportional to the temperature (the density of the photon gas) between the molecules. Modern thermodynamics does not explain this fact.

I.e. it is proved that molecules are carriers of potential thermal energy, which is essentially magnetic (kinetic) energy of molecules $\left(\frac{m.v^2}{r}\right)$, since they are driven by the energy of the photon gas, whose photons move at velocity $\vec{c}$ and have a momentum

$$\vec{P}_f = \frac{W_f}{c}.\vec{c}_0 = \frac{h.\nu}{c}.\vec{c}_0; \tag{1-6}$$

The experiment of Newton poses the question, why both thermometers get heated almost simultaneously although a photon density w_f of the energy acts in the vacuumed vessel as well as a density of the energy of the molecules, which have concentration n_0.

The explanation that in the vacuumed vessel the photon energy is distributed in the entire volume of mercury or alcohol, both in the reservoir and in the column that shows the degrees, as acts the emitted and other forms of molecules in the non-vacuumed vessel.

2. FORMING OF THE DYNAMIC FORM OF THERMAL ENERGY

2.1. Emission of photons by the electrons of the atoms

According to the law of Larmor of 1897, an electron with electric charge q_e and acceleration $\vec{a}$ releases power

$$N = \frac{dW}{dt} = \frac{2}{3}.\frac{q_e^2.a^2}{c}; \tag{2-1}$$

And for time τ it emits energy

$$W = N.\tau = \frac{2}{3}.\frac{q_e^2.a^2}{c}.\tau;\ \text{J} \tag{2-2}$$

When centripetal force $\vec{F}_я$, generated by electric field $\vec{E}_я$ of the nucleus acts upon the electron, which is in orbit of its atom

$$\vec{F}_я = q_e.\vec{E}_я = \frac{q_e^2}{4.\pi.\varepsilon_0.r^2}.\vec{r}_0;\ \vec{r}_0 = \frac{\vec{r}}{|\vec{r}|}; \tag{2-3}$$

This force imparts energy dW_e to the electron

$$dW_e = \vec{F}_я.d\vec{r} = F_я.dr.\cos\alpha;\ d\vec{r} = \vec{v}_e.dt; \tag{2-4}$$

where: $\vec{v}_e$ is velocity of the electron along the orbit.

Here, depending on the angle α between $\vec{F}_я$ and $\vec{v}$ are possible three states:

a) $\alpha < \frac{\pi}{2} \rightarrow \cos\alpha > 0$: the tangential component of acceleration $a_\tau > 0$, due to which the force imparts energy to the electron and it is accelerated, its velocity v_{e0} increases by Δv_e to $v_e = v_{e0} + \Delta v_e > v_{e0}$, i.e. its magnetic (the kinetic) energy increases.

$$\text{from a) } W_{Ke0} = \frac{m_{e0}.v_{e0}^2}{2} \text{ of b) } W_{Ke1} = \frac{m_{e1}.v_{10}^2}{2}; \tag{2-5}$$

and since the sum of its potential and kinetic energies W_P and W_K is constant

$$W_P + W_K = \text{const.} = A; \tag{2-6}$$

And since the kinetic energy increases to W_{Ke1}, its potential energy should decrease

$$\text{from a) } W_{P0} = A - W_{Ke0}; \text{ to b) } W_{P1} = A - W_{Ke1}; \tag{2-7}$$

And since

$$W_{P0} = -\frac{\beta}{r_0} = A - W_{Ke0}; \tag{2-8}$$

And

$$W_{P1} = \frac{\beta}{r_1} = A - W_{Ke1} < W_{P0}; \tag{2-9}$$

therefore, the radius r_1 should increase to

$$r_1 = \frac{\beta}{A - W_{Ke1}} > r_0; \tag{2-10}$$

And the increase of the kinetic energy W_{Ke0} of the electron in the atom with orbit of radius r_0 is possible, when the electron absorbs from outside a photon with energy $W_f = h.\nu$ and its magnetic (kinetic) energy becomes

$$W_{Ke1} = W_{Ke0} + W_f; \tag{2-11}$$

or according to (2-10) the radius becomes

$$r_1 = \frac{\beta}{A - W_{Ke0} - W_f}; \tag{2-12}$$

This is the mechanism of changing the radius of the orbit of the electron, when it absorbs a photon and increases its magnetic energy. This mechanism is also explained by force $F_я$, which attracts the electron because of the influence of the electric field $\vec{E}_я$ of the nucleus.

b) $\alpha = \frac{\pi}{2} \rightarrow \cos\alpha = 0$: the tangential component of acceleration $\vec{a}_\tau$ is zero, since $\vec{F}_я \perp \vec{v}_e$.

In this case according to classical physics, the object (the electron) moves only at its orbit and neither emits nor absorbs energy, i.e.

$$dW_e = \vec{F}_я.d\vec{r} = F_я.dr.0 = 0; \tag{2-13}$$

c) $\alpha > \frac{\pi}{2} \rightarrow \cos\alpha < 0$: the tangential component of acceleration $a_\tau < 0$, due to which the force takes away magnetic (kinetic) energy (acts as a resistive force) ΔW_{Ke}, due to which the kinetic energy W_{Ke} of the electron decreases to

$$W_{Ke2} = W_{Ke0} - \Delta W_{Ke}; \tag{2-14}$$

This entails increase of its potential energy because of condition (2-6), whence its radius decreases to

$$r_2 = \frac{\beta}{A + W_{Ke} + \Delta W_{Ke}} < r_0; \tag{2-15}$$

Such is the mechanism of decrease of the radius of the orbit of the electron, when it emits a photon, which takes away part of its magnetic (kinetic) energy.

Emphasis

When there is force action upon substance, which essentially consists of atoms, which are structured by electrons and nucleus, through external force factors, as a result of which there is a forced change (increase, decrease, radiuses, orbits or are deformed the orbits of the electrons, then the electrons in orbits are forced to emit photons and substance gets heated.

This is the explanation of the facts that during the action by hits, pressure from outside and friction, the substance emits inside itself and outside of itself photons and gets heated (increases its temperature).

2.2. Characteristic features of photons

Photons are emitted by electrons at the velocity of light $c = 3.10^8$ m/s for time appr. $\tau = 10^{-8}$ s and therefore they have length

$$\ell_f = c.\tau = 3.10^8.10^{-8} = 3 \text{ m}. \tag{2-16}$$

At frequency close to the light one $\nu = 10^{14}$ Hz, the length of their wave is $\lambda = \frac{1}{\nu} = 3.10^8.10^{-14} = 3.10^{-6}$ m. The number of the waves of one photon with frequency 10^{14} Hz is

$$n = \frac{\ell_f}{\lambda} = 3.3^{-1}.10^6 = 10^6 \text{ waves}; \tag{2-17}$$

According to the book of Y. Smorodinski, Temperature, publ. „Nauka“, Moscow, 1981 (library „Quantum“) issue 12 (p. 13), the equation of the photon gas is

$$p = \frac{1}{3}.a.T^4; \tag{2-18}$$

where: p is the pressure, generated by photon gas; $a = 2,52.10^{-16}$ physical coefficient.

The characteristic features of the photon gas relative to the molecular gas are given in the following table

Table 1

Features of the molecules of an ideal gas and of a photon gas	
Molecules	Photons
1. $m_M = \text{const.}$;	a) $c = \text{const.}$; b) $m_f = \frac{W_F}{c^2} \neq \text{const.}$;
2. $W_{KM} = \varepsilon_M = \frac{p^2}{2m} = \frac{m\vec{v}^2}{2}$;	a) $W_f = \varepsilon_f = h.\nu = p.c$; b) $m_f.c^2$;
3. $N = \frac{N_0}{z}.\exp\left(-\frac{\varepsilon_f}{k_B.T}\right)$;	$N_f = \frac{1}{\exp\left(\frac{\varepsilon_f}{k_B}\right)-1}$;
4. $N_0 = \text{const.}$;	$N_f = \text{var.}$; $\left(N_f \neq \text{const.}\right)$;
5. $\vec{p} = m.\vec{v}$;	$\vec{p}_f = m_f.\vec{c} = \frac{W_f}{c}.\vec{c}_0$;

The table shows the features of the photon gas relative to an ideal gas of N molecules. They are:

1. there is no distribution of the photons by momentum and velocity, since here their velocity is $v = c = \text{const.}$;

2. the number of the photons N_f is not constant, whereas the number of the gaseous particles (the molecules) N_0 *is* constant;

3. the mass of the photons is not constant $m_f = W_f / c^2 \neq \text{const.}$;

4. the energy of the individual photons is different $W_f \neq \text{const.}$, ***but the energy in the volume with ensemble of photons in a closed system is constant*** $W_{fV} = \sum W_{fi} = w_f.V_{fV} = \text{const.}V_{fV}$ (where V_{fV} is the volume of the photon gas);

The energy of photons in a unit of volume - density of the energy of photons w_f is equal to part of the energy of the gas in volume V_Γ, i.e. $w_f = \frac{W_{f\Gamma}}{V_{f\Gamma}}$. And the energy which belongs to one molecule W_{km} is equal to

$$W_{km} = \frac{m \cdot \bar{v}^2}{2} = k_\Gamma \cdot \frac{V_{\Gamma N}}{N} = \frac{energy\,of\ gas\,molecules}{number\,of\ molecules}; \qquad (2\text{-}19)$$

where: $k_\Gamma < 1$ is a coefficient, which accounts for the decrease of the energy in the volume of the gas with the energy of the photons.

In conclusion, the characteristic features of thermal energy are:

1. it is electromagnetic energy in the form of a photon gas – electromagnetic waves (of electric and magnetic fields);
2. it generates force when photons hit upon atoms and molecules;
3. it generates pressure when hitting upon atoms and the molecules;
4. it performs work via the force or pressure which it generates;
5. ***it moves from places of higher density of energy of photons (thermal energy) to places of lower density of the energy of photons or from places of higher pressure to places of lower pressure, or from places of higher temperature to places of lower temperature, since temperature is proportional to the density of photon energy, which is thermal energy.***
6. ***photons are always emitted at the velocity of light $v = c = 3.10^8\ m.s^{-1}$***
7. ***there is no place in nature, where there is no photon gas – electromagnetic matter and electromagnetic energy – thermal energy, as well as gravitational field. I.e. in each point of space between bodies as well as between molecules, as well as between planets, there is photon gas (thermal energy – electromagnetic energy) of respective density of the energy of the photon gas w_f, which is electromagnetic energy, like the energy which the Earth receives through the sun rays.***

Under these conditions analogous dependencies for the photon gas and the molecular gas are given in Table 2.

The presented above makes it evident and clear that:

1. Thermal energy is electromagnetic energy, i.e. electromagnetic laws of electrodynamics hold true for it under the specific conditions of thermal processes (photon gas) and the magnetic (kinetic) energy of molecules.

2. The ascertainment in the above item 1 entails that thermodynamics, as a specific electrodynamics, does not need the three principles, because sufficient are the general physical laws of gravitoelectromagnetic dynamics:.

a) unitary matter in the world is only electromagnetic matter in field and substantial forms;

b) there is a law of electric charge conservation (LECC) and as a consequence of it, there is a law of matter and energy conservation;

c) electromagnetic (photon) energy moves from places of higher density (higher temperature) to places of lower density, and

d) the lowest, threshold limit of the density of kinetic (magnetic) energy of physical objects tends to zero, i.e. the lowest temperature, to which thermal phenomena tend, is zero degrees Kelvin (0 K).

3. The assumption that thermal energy is electromagnetic, on the one hand, simplifies the principles (laws) of thermodynamics, on the other hand, makes it clearer and its regularities more general in terms of electromagnetic phenomena and, moreover, this is really important since it would alleviate its presentation with regard to the unity of science as is the evolutionary trend in the development of knowledge. The problems of thermodynamics of gases, liquid medium and substance could be reduced to a single, unitary science - thermoelectrodynamic theory of electromagnetic matter, i.e. thermoelectrodynamics.

Table 2

Molecular gas	**Photon gas**
1. Energy of the molecular gas $W_{\Gamma M} = w_M.V_M$;	1. Energy of the photon gas $W_f = w_f.V_{\Gamma f}$.
2. Volume of molecular gas $V_{\Gamma M} = \frac{W_{\Gamma M}}{V_M}$;	2. Volume of the photon gas $V_{\Gamma f} = V_{\Gamma M}$.
3. Density of the energy of the molecular gas $w_M = \frac{W_{\Gamma M}}{V_{\Gamma M}} = \vec{W}_{k_m}.n_0^{-1}$;	3. Density of energy of the photon gas $w_f = \frac{W_f}{V_f} = \vec{W}_{k_m}.n_0^{-1}$.
4. Number of molecules N in $V_{\Gamma M}$, with masses m_M $N = \frac{V_{\Gamma M}}{n_0}$;	4. Number of the photons in $V_{\Gamma f}$ $N_f = \frac{1}{\exp\left(\frac{W_f}{k_B}\right)^{-1}} \neq \text{const.}; W_f = h.\nu;$
5. Concentration of molecules is $n_0 = \frac{N}{V_{\Gamma M}}$;	5. Concentration of the photons $n_f = \frac{N_f}{V_{\Gamma f}} \neq \text{const}.$
6. Mean statistical energy of one molecule $\vec{W}_{k_m} = \frac{m_M.\vec{v}^2}{2} = \frac{3.k_B.T}{2} = \frac{W_{\Gamma M}}{N} = w_M.n_0^{-1}$; where: k_B is Boltzmann constant.	6. Photon energy W_{Nf}, which corresponds to volume V_N of the molecular gas on condition that: a) $W_{\Gamma M} = W_{\Gamma f}$; b) $V_{\Gamma M} = V_{rf}$; is $W_{Nf} = V_N.w_M = \frac{w_M}{n_0}$
7. The volume, which belongs to one molecule $V_N = \frac{V_{\Gamma M}}{N} = \frac{1}{N/V_{\Gamma M}} = \frac{1}{n_0}$;	
8. Mean statistical velocity of one molecule $\overline{v}^2 = \frac{3.k_B.T}{m_M}$.	

3. GENERAL FORMULATIONS ON THERMAL ENERGY

It has been known since Antiquity that the Sun emits a flow of heat upon the Earth via light rays without atoms or molecules, i.e. neither atoms, nor molecules are carriers of thermal energy in a dynamic (real) state.

In modern terms, the flow of light rays is a flow of elementary field electromagnetic particles, which are called photons. They are carriers of electromagnetic energy W_f, electromagnetic mass (matter) m_f and electromagnetic momentum $\vec{P}_f$, i.e.

$$\text{a) } W_f = h.\nu \text{ ; b) } m_f = W_f / c^2 \text{ ; c) } \vec{P}_f = m_f.\vec{c} = \frac{W_f}{c}.\vec{c}_0; \vec{c}_0 = \frac{\vec{c}}{|\vec{c}|}; \tag{3-1}$$

This photon energy W_{fm} being a sum of photons, in a certain aspect is thermal energy W_{fm}, thermal mass m_{fm} and thermal momentum $\vec{P}_{fm}$, i.e.

$$\text{a) } W_{fm} = W_f \text{ ; b) } m_{fm} = m_f \text{ ; c) } \vec{P}_{fm} = \vec{P}_f \text{ ;} \tag{3-2}$$

The presented clearly shows that a given quantity of thermal energy from the Sun W_{fc} is a sum of photon energy

$$W_{fc} = \sum_{1}^{n} W_{fm} \; ; \qquad (3\text{-}3)$$

while not containing a single atom or molecule, i.e. the transfer of thermal energy from one object, the Sun, to the other object, the Earth, is not achieved via atoms or molecules, but only via elementary particles, photons. I.e. the essence of thermal energy is in the form of portions (quanta), called photons, which are carriers and essence of the dynamic (real) form of thermal energy, which is essentially a flow of electromagnetic energy or a flow of a field from of electromagnetic energy. This flow is in the form of photon gas. This gas occupies at various densities and various frequencies the world space, i.e. there is no space in the world without a photon gas – thermal energy. Or in other words, there is no place in the world at temperature T zero degrees Kelvin ($T_K = 0$K) .

The presented above entails the inferences:

First

ENERGY IN GENERAL, INCLUDING THERMAL ENERGY, IS INSEPARABLE FROM MATTER AND IN ESSENCE IS MATTER IN A STATE OF MOTION, BECAUSE WERE IT NOT IN THE FORM OF MATTER THERE WOULD NOT BE POSSIBLE TO STATE THAT IT COULD BE CONSERVED SINCE ONLY OF SOMETHING MATERIAL CAN WE STATE THAT IT IS CONSERVED.

Second

Energy in general, including thermal (electromagnetic) energy, is essentially is a typical state of matter, which is in a real or potential (explicit or implicit) state of motion.

Third

Energies W, including thermal energy, are homogenous in essence, as well as matter is - a fact, which is a direct result from the law $W = m.c^2$ **.**

AND SINCE ON THE ONE HAND MATTER, WHICH IS A CARRIER-GENERATOR OF THERMAL PHENOMENA, IS HOMOGENOUS, AND ON THE OTHER HAND THERE IS ONLY ELECTROMAGNETIC MATTER, THEN IT FOLLOWS THAT THERE IS NO OTHER KIND OF MATTER, WHICH IS A CARRIER AND GENERATOR OF THERMAL PHENOMENA, BUT ELECTROMAGNETIC, HENCE THEREFORE, THERMAL PHENOMENA ARE ELECTROMAGNETIC PHENOMENA.

THE CONDITION THAT MATTER IS HOMOGENOUS AND THE LAW $W = m.c^2$ ***REFERS TO IT, ENTAILS THE UNCONDITIONAL INFERENCE THAT ENERGY AS WELL, INCLUDING THERMAL ENERGY, IS ALSO SOLELY HOMOGENOUS IN ESSENCE, BUT IT CAN APPEAR IN DIFFERENT STRUCTURAL STATES OF ELECTROMAGNETIC MATTER***. For instance, these correspond to different structural states of electromagnetic matter a) independent electric charges (electrons and positrons); b) electric field; c) magnetic field and d) gravitational field; e) electromagnetic waves of various frequency which are generated by electrons and positrons in explicit or implicit form as electrons and positrons. To these fields correspond respective kinds (structural states) of energy. I.e. to the different structural states of electromagnetic matter correspond respective energies. **OR** ***ENERGY IS AN EXPRESSION OF THE RESPECTIVE STATE OF MATTER, I.E. THERE IS NOT ANY INDEPENDENT ENERGY WITHOUT A RESPECTIVE QUANTITY AND STATE OF ELECTROMAGNETIC MATTER, JUST AS THERE IS NOT ANY MATTER WITHOUT A RESPECTIVE QUANTITY OF DYNAMIC (KINETIC) AND POTENTIAL ENERGIES.***

By the beginning of 20th c. it had become clear that thermal energy is electromagnetic wave (radiation) energy in the form of an ensemble of electromagnetic radiation, which were later called photons, and their ensemble of radiations was later called photon gas. This fact is evident in the publications of G. Kirchhoff in 1860, L. Boltzmann in 1884, Max Planck in 1900, J. C. Maxwell in 1873 and in the experimental results of P. Lebedev in 1900, who proved Maxwell's thesis that to the energy of photons W_f which are carried by light rays corresponds (generates) momentum $\vec{p}_f$, respectively pressure $p = 1/3w$ (where w is the density of wave electromagnetic energy) and that is why photons can perform work, i. e. for the electromagnetic energy, Maxwell's pressures hold true.

THERE IS A THESIS IN PHYSICS THAT THE DYNAMIC FORM OF THERMAL ENERGY W_T ***OR THE THERMAL MASS*** $m_T = W_T / c^2$ ***ARE EXPRESSION OF THE ENERGY (MASS) OF THE PHOTON GAS, AT LOWER FREQUENCIES (ABOUND AND BELOW*** 10^{12} ***HZ). BUT ESSENTIALLY THE PHOTON ENERGY (ELECTROMAGNETIC ENERGY) FOR ALL FREQUENCIES OF THE PHOTONS, UNDER RESPECTIVE CONDITIONS MAY OCCUR AT RESPECTIVE CONDITIONS AS THERMAL ENERGY. IN THIS SENSE, THERMAL ENERGY IS A FIELD FORM OF ELECTROMAGNETIC MATTER, IN THE FORM OF PORTIONS (PHOTONS) OF ELECTROMAGNETIC WAVES .AND IT IS EXACTLY THE***

ENERGY OF THESE WAVES, WHICH IS ELECTROMAGNETIC ENERGY AT A RESPECTIVE FREQUENCY, IS ALSO THERMAL ENERGY. IN THIS ASPECT, IN THE PHYSICAL SENSE, I.E. IN ESSENCE, THERMAL ENERGY IS EQUAL TO ELECTROMAGNETIC ENERGY OF ELECTROMAGNETIC WAVES, AND THE MAGNETIC ENERGY OF ATOMS (MOLECULES)IS A POTENTIAL FORM OF THERMAL ENERGY.

However, electromagnetic energy of electromagnetic waves, depending on frequency ν of the waves, has various characteristic features (properties), which result mainly from the energy and the mass of one quantum of electromagnetic waves. Here, a quantum (photon) is assumed to be a sum of a series of n waves, bound in one impulse of duration τ seconds with a dominant frequency ν, which are emitted by an electron or the nucleus of an atom.

It should be pointed out here that there is also emission of a quantum of energy by atom nuclei, but they are very rare and at very high frequency, far above the thermal one (10^{12} Hz) and only their secondary manifestations may have a direct thermal effect, although as a whole they can manifest under respective condition as thermal energy as well.

In general, every quantum of electromagnetic energy can turn into thermal energy; therefore, all electromagnetic waves are carriers of thermal energy, but due to the properties of the structures of material objects, which react with photons in a variety of ways depending on the frequency of the absorbed electromagnetic energy, which has influence upon them, or they react in a variety of ways to the thermal components of electromagnetic energies of photons.

Moreover, there are electromagnetic energies of such frequency that some structures of objects cannot absorb and these energies pass freely through them - for instance, just as light through glass objects.

These circumstances explain the rule that when an object experiences electromagnetic energies (waves), it reacts to them in a different way depending on its structure and the frequencies of the waves that influence it.

Therefore, the same electromagnetic waves (photons) can manifest in some structures of electromagnetic matter as explicitly thermal, and in others – as explicitly light (in transparent structures).

In general however, the mechanism of emission (generation) and absorption of photons by particles of substance is one and the same. Subsequently, the mechanism of absorption and emission of thermal energy (heat) is also one and the same, i.e. the mechanisms of interaction of electromagnetic energies are governed by the same principles.

Emphasis

An irresistible proof that the essence and carrier of thermal energy $Q = W_T$ are electromagnetic waves, described in the form of a photon gas, is the following experimental fact:

It is known that thermal energy Q for heating of premises (rooms) is hot water (in liquid and evaporated state), which passes through the heating radiators. However, the thermal energy, which heats the premises is not in the form of water, but in the form of electromagnetic waves (photon gas), which, as a result of their absorption by the atoms and molecules, accelerate the molecules of the air – they heat the air in the room.

The mechanism of transfer of thermal energy *Q* from the hot water in the radiator is not via transfer of water molecules from inside the radiator to outside the room, but via:

First. ***Transfer of radiant electromagnetic energy, emitted by the molecules of water to the walls of the radiator, and they attain temperature T_P, but they do not absorb water molecules, i.e. the molecules do not leave the water.***

Second. ***Thermal energy Q, obtained within the radiator by the water in the form of a photon gas and, according to Fourier's law, it is transferred to the external surface of the radiator at temperature T_P, as a result of its temperature T_P, according to Stefan-Boltzmann law, and is emitted in the room at temperature $T_0 < T_P$, without transferring a single water molecule, but only of photons in the form of a photon gas.***

This thermal energy Q_P emitted in the room by a unit of area on the radiator at temperature T_P, according to Stefan-Boltzmann law is

$$Q_P = k_\sigma.\sigma.\left(T_P^4 - T_0^4\right); \tag{3-4}$$

Therefore, it is the photon gas that manifests in the room , at density of photon energy w_f, which is in direct contact with the objects in the room and with the molecules, which get accelerated to a higher velocity and at the same time absorb photon energy converting it into magnetic (kinetic) energy of mole-

cules. Under these conditions, the objects, including molecules, constantly emit photons and absorb photons, according to the laws of Newton (1704) and Kirchhoff (1860), until temperature T_f, which corresponds to the photon gas becomes equal to temperature T_0 (the ambient temperature in the room). ***The experimental fact thus described makes it evident that thermal energy Q is not carried by the molecules of the substance, but the molecules only emit photons, i.e. portions of thermal energy are emitted in the form of photons or photons are the essence and the carriers of thermal energy.***

In this sense thermodynamics, as a science studying thermal energy, should study the manifestations of photons and of the photon gas, i.e. thermodynamics is electrodynamics of photons – the photon gas.

In this sense all sections of physics study the manifestations of electromagnetic matter, i.e. they are sections of the science of electrodynamics under various conditions (situations).

The experiments of Seebeck and Peltier show direct interconvertibility of thermal energy in electromagnetic energy and vice versa.

The presented above proves the fact that thermal processes are electromagnetic phenomena, and this fact leads to the inferences that:

- IN GENERAL, THERMODYNAMICS IS ELECTRODYNAMICS UNDER RESPECTIVE SPECIFIC CONDITIONS;

- THERMODYNAMIC PROCESSES DESCRIBE THE CONVERSION OF ELECTROMAGNETIC ENERGY FROM ONE FORM INTO ANOTHER (ELECTROMAGNETIC WAVES INTO MAGNETIC ENERGY AND VICE VERSA);

- SO THAT PHYSICS IS UNIFIED, IT IS REQUIRED THAT THERMODYNAMICS SHOULD BE RATIONALIZED, IN ASPECT THAT IT IS A SPECIFIC PART OF ELECTRODYNAMICS, WHICH CIRCUMSTANCE WOULD PERFECT IT IN THE SENSE OF THE PRINCIPLE OF SIMPLICITY, SINCE:

FIRST, PHYSICS WOULD USE THE ALREADY KNOWN LAWS OF ELECTRODYNAMICS, AND

SECOND, PHYSIC WOULD USE A FEWER NUMBER OF SPECIFIC THERMAL QUANTITIES AND LAWS, I.E. IT WOULD BE SIMPLIFIED, AND THUS MORE PERFECT.

THIRD, IN REALITY, IN NATURE, WITHOUT PHOTONS THERE IS NO TRANSFER OF THERMAL ENERGY, WHICH IS A FIELD ELECTROMAGNETIC MATTER (MASS) AND IS IN ETERNAL MOTION.

In view of conservation of thermal balance of the atom relative to the ambient photon gas in the environment (ambient temperature *T*), the atoms emit and absorb photons (thermal energy).

Photon gas (or rather the density of photon energy) is what is felt on approaching an object, not the energy of the atom, which has absorbed or emitted a photon.

Here it should be emphasized on the fact that photons, as wave processes, have momentum $\vec{P}_f$, which is absorbed by the electron of the atom for time τ, the result of which is a force, which acts upon the atom with a value

$$\vec{F}_f = \vec{F}_\tau = \frac{\vec{P}'_f}{\tau} = \frac{W_f}{c}.\frac{1}{\tau} = \frac{W_f}{\Delta r};\ \Delta r = c.\tau; \tag{3-5}$$

This force sets the electron, respectively the atom into motion in direction of the momentum $\vec{P}_f$. The many photons, which hit upon the atom set it into oscillation around a middle point. An analogous, but opposite effect, called recoil effect, is obtained during emission of photon.

Since atoms on the surface emit photons (generate forces, respectively, pressure, which is a force per a unit of area) toward the inside of the object, their oscillating movements are transmitted to the inside, as there exist photons between atoms as well.

The particles (molecules) of the gas are always in a gas of photons, i.e. the particles of the gas are always molecules and photons.

The energy density w_f of the photon gas, to which is proportional temperature *T*

$$T \equiv w_f; \tag{3-6}$$

In a gas of substantial particles (molecules), their velocity is proportional to the energy, which they obtain from the photons – Maxwell's pressure of photons, respectively from the density of the energy of the photons.

IN THIS SENSE, THE ATOM ITSELF IS NOT A DIRECT CARRIER OF THE PHOTON, BUT IT IS A CARRIER OF POTENTIAL FORM OF THERMAL ENERGY AND CONCURRENTLY IT EMITS PHOTONS, I.E. IT IS A SOURCE (GENERATOR) OF PHOTONS, OF EXPLICIT FORM OF THERMAL ENERGY, BECAUSE IT EMITS A PHOTON AS WELL AS ABSORBS PHONONS FROM THE OUTSIDE, AND – THROUGH THE PHONONS WHICH ARE THERMAL ENERGY –THE LATTER INTERACTS WITH THE SUBSTANTIAL FORM OF ELECTROMAGNETIC MATTER.

In this sense, a quantity of matter (mass) $m_T = W_T / c^2$ *, which interacts with the substance, corresponds to thermal energy* W_T **.**

The action of the photons is illustrated by the following examples:

The power of electromagnetic waves – a flow of photons according to Stefan-Boltzmann law is

$$\Pi = k_\sigma.\sigma.T^4 = w_T.c = \sum h\nu_i = c.\sum w_{fi} \; ; \; w_{fi} = h.\sum \nu_i \; ; \tag{3-7}$$

where: k_σ – Stefan-Boltzmann constant; $k_\sigma < 1$ - accounting for the influence of the surface which, with a black body, emits $k_\sigma = 1$ T – temperature in K; $w_f = h\sum \nu_i$ – density of the energy of photons with various frequencies; h – Planck's constant; ν_i – frequency

That is why when the electromagnetic waves (photons) hit upon an object (body) with mass m_0 for time τ they impart to it force $\vec{F}_{\Pi} = \frac{\vec{\Pi}}{c}.\vec{c}_0$ acceleration $\vec{a}_i$, velocity $\vec{v}_i$ and kinetic energy.

Significant features of electromagnetic waves are:

a) ***They are carriers of energy, which, according to Maxwell, is absorbed and converted into magnetic (kinetic) energy of the object (body) that has absorbed it. As a result of this, the dynamic state and the structure of the object may be changed.***

b) ***They have momentum, which generates pressure and force upon the object that has absorbed them with the respective consequences: they impart to it acceleration and velocity during the time of their action*** Δt***.***

4. TEMPERATURE IS PROPORTIONAL TO THE DENSITY OF THERMAL ENERGY

1. Gaseous particles (molecules) moving at velocity $\vec{v}$ ***with mass m constantly emit and absorb photons and are in a medium of photon gas***

Photons are characterized by energy W_f, mass m_f, momentum $\vec{P}_f$ and force $\vec{F}_f$, as follows

$$\text{a) } W_f = h.\nu \text{ ; b) } m_f = W_f \big/ c^2 \text{ ; c) } \vec{P}_f = W_f \big/ c \; .\vec{c}_0 \text{ ; d) } \vec{F}_f \approx \frac{\vec{P}_f}{\tau} = \frac{W_f}{c.\tau} = \frac{W_f.\vec{c}}{\Delta r} : \vec{c}_0 = \frac{\vec{c}}{|\vec{c}|} \text{ ;} \tag{4-1}$$

Let in a unit of volume of the gas there are n_0 molecules (the concentration of the molecules is n_0), and the densities of the energy and mass of the photon gas are w_f and ρ_f ($w_f = \rho_f.c^2$). As a result of the forces (momentums) pressure and of recoil, which atoms (molecules) receive from the momentums $\vec{P}_f$ of the photons during emission and during absorption as a result of the force $\vec{F}_f$, they are set into motion at velocity v_i and receive kinetic energies W_{kMi} at a mean statistical square of velocity $\overline{v}^2$. The mean statistical square of velocity $\overline{v}^2$ determines the mean kinetic energies of the molecule W_{kM} and of the density of the energy of the gas w_{kT}, as follows, at mass m_M of the molecules

$$\text{a) } W_{kM} = \int_0^v \vec{F}_f = \frac{m_M.\overline{v}^2}{2} = \frac{3}{2}k_B.T; \text{ b) } w_{kT} = n_0.W_{kM} = n_0.\frac{3}{2}.k_B.T; \tag{4-2}$$

The pressure of the gas is

$$p_r = \frac{1}{3}w_{kT} = \frac{1}{3}n_0.k_B.T \; ; \tag{4-3}$$

During elastic collision of the molecule is generated pressure

$$p_r = \frac{2}{3}w_{KT} = \frac{2}{3}n_0.k_B.T \; ; \tag{4-4}$$

2. ***Because of the high velocity "c" of the photons, their distribution in a finite volume is always uniform, since their time of relaxation is practically about*** $\tau < 10^{-6} s$ **.**

3. The collisions between the molecules are believed to be about 10^9 per second and it is accepted that they are fully elastic.

4. From (4-2) we determine the temperature

$$\text{a) } T = \frac{2}{3}.\frac{W_{\text{KM}}}{k_B}\text{ ; b) } T = w_{\text{KT}}.\frac{3}{n_0.k_B}; \tag{4-5}$$

From (4-5) it is evident that the temperature is proportional to the density of the thermal energy w_{KT}. And in electrodynamics, according to Maxwell's law on pressure, the thermal energy (which is electromagnetic energy) W_T and its mass m_T $\left(W_T = m_T.c^2\right)$ (the molecules) move from places of a higher density of energy w and of the mass $\rho_m = \frac{w}{c^2}$ to places of lower w and ρ_m. *From here, according to the laws of electrodynamics, the thermal energies W_T and mass m_T also move from places of higher temperatures to places of lower temperatures.* **THAT IS ESSENTIALLY THE SECOND PRINCIPLE OF THE THEORY OF THERMAL PHENOMENA, NOT ENTROPY. I.E. THE SECOND PRINCIPLE OF THERMODYNAMICS IS ALSO AN ELECTROMAGNETIC LAW.**

5. GENERATION OF THERMAL ENERGY

5.1. General formulations

In 1900, Max Planck proved that the atoms (molecules) constantly, at intervals of time, emit and absorb electromagnetic energy in the form of short-lasting impulses (for a time of the order of $\Delta t \approx \tau \equiv 10^{-8}$ s) *of electromagnetic energy in the form of portions of electromagnetic waves, called photons. Photons have energy W_{fi}, mass m_{fi}, momentum $\vec{P}_{\text{fi}}$ and force $\vec{F}_f$, i. e.*

$$\text{a) } W_{\text{fi}} = h.\nu_{\text{i}}\text{ ; b) } m_{\text{fi}} = W_{\text{fi}}/r^2\text{ ; c) } \vec{P}_{\text{fi}} = m_{\text{fi}}.\vec{c} = W_{\text{fi}}/c.\vec{c}_0\text{ ; d) } \vec{F}_{\text{fi}} = \frac{d\vec{P}_{\text{fi}}}{dt} = \frac{dW_{\text{fi}}}{dr}.\vec{c}_0\text{ ; } \vec{c}_0 = \frac{\vec{c}}{|\vec{c}|}; \tag{5-1}$$

A surface of a substance (body) with an area $S = 1$ for a unit of time $t = 1$ according to Stefan-Boltzmann law (1879-1894) emits power N of electromagnetic energy of an ensemble (gas) of photons which generate pressure $\vec{p}_{\text{n}}$, density of energy W_{Π} and force $\vec{F}_{\Pi}$, as follows

$$\begin{gathered}\text{a) } \vec{N} = \frac{dW}{dt}.\vec{c}_0 = \vec{\Pi} = \sigma.T^4.\vec{c}_0 = w_{\text{n}}.\vec{c} = \left[\vec{E}.\vec{H}\right]\text{; b) } \vec{p}_{\text{n}} = \frac{\vec{\Pi}}{c} = w_{\text{n}}.\vec{c}_0\text{ ;} \\ \text{c) } \vec{F}_{\text{n}} = \frac{dW_{\text{n}}}{dr}.\vec{c}_0 = \frac{d\vec{\Pi}}{c.dt} = \frac{d\vec{\Pi}}{dr}\text{ ; d) } d\vec{r} = \vec{c}.dt\text{ ;}\end{gathered} \tag{5-2}$$

This relationship $\vec{\Pi} = \left[\vec{E}.\vec{H}\right]$ is called Poynting vector in electrodynamics, and $\vec{E}$ and $\vec{H}$ respectively, are the intensities of the electric and the magnetic fields.

If this force (or pressure $\vec{p}_{\Pi} = \frac{\vec{F}}{S}$) lands:

A. Upon a surface of a body with surface $S \neq 1$, force $\vec{F}_{\text{S}} = \vec{F}_{\text{n}}.S$ acts upon the body generating its acceleration $\vec{a}_{\text{T}}$, and setting it into motion for time *dt* at velocity $d\vec{v}_{\text{T}} = \vec{a}_T.dt$ thus performing work $dA = \vec{F}_{\text{S}}.d\vec{r}$

$$\text{a) } \vec{a}_{\text{T}} = \vec{F}_{\text{S}}/m_t\text{ ; b) } dA = \vec{F}_{\text{S}}.d\vec{r} = \vec{F}_{\text{n}}.S.\vec{a}_{\text{T}}.t.dt\text{ ; c) } d\vec{r} = \vec{v}_{\text{T}}.dt; \tag{5-3}$$

B. Upon a piston of a cylinder of a steam engine with surface *S*, force $\vec{F}_{\text{S}} = \vec{F}_{\text{n}}.S = \vec{p}.S$ acts upon the piston for time *dt* setting it in motion along distance $d\vec{r} = v_{\text{T}}.dt$ thus performing work

$$\text{a) } dA = \vec{F}_{\text{S}}.d\vec{r} = \vec{p}.S.d\vec{r} = p.dV\text{ ; b) } dV = S.dr\text{ ;} \tag{5-4}$$

From the presented above, the following characteristic features of the electromagnetic (thermal) radiant energy can be outlined:

1. ***It is described by deterministic (dynamic) laws;***
2. ***It generates force (pressure) and can perform work.***
3. ***Due to the emission of photons (photon gas), on the surface of the substance (the body) is generated pressure (force) in direction from the surface towards outside perpendicularly to the surface. The pressure is maximal next to the surface and because of dissipation it decreases with the increase of the distance r from the surface from*** $p_{\text{n}} = p_0$ ***at*** $r = 0$ ***to***

$$\text{a)}\ p = p_0\left(1 - k_p.r\right);\ \text{b)}\ k_p < 1; \tag{5-5}$$

With two bodies of parallel surfaces $S_1 \uparrow\uparrow S_2$ and different temperature $T_1 > T_2$, body one releases power upon body two (surface $S_2 = S_1$) according to (5-2).

$$\text{a)}\ \Pi_{12} = \sigma\left(T_1^4 - T_2^4\right) = w_{12}.c;\ \text{b)}\ p_{12} = p_1 - p_2 = \Delta p_{12} = \left(w_{n1} - w_{n2}\right).c; \tag{5-6}$$

If the surfaces are at distance r_{12}, the repelling force (pressure) according to (5-6)b and (5-5) is (here $p_0 = p_{12}$)

$$p_{12}^{'} = p_{12}\left(1 - k_p.r_{12}\right) < p_{12};\ \text{b)}\ F_p = p_{12}^{'}.S; \tag{5-7}$$

It is exactly due to this pressure (force) $p_{12}^{'} > 0$ ***that the surfaces of the bodies cannot touch each other, despite the force of cohesion whose attraction component is proportional to*** r^{-7} ***, i.e.***

$$\text{a)}\ F_c = 4\varepsilon\left(\frac{\alpha}{r^{13}} - \frac{\beta}{r^7}\right) = F_c^{'} + F_c^{''};\ \text{b)}\ F_c^{'} = 4\varepsilon\frac{\alpha}{r^{13}};\ \text{c)}\ F_c^{''} = -4\varepsilon\frac{\beta}{r^7}; \tag{5-8}$$

Which decreases much faster from its initial value $F_{c0}^{'} > 0$. In case its two components are equal

$$\text{a)}\ F_c = 4\varepsilon\left(\frac{\alpha}{r^{13}} - \frac{\beta}{r^7}\right) = 0;\ \text{b)}\ \frac{\alpha}{r^{13}} = \frac{\beta}{r^7} = F_{\text{ОТС}} = F_{\text{ПС}} > 0, \tag{5-9}$$

therefore $F_c^{''}$ and $F_p = p_{12}^{'}$ counteract to each other so that at first at larger distances $r_{12} > r_b$ the repulsion of the radiation dominates $F_p > F_c^{''}$, but when distance r_{12} decreases, the forces of repulsion increase and there comes a moment, when the forces become equal, say, at $r_{12} = r_{0'}$ And $F_c^{''} = F_p$, and after that, with the decrease of the distance $r_{12} < r_{0'}$, the force of cohesion $F_c^{''}$ dominates, i.e.

$$\text{a) at}\ r_{12} < r_{0'} \rightarrow F_p > F_c^{''};\ \text{b) at}\ r_{12} < r_{0'} \rightarrow F_c^{''} > F_p; \tag{5-10}$$

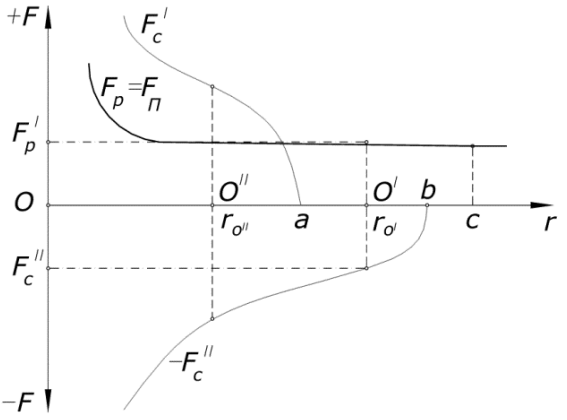

Fig. 5.1.

In Fig. 5.1. for illustration is given an example of the relationship between forces $F_c^{'}$, $F_c^{''}$ and distance F_r between the surfaces. The curve F_p continues even beyond $r = c$. Apparently, when r is longer than $r_{0'}$ dominant is the force of repulsion from the emitted thermal (electromagnetic) energy. At $r = r_{0'}$ the forces $F_c^{''}$ and $\left(F_c^{'} + F_p\right)$ become equal, their sum $F_c^{''} + F_c^{'} + F_p = 0$ with the decrease of the distance to r^+ between $r_{0''} > r < r_{0'}$ the force of cohesion $F_c^{''}$ becomes dominant and the surfaces can remain attached to each other.

This model illustrates the known experimental fact that when the external force of pressure upon two bodies is sufficiently great, they can get attached to each other, i.e. they become one body. Therefore the radiant energy from bodies, or its respective pressure, is the reason for them not to get attached to each other, if the pressure is not great enough.

5.2. Generation of photons occurs in the following processes

5.2.1. In interaction between a particle and an antiparticle and in particular in annihilation of an electron e^- and a positron e^+ is obtained from photons:

A) At velocities $v \approx 0$

$$\text{a) } e_0^- + e_0^+ \to 2.\gamma \text{ ; b) } 2.m_{e0}.c^2 = 2.h.\nu_0 \text{ ; c) } W_f = h.\nu_0 = m_{e0}.c^2 ; \tag{5-11}$$

B) At velocity $v < c$

$$\text{a) } e^- + e^+ \to 2.\gamma + (p + \overline{p}) \text{ ; b) } 2.m_e.c^2 = 2.h.\nu_0 + 2.m_n.c^2 ; \tag{5-12}$$

$$\text{a) } e^- + e^+ \to 2.\gamma + (n + \overline{n}) \text{ ; b) } 2.m_e.c^2 = 2.h.\nu_0 + 2.m_n.c^2 ; \tag{5-13}$$

where: γ is photon; p, $\overline{p}$ *u* n, $\overline{n}$ – proton and antiproton and neutron and antineutron.

5.2.2. When an electron or atoms (molecules) collides against a wall at velocity $v \neq 0$. Since the velocity of the electron or the atom (molecule) for time $\Delta t << 1$ drops from $v \neq 0$ to $v_1 = 0$, the result is a mean acceleration $\vec{a} = \vec{v} / \Delta t$ and according to classical electrodynamics, at $a \neq 0$, powers are released which are

$$\text{a) } N_e = \frac{dW}{dt} = \frac{2.q_e^2.a_e^2}{3.c^3}; \quad \text{b) } N_T = \frac{dW}{dt} = \frac{2}{3}\frac{Q_T^2.a_T^2}{c}; \tag{5-14}$$

where: q_e and a_e are the electric charge and acceleration of electrons; Q_T^2 и a_T^2 - effective square of the square the electric charge of the body (see chapter 5.2 of the premise) and acceleration of the atom (molecule – body).

5.2.3. In exercising a strain (pressure or extension) upon the substance, the orbitals of the electrons change from their normal state and that is why they emit photons (inside and outside of the substance). This is the explanation why during mechanical treatment (cutting or plastic processing) the substance gets heated.

5.2.4. In friction between smooth surfaces of the bodies, since they are not perfectly smooth, the structural bonds of part of the molecules with the bodies tear apart, which are generated by the forces of cohesion - the derivative of Lennard-Jones potential. And in another part of the molecules deformations are generated in a relatively thin layer of the bodies.

These two processes result in generation of photons and heating of the surfaces of the bodies.

5.2.5. Effects, as a result of hits between electrons in electric wire and with the nuclei of the atoms

Proceeding from the scientific fact that in collusion of an electron (electric charge) into something hard (another electron, atomic nucleus, wall, and so on) its velocity v, which is greater than zero $(v > 0)$ changes to zero $(v = 0)$ for time $\tau \ll$ second, i.e. it can be assumed that in this interval of time τ there exists a mean negative acceleration

$$\overline{a}_{cp} = \frac{v}{\tau}; \tag{5-15}$$

And according to the law of Larmor of 1897 in a state of acceleration, electrons (electric charges q_e) release power

$$N = \frac{dW}{dt} = \frac{2}{3}.\frac{q_e^2.\overline{a}}{c} = \frac{2}{3}.\frac{q_e^2.\overline{a}_{cp}^2}{c}; \tag{5-16}$$

or for the time of emission of the photon about $\tau = 10^{-8}$ s, they emit a photon γ with energy

$$W_f = h.\nu = N.\tau = \frac{2}{3}.\frac{q_e^2.\bar{a}^2}{c}.\tau; \tag{5-17}$$

And since the emission of energy and mass of the photon is at velocity $c = 3.10^8$ m.s^{-1}, the length of the photon is about

$$l_f = \tau.c = 10^{-8}.3.10^8 = 3 \text{ m}; \tag{5-18}$$

and it has quantity of matter (mass)

$$m_f = \frac{W_f}{c^2} = \frac{2}{3}.\frac{q_e^2.\bar{a}^2.\tau}{c^3} = \frac{h.\nu}{c^2}; \tag{5-19}$$

By this mechanism of emission of photons (energy *W* and mass *m*) is also explained the emission of electromagnetic energy by a wire, when trough it runs (passes) electric current *I* (measured in Amperes). At present, this experimental fact is motivated (explained) by the presence of electric resistance *R* measured in ohms $[\Omega]$ $\Omega = \frac{\text{V}}{\text{A}}$ or

$$R \to \left[\frac{\text{V}}{\text{A}}\right] = \left[\text{m}^2.\text{kg.s}^{-3}.\text{A}^{-2}\right]; \tag{5-20}$$

Or the power *N* of the emitted energy through the photons for one second and its respective density are

$$\text{a) } N = \frac{dW}{dt} = \frac{R.I^2}{t} \to \left[\text{m}^2.\text{kg.s}^{-3}\right]; \quad \text{b) } W_N = \left[\frac{N}{m^3}\right] \to \left[\text{m}^{-1}.\text{kg.s}^{-3}\right]; \tag{5-21}$$

And the density of the emitted energy $W = R.I^2$ is $w = w_N.t \to \left[\text{m}^{-1}.\text{kg.s}^{-2}\right]$.

The name of this density of energy corresponds to the emitted photon of energy by a unit of length of the wire

$$R.I^2 = \sum_{i=1}^{i=n} W_{Ri} = \frac{V}{A}; \tag{5-22}$$

whence it follows that the resistance is

$$R = \frac{\sum_{i=1}^{i=n} W_{fi}}{I^2} = \frac{\text{energy}}{\text{square of current}} \to \frac{J}{A^2} = \frac{J.s^2}{c^2}; \tag{5-23}$$

In this sense the resistance *R* is equal to the quantity of electromagnetic energy, which is emitted for the square of the electric current *(I^2)*, which runs through the electric wire.

These conditions account for the facts:

a) why when heating the wire the resistance increases, i.e. because the hits between the electrons increase, and with that also increase the emitted photons – the emitted electromagnetic energy;

b) when decreasing the temperature, also decrease: **first** – the velocity of the photons, and hence decreases the released power; **second –** magnetic (kinetic) energy of electrons decreases, and with that also the energy emitted by them; **third** – the number of hits between electrons decreases, and with that also decreases the number of the emitted photons; **fourth** – when the temperature drops so much that the velocity of electrons also drops a lot, their motion tends towards almost in a straight line, their hits tend towards zero, and with that also their acceleration, due to which circumstance there is almost no emission of photons – no losses – then follows a sudden decrease of resistance – it tends to superresistance.

5.2.6. When the electron passes through very narrow channels of substance (of crystals) with dielectric constant ε ***different from that*** ε_0 ***of vacuum (air)*** $\varepsilon \neq \varepsilon_0$**.**

Here two effects occur, as follows:

A. Because the channel in the substance has a very small radius $R << 1$, and when passing through the channels the electron can rarely hit the center of the channel, but usually passes closer to one of the walls of the channel, and so it is attracted more heavily toward the wall by the force of cohesion F_c, **so that this force declines it on its exiting the channel toward the wall and it declines, and does not fall upon the screen in a point opposite the channel, but aside.** Naturally, this is a real fact, if the electron does not convert into a photon after the channel.

B. In entering a channel for a very short time *dt*, or along a very small spatial interval $\mathrm{d}\vec{r} = \vec{v}_0.\mathrm{d}t$, the dielectric constant changes from $\varepsilon = \varepsilon_0 \approx 1$ to $\varepsilon \neq 1$. Because of this fact the surrounding electric field changes significantly as well, because it is changed, is

$$\frac{dE}{dt} = -\frac{q_e}{4\pi\varepsilon^2 r^2}.\frac{d\varepsilon}{dt} = -q_e\frac{A}{\varepsilon^2}.\frac{d\varepsilon}{dt};\ A = \left(4\pi\varepsilon r^2\right)^{-1}; \tag{5-25}$$

In this change of the electric field, its magnetic field $\vec{H} = \varepsilon\left[\vec{v}.\vec{E}\right]$ changes too, so that a system is formed which describes, say, a flat electromagnetic wave

$$\text{a)}\ \frac{d^3E}{dt^2} = c^2\frac{d^2E}{dx^2};\ \text{b)}\ \frac{d^2H}{dt^2} = c^2.\frac{d^2H}{dx^2};\ c^2 = \left(\varepsilon\mu\right)^{-1}; \tag{5-26}$$

This process with the electron is manifested in reverse direction from $\varepsilon \neq 1$ to $\varepsilon = \varepsilon_0 = 1$ on exiting and therefore, not an electron exits the channel at velocity $v_e << c$, but a photon with energy and frequency

$$\text{a)}\ W_f = m_{e0}.c^2 = h.\nu_0;\ \text{b)}\ \nu_0 = \frac{m_{e0}.c^2}{h}; \tag{5-27}$$

C. The walls of the channel emit photons, which exert force action upon the electrons, when they are in the channel. These effects influence the state of the electrons, which are in the channel, in two directions:

a) upon the direction of the velocity of the electron on its exiting the channel;

b) upon the possibility for the electron to be transformed into a photon at the exit of the channel.

5.3. Some analyses

1. The atom (molecule, substance), as a result of the oscillating motions accumulates (carries inside itself) internal kinetic energy, which is is magnetic energy, of which it is assumed in statistical physics that it is identical to its thermal energy, and has density of its thermal energy, proportional to the respective temperature.

2. In a stationary state of the system of atoms and the environment, the densities of the energies inside the atoms and in the environment are identical $\left(w_A = w_{cp}\right)$ and have slight fluctuations, therefore, their temperatures are identical, too ($T_A = T_{cp}$).

3. Regardless of the stationary or seemingly static state of the system of atoms (molecules) and the environment, the atoms in gas, liquid or solid body always emit and absorb photons, which cause the slight fluctuations in the densities of their energies, respectively in their temperatures.

4. As a consequence of point 3 above, there is always a halo (aura) of a photon gas around the atoms (molecules).

5. When the densities of energies w_{AT} of the atoms, respectively the temperatures T_A are higher than the respective values of the environment, i.e.

$$\text{5.1. At: a)}\ w_A > w_{cp};\ \text{b)}\ T_A > T_{cp}; \tag{5-28}$$

the process of emission of photons by the atoms is dominant until the moment when there is a mode in which there is balance, i. e.

$$\text{a)}\ w_A = w_{cp};\ \text{b)}\ T_A = T_{cp}; \tag{5-29}$$

$$\text{5.2. At: a)}\ w_A < w_{cp};\ \text{b)}\ T_A < T_{cp}; \tag{5-30}$$

the process of absorption of the photons by the atoms is dominant, which photons enter from the environment until balance is established, i. e. at (5-29).

7. The atom (molecule) can emit thermal energy (photons) only as long as its structure is preserved.

8. ***Id est there is no atom in the observable space which does not emit and absorb such energy (photons)***.

9. ***In nature, there is no place without photons (photon gas), since natural objects always have density of energy greater than zero, respectively temperature higher than OK – T → OK.***

5.4. Mechanism of conversion of a solid body into gas

The dependence of the force of repulsion F_p between the molecules if it increase as a result of the increase in the temperature since from (5-21) it is evident that $F_{\text{p}} = F_{\text{n}}.\sigma T^4 / c.dt$ and reaches a value $F_c^{"}$ greater than $F_c^{'}\left(F_c^{"} > F_c^{'}\right)$ (see Fig. 5.1.), at $T_2 \gg T_1$, the force of repulsion dominates and the distance r between two contiguous molecules increases to $r_{0'} \gg r_{0"}$. Then the molecules go into a state of gas and are almost without a potential force (force bonds). But in an interval of r, say, $\Delta r = r_{0'} - r_{0"}$, the molecules have weak potential forces, because of which their bonds are weak in this interval Δr and at temperatures, say, $\Delta T_{12} = T_{12}^{'} - T_{12}^{"}$, this is in a liquid state of the substance. Here $r_0 = r \approx 10^{-9}\,\text{m}$.

The substance in gaseous state and the corresponding normal temperature in a normal state is characterized by the following data:

Exemplifying data for air

At pressure $p_0 = 1,01.10^5 Pa$ (one atmosphere) and temperature $T_0 = 273,15\ K = 0\,°C$.

At concentration of the molecules $n_0 = 10^{25} m^{-3}$, the distance between them is $r_{12} = 10^{-8} m$.

The volume $1\,\text{m}^3$ has $n \approx 10^{25}$ molecules, whose volume is $V_{\text{m}} = 10^{-6} m^3 << 1m^3$, i. e. the volume only of the molecules in the air is $10^{-5} m^3$, which is much less than the volume, in which are $1m^3$. But the total surface S_{M1} of these molecules with volume $V_{\text{m}} = 10^{-6} m$, which emits and absorbs photons is $S_{\text{M1}} = 5.10^5 m^3$, i. e. much greater than the surface S_{M1} of this $1m^3$, which is $S_{\text{M1}} = 6.m^2 << S_{\text{M}} = 5.10^5 m^2$.

On these conditions, from the surface of the molecules S_M, at $T = T_0 = 273,15K = 0°C$, according to Stefan-Boltzmann law, in the form of photons, is released power

$$N_{\text{M}} = \Pi.S_{\text{M}} = \sigma.T_0^4.S_{\text{M}} = 5,6.10^{-6}.273,15^4.5.10^5 = 4.64.10^7\ \text{J.s}^{-1}; \tag{5-31}$$

or one molecule releases power

$$N_0 = \frac{N_{\text{n}}}{\text{n}} = 4,64.10^7 / _{10^{25}} = 4,64.10^{-18}\ \text{J.s}^{-1}; \tag{5-32}$$

To this power N_0 according to (5-2)b corresponds force of pressure (of repulsion) with force

$$F_{12} = N_0 / \text{c} = 4,64.10^{-18} / 3.10^8 = 1,54.10^{-26} N \to \left[J.m^{-1}\right]; \tag{5-33}$$

At density of the mass of one molecule ρ_m at $T \approx T_0$ the mass of one molecule is

$$m_{\text{M}} = \frac{V_{\text{M}}.\rho_{\text{M}}}{\text{n}_0} = \frac{10^{-6}.3}{10^{25}} = 3.10^{-29} kg\ , \tag{5-34}$$

the force $\vec{F}_{12}$ generates acceleration upon one molecule, which is of the order of

$$a = \frac{F_{12}}{\text{m}_{\text{M}}} = \frac{1,54.10^{-26}}{3.10^{-29}} \approx 5.10^2\ \text{m} / \text{s}^{-1}; \tag{5-35}$$

The obtained approximate data are within the frames of the actual ones.

Since here the photons, respectively the photon gas play a significant role, this role must be clarified by explaining some of their properties.

6. MECHANISM OF TRANSFER OF THERMAL ENERGY BY GAS THROUGH SOLID MEDIUM

6.1. General formulation

Let us consider a plane wall with surface $S = 1$, temperature T_0 and concentration of molecules n_S on the surface S_1 as well as in each cross-section of the wall on a plane parallel to S along the thickness Δ of the wall perpendicular to S.

In a balanced state of the wall relative to the environment, their temperatures are T_0.

According to statistical physics, under the above conditions, each molecule contains the quantity of thermal energy W_{k_m}, and according to M. Planck, this electromagnetic energy corresponds to the energy of the photon ensemble (gas) with energy W_ν, as follows

$$W_{\text{KM}} = \frac{m\bar{v}^2}{2} = k_{\text{B}}.T_0 = W_\nu = h\sum_{i=1;\, j\neq 0}^{i=n;\, j<10^{20}} \nu_{\text{ij}} \; ; \tag{6-1}$$

where: h is Planck constant; ν_j is j frequency of the photon (with number j), and i is the number of the photons with identical frequency ν_i ; the frequency here is limited to that of the gamma photons.

Let upon the external layer of molecules n_S at $S = 1$ m^2 falls a thermal flux of photons according to Stefan-Boltzmann law

$$\text{a)}\ \frac{\text{d}W_{\Pi}}{\text{dt}} = \Pi = \sigma.T^4 = \frac{w_{\Pi}}{4}.c \ ;\ \text{b)}\ w_{\Pi} = 4\Pi/c \ ; \tag{6-2}$$

where: $w_{\text{п}}$ is the density of the thermal energy carried by the photons, emitted from the surface of an object with temperature T_0; c - velocity of the photons (electromagnetic waves - the light).

To w_{Π} corresponds the density of the mass of thermal (electromagnetic) energy ρ_{Π} and thermal momentum $\vec{P}_{\Pi}$

$$\text{a)}\ \rho_{\Pi} = w_{\Pi}/c^2 \ ;\ \text{b)}\ \vec{P}_{\Pi} = \rho_{\Pi}.\vec{c} = \frac{w_{\Pi}}{c}.\vec{c}_0 \ ;\ \vec{c}_0 = \frac{\vec{c}}{|\vec{c}|} \ ; \tag{6-3}$$

To the derivative of $\vec{P}_{\Pi}$, relative to time, corresponds thermal force $\vec{F}_{\Pi}$ upon a unit of surface ($S = 1$), which is also pressure $\vec{p}$

$$\text{a)}\ \vec{F}_{\Pi} = \frac{\text{d}\vec{P}_{\Pi}}{\text{dt}} = \frac{\text{d}\rho_{\Pi}}{\text{dt}}.\vec{c} = \frac{\text{d}\,w_{\Pi}.\vec{c}_0}{c.\text{dt}} = \frac{\text{d}\,w_n}{\text{d}\,r}.\vec{c}_0 = \vec{p} \ ;\ dr = c.dt \ ; \tag{6-4}$$

Under these conditions, when the molecules have on their surface energy $W_{\text{KM}} = W_{\text{V}}$ and temperature T_0 and the energy of radiation $\vec{\Pi}$ (6-2) falls upon them, which is, for one molecule, $W_{\text{ПМ}} = \Pi/n_{\text{S}}$, it follows that the quantity of the thermal energy of the molecule has increased to

$$\text{a)}\ W'_{\text{KM}} = W_{\text{KM}} + W_{\text{ПМ}} = k_{\text{B}}.T' > k_{\text{B}}.T_0 \ ;\ \text{b)}\ \Delta T = T' - T_0 = \frac{W_{\text{ПМ}}}{\text{k}_{\text{B}}} \ ; \tag{6-5}$$

and W'_{KM} continues (with the time) to increase, so T' becomes higher than the temperature T_0 of the molecules in the contiguous layer, which is within the thickness of the wall at distance $\Delta r \ll \Delta$, due to which according to Maxwell's pressure or the law (6-6) the first layer with surface $S = 1$ (on the surface) emits energy $\Delta W_{\Pi 12}$ toward the second layer at temperature $T_0 < T'$

$$\Delta W_{\Pi 12} = \sigma.\left(T'^4 - T_0^4\right) = \Delta W'_{\text{T}} \ ; \tag{6-6}$$

until the temperatures become equal or this state sets in: $T_0 = T'_0 = T'$.

Or the same relationship, obtained for the layer with surface $S = 1$ through Fourier's law, is

$$\text{a)}\ \Delta W_{\Pi 12} = -\lambda..\frac{\left(T' - T_0\right)}{\Delta \text{r}} \ ;\rightarrow \text{b)}\ \text{d}W_{\Pi 12} = F_{\Pi}.\text{d}\,r = -\lambda..\frac{\text{d}T}{\text{d}\,r} \ ; \tag{6-7}$$

Evidently, this deterministic process continues in the wall until it passes through its whole thickness Δ and is emitted out on the other side, on condition that the temperature of the surface (at the end of Δ) is $T_\Delta > T_{\text{ср}}$ of the environment.

Photons, which are in the space between atoms (molecules) of the respective medium (matter), since atoms constantly, at short intervals, emit and absorb photons, in this space between atoms (molecules) the photons form a layer of photons of a higher density of the photon gas (of thermal energy), through which they exert pressure upon atoms (molecules) inside substance. **I.e. in substance, there**

are photons (photon gas), which are not bound to the atoms and molecules, but are in the space between them and, moreover, with a high density of photons (photon gas).

In the above sense, it is considered that matter (in substantial medium, including gas medium) is the carrier (it contains) photons, i.e. photons are in layers between atoms (molecules), and are not inside in the volume of the atoms.

Due to this, coefficient of thermal content is defined for the respective medium (substance or gas), depending on the weight or volume quantity of the substance (gas). For the radiant thermal energy in vacuum, only the quantity of thermal energy is defined via the notion of density of thermal energy in a unit of volume.

According to I. Newton's law for convection and radiation, thermal energy $W_{\text{ТЛ}}$ is released from the wall at $S = 1\ \text{m}^2$, which is

$$W_{\text{ТЛ}} = \alpha\left(T_{\Delta} - T_{\text{ср}}\right) = \alpha.\tau\ ;\ \ \tau = T_{\Delta} - T_{\text{ср}}\ ; \tag{6-8}$$

where: α is a coefficient of thermal release in radiation and convection.

Evidently, after the photon flux has generated force and pressure, it can performs work which at $S \neq 0$ is

$$\text{a)}\ \ A = \int \vec{F}_{\Pi}.\mathrm{d}\vec{r};\ \ \text{b)}\ \ A = \int \vec{p}.S.\mathrm{d}\vec{r} = \int p.\mathrm{d}V; \tag{6-9}$$

6.2. Short analysis

It is evident from the description of the mechanism of transfer of thermal energy released by a substance in a volume V_{Γ} that not a single molecule of the substance is carried through the wall. This fact proves that molecules are not carriers of thermal energy (which is in the form of a photon gas, but they emit and absorb photons), although present-day thermodynamics leaves a wrong impressions that thermal energy in volume V_{Γ} of the gas is carried by the molecules. This wrongly alleged idea of thermal phenomena, which is deeply rooted in the minds of not a small number of researchers, has been established by the circumstance that statistical calculations do not make it sufficiently clear that the statistical method is a proper computing method but it is not quite proper as regards the expression of the physical essence of thermal process. In fact, most researchers are fully aware of the apparent fact that molecules are not carried through the wall. However, the coefficient of thermal conductivity λ in the law of Fourier depends on the kind and concentration n_0 of the molecules of the medium whose λ is discussed.

Fourier's law of 1822

The thermal flow through the substance for a unit of area per second

$$j = -\lambda\frac{dT}{dr} = -w_B.v_j\ ;\ \rightarrow\left[\text{J.m}^2.\text{s}^{-1}\right]; \tag{6-10}$$

where: λ is coefficient of thermoconductivity of substance (the substantial form) of electromagnetic matter; w_f – the substantial density of thermal (electromagnetic density) energy; v_j - the velocity of thermal energy in substance $\ g\text{rad}T = \dfrac{dT}{dr}.\vec{r}_0;\ \ \vec{r}_0 = \dfrac{\vec{r}}{|\vec{r}|}$.

In this case, an old idea is brought forth again, the idea of the thermal fluid, which is the photon gas and which determines pressure $P_{\Gamma} = \dfrac{W_f}{3}$ in volume V_{Γ} of the gas of the molecules, whereby here too the statistical method of calculation has led to a misinterpretation that there is no photon gas or photon pressure, although in electrodynamics it is clearly indicated that to energy $W_f = h.\nu$ corresponds momentum $\vec{P} = \dfrac{W_f}{c}.\vec{c}_0;\ \ \vec{c}_0 = \dfrac{\vec{c}}{|\vec{c}|}$ and this fact proves the photon pressure.

According to the law, proved by Lord Rayleigh in 1902, all wave processes, which move at wave velocity, exert pressure (force) upon the surface of objects which they encounter at their wave velocity.

The analysis of the mechanism of passing of thermal energy $W_T = h.\sum \nu_i$ through a solid body shows that the beginning of the thermal flow W_T has a temperature T_1 and the end of the surface of the body has $T_2 < T_1$.

If the temperature of the external environment, when the heat is leaving the body, is $T_0 < T_2$, then it releases upon the surface of the body $S_2 = 1$ surface temperature T_2 via thermal flow through area $S_2 = 1$, which is

$$Q_T = \alpha(T_2 - T_0); \tag{6-11}$$

This is I. Newton's law.

In this case, it is evident that the quantity of thermal energy Q is not carried by any molecules, nor by atoms . I.e. the quantity of heat is the heat, which the photon gas carries and it is

$$Q_T = W_{fT} = \sum W_{fi} = h.\sum \nu_i; \tag{6-12}$$

which is a sum of the energies of the photons, which have passed through the wall.

Therefore, the molecules (atoms) of a solid body, and of any substance in general (gas, liquid or solid) are only absorbents and emitters of photons of the photon gas. And only the photons themselves are carriers of thermal energy which is in the form of electromagnetic waves, i.e. thermal energy is only carried by electromagnetic waves. But the electromagnetic waves themselves, the photons, are emitted and absorbed by molecules (atoms). The mechanism of absorption of photons by the atom (molecule) consists in the following. When the photon hits the electron, which is in a respective orbit, it is absorbed by the electron, which is of respective magnetic (called kinetic) energy, at respective velocity *v*

$$W_{He} = \frac{m_{e0}.v^2}{2}; \tag{6-13}$$

where: m_{e0} is mass of the electron at rest, since $v \ll c$.

As a result of this absorption, the energy of the photon is transformed (restructured) and is localized upon the electron in the form of magnetic energy ΔW_{He}, as a result of which it is absorbed by the electron and its velocity increases to $v' > v$, by Δv, due to which its magnetic energy increases.

$$\text{a) } W_{He}^{'} = \frac{m_{e0}.v'^2}{2}; \text{ b) } v' = v + \Delta v; \tag{6-14}$$

Due to this fact, the electron moves to a higher orbit. After a short interval of time, the electron in the atom emits a photon of energy W_f and momentum $\vec{P}_f = \frac{W_f}{c}.\vec{c}_0$ and returns to its original orbit.

In this sense, atoms and molecules are not carriers of photons, and hence it follows that they are not carriers of thermal energy as well in the form of potential thermal energy, such as is the magnetic energy of the electrons, which is called kinetic and part of which is transformed into a photon (thermal) energy. *Moreover, the potential thermal energy of the nucleus of the atom is the oscillating (magnetic) energy of the nucleus and its parts (protons and neutrons), since the nucleus, too, under respective conditions, emits high-energy photons.*

In this sense, the molecules of the gas are also carriers only of potential thermal energy, which is inside the molecules in the form of magnetic (kinetic) energy of the electrons, which are in orbits around the nuclei of the atoms and molecules, which are enveloped by the electrons, connecting the atom molecules.

It is known from Pound's experiment (1960) that masses m_f of the photons are attracted by gravitational field G_3 of the Earth by force

$$\text{a) } \vec{F}_f = -m_f.\frac{m_3.\gamma}{r^2}.\vec{r} = -m_f.\vec{G}_3; \text{ b) } m_f = \frac{w_f}{c^2} = \frac{h.\nu}{c^2}; \text{ c) } \vec{G}_3 = -\frac{m_3.\gamma}{c^2}.r_0; \tag{6-15}$$

where: m_3 is mass of the Earth; γ – gravitational constant.

The relationship between density of mass ρ_f and density of energy w_f of the photon gas is

$$\rho_f = \frac{w_f}{c^2}; \tag{6-16}$$

And the pressure of the photons of the photon gas is

$$\text{a) } P = \frac{1}{3} w_f; \text{ b) } \omega_f = 3.P = \frac{3}{2} k_B.T; \text{ c) } P = \frac{1}{2}.k_B.T; \text{ d) } T = 2.\frac{\rho_f}{k_B}.c^2; \tag{6-17}$$

And the pressure exerted by the gravitational filed upon the density of the mass of the photon gas ρ_f at altitude $\mathrm{d}h$ is

$$\mathrm{d}P = \rho_f.G.\mathrm{d}h = \frac{1}{3}.\frac{w_f}{c^2}.G.\mathrm{d}h = P.\frac{G}{c^2}.\mathrm{d}h; \tag{6-18}$$

Since

$$\rho_f = \frac{w_f}{c^2} = \frac{\Pi}{3.c^3} = \frac{\left[\vec{E}.\vec{H}\right]}{3.c^3} = \frac{\sigma.T^4}{3.c^3}; \tag{6-19}$$

$$\text{a) } \frac{\mathrm{d}P}{P} = \frac{G}{c^2}.\mathrm{d}h; \text{ b) } \frac{\frac{1}{2}.k_B.\mathrm{d}T}{\frac{1}{2}k_B.T} = \frac{G}{c^2}.\mathrm{d}h = \frac{\mathrm{d}T}{T}; \text{ c) } T = T_0.\exp\left(-\frac{G.h}{c^2}\right); \tag{6-20}$$

7. OTHER SPECIFIC MANIFESTATIONS OF THE PHOTON GAS

In principle, at the level of substantial manifestations of thermal energy, it always occurs in the form of a photon gas (ensemble of photons), which is generated or absorbed by the substance. However, depending on the structure [construction of the system of material objects in which photons are manifested – (generated or absorbed)], as a result of the changes in the energy, relevant forces (of pressure or extension) of Maxwell's pressures appear and different effects are generated. For example:

a) when exerting pressure (in mechanical treatment of materials), since the pressure is stress

$$p = \frac{F}{S} = \frac{force}{surface} = \frac{\left[J.m^{-1}\right]}{\left[m^2\right]} = \frac{\left[J\right]}{\left[m^3\right]} = w = density\ of\ \ the\ energy; \tag{7-1}$$

a flux of photon gas is generated with density of the energy $w = p$.

This energy interacts (presses on) with the molecules, which leads to weakening of the force bonds between the molecules, which are bound through the force of cohesion F_c (which is derivative of Lennard-Jones potential (4.2-8)) and when it weakens sufficiently, the bond between the molecules disintegrates. This is the electromagnetic (physical) essence of the mechanical treatment of materials. But in ancient times this essence was not clear and this electromagnetic process was called a mechanical process without clarifying the essence of the mechanism of cutting or the essence of the forces.

b) *When photon gas (energy) is introduced into the substance through heating, as a result of this the structural bonds between the molecules are loosened and they are restructured, after which the substance is quickly cooled or not, but it gets cool with a different structure between its molecules; this is the essence of thermal treatment of materials.*

c) In the example b) if when the structures are loosened another material is introduced, this is also thermal treatment, but with introduction of another material.

d) ***With macromolecules, there is a constant emission and absorption of photons by the atoms in different direction; because of this fact, photon forces act, due to which the parts of the macromolecules are always in motion one relative to another, as well as the macromolecules themselves.*** **Some scientists call the forces, which are generated with the macromolecules by photons, Van der Waals forces.** ***But these are purely electromagnetic forces generated by the photon gas.***

Depending on the configuration of these forces, generated by the photon gas, some of the structures of the macromolecules are formed.

These forces are very weak, but the parts of the macromolecules are very sensitive to the forces of the external photon gas, which easily restructures them (for example, the eye retina, biomacromolecules). That is why living organisms are sensitive to thermal phenomena.

e) As for the mechanism of how humans feel the thermal energy of the photon gas (photons), there is certain analogy to the presented in point b), but is associated with the organs of perception and their signals in the brain. The weak heating (a slight density of the photon gas) has as effect: 1) loosening of the bonds inside the cells of the human matter and outside them resulting in improvement of metabolism and blood supply; 2) when the density of the photons increases and the destructive forces start disintegrating structural bonds – pain is felt; 3) when the destruction of structural bonds is serious or irreversible, including that of the blood supply, the pains become constant, some living cells die – there is a wound, partial decay and microbial action – medical treatment is required.

8. CONCLUSIVE INFERENCES

First. **Thermal energy is electromagnetic energy and the laws of the electromagnetic theory of Maxwell hold true for it, with accounting for its specific feature that its primary and dynamic manifestation is in the form of a photon gas, and in a localized potential state, thermal energy is carried by the electrons in the atoms in the form of magnetic energy of electrons.**

Second. Thermal energy, as well as all other structural states of energy, which is only electromagnetic, can convert (get restructured) from one into another state, while retaining its quantities. *During this conversion, the initial state is called energy, and the converted (restructured) state is called work.* This is the reason why Newton defined that energy *dW* is measured by the performed work *dA* as a product of force $\vec{F}$ and distance *dr*, i.e.

$$\text{a) } dW = dA = \vec{F}.d\vec{r} \text{ ; b) } \vec{F} = \frac{dA.\vec{r}_0}{\mathrm{dr}} = \frac{dW}{dr}.\vec{r}_0 = \frac{d\vec{P}}{dt}; \qquad (9\text{-}1)$$

i. e. the work is the new state of the respective quantity of restructured energy.

Third. **Inside the substance, the dynamic state of thermal energy is in the form of energy of photons – a dense photon gas, between the small distances between atoms and molecules and is electromagnetic (kinetic) energy, which should be called internal wave kinetic energy, which manifests and is described by force or momentum or pressure.** That is why gasses (vapors) perform work – they transform part of their internal wave energy into external by setting an object into motion.

Fourth. The description of the thermal processes is in a determinist form, in the form of dynamic laws or through statistical physics by means of statistical laws.

1. In general, due to the practically unlimited number of thermally interacting objects at micro level, their analysis as deterministic processes is impossible. ***The main reason for this is that there is no solution in physics to the issue of the description of energy interactions between more than two objects, and at micro level they are practically unlimited in number.***

Thus, micro processes are treated in the form of probabilistic moment values of their energy states

2. Therefore, these laws are used, that:

2.1. For a limited interval of time the probabilistic processes at micro level can have determinist value.

2.2. The effective result of the sum of micro processes of a given macro object for a finite interval of time has a determinist value. Therefore, thermal processes are a determinist macro manifestation with very slight fluctuations, of the order of $\Delta T \approx 10^{-9} K$ of the temperature in degrees by *K*.

I.e. generally speaking, thermal processes change and are described as continuous in time, although they are known to be quantized.

For example. The description of velocities of gas particles is probabilistic, but the effective work, which the gas performs is described by deterministic laws.