DOI: 10.63550/ICEIP.2025.46.94.026

Elementary Energy Carriers

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Keywords: mass, energy, electron, field, charge, combination.

Abstract: As you know, heat, light and electricity are forms of energy transfer that manifest themselves during physical and chemical transformations. The purpose of this article is to clarify the nature of elementary energy carriers between material objects. Since energy is a single measure of various forms of matter movement, in order to reveal the essence of energy manifestations, structural and energy characteristics of substances from atomic to macroscopic components as a single interconnected system are considered. And in the article, on the basis of scientific literature data, the analytical - deductive method suggests the presence of elementary particles that carry out the energy interaction of nuclear - electronic structures in the atomic - molecular structures of substances. These substances called "electromagnetic particles" are formed from opposite charges of electrical matter, they represent a combination of elementary dipoles and magnetic bipoles and are the creation of Nature. Energy manifestations in the form of thermal, light, magnetic or other forms of energy transfer are determined by the conditions of the processes. For conductors of the first kind, the role of "electromagnetic particles" in the formation of an electromagnetic field and electric current under the influence of an external electromotive force is shown. "Electromagnetic particles" creates a picture of a standing wave by pulsating motion, which is taken as a corpuscular-wave property of elementary particles. Under stationary conditions and changes in the volume of "electromagnetic particles" expresses the work they do, which is completely converted into heat at the microscopic level. The frequency of pulsations of "electromagnetic particles" reveals the physical meaning of the temperature of the system. To clarify the individual provisions of the mechanisms for converting the form of transmission of electrical energy into magnetic, the principle of operation of an oscillatory circuit consisting of a coil and a capacitor is considered. In addition, energy and momentum characterizes moving matter, so the elucidation of the nature of elementary energy carriers is of fundamental interest in the rational extraction and accumulation of energy resources, which generally characterizes the relevance of work in this area.

1 INTRODUCTION

The main properties of matter include mass (m) characterizing the measure of inertia, and energy (E) – the measure of its movement (rest), the relationship of which is described by well-known equations in the form (Ginzburg, Levin, Rabinovich, Sivukhin, 1965; Sivukhin, 1990):

$$E = mgh; \qquad E = 0.5mv^2 \quad \text{and} \quad E = mc^2$$

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Here the potential energy ***mgh*** can flow into kinetic ***0.5 mv²*** for material objects with mass "***m***" and speed of movement "***v***". For elementary particles with mass "***m***" moving with the speed of light "***c***", the energy is also described by the Planck equation ***E = hv***. The form of energy transfer depends on the nature of the interaction of material objects (Pandey, 2018; Zhangabay, Baidilla, Tagybayev, Suleimenov, Kurganbekov, Kambarov, Kolesnikov, Ibraimbayeva, Abshenov, Volokitina, Nsanbayev, Anarbayev, 2023), their nature and conditions of the processes and manifests itself in different ways (Zhangabay, Tursunkululy, Utelbayeva, Abdikerova, Sultanov, 2025; Bonopera, Baidilla, Utelbayeva, Tursunkululy, 2023).

In turn, the energy equality ***mc²*** = ***hv*** represents the form of energy transfer in the form of radiation for an elementary particle with wave properties (de Broglie waves), which allows to determine its mass. Consequently, to describe the general characteristics of the forms of movement of matter with a certain mass or their relative rest researchers introduce the conceptual expression "energy". And the definition of which is expressed in the form: *"energy is a scalar physical quantity, which is a single measure of various forms of movement and interaction of matter, a measure of the transition of movement of matter from one form to another"*.

The study of the properties and movement of matter allows to clarify the essence of energy manifestations in various physicochemical processes. Knowledge of these phenomena and forms of movement of substances gives an idea of the structural-energy correspondence of the constituent elements and elementary particles in the organization of the system under study, which will open the possibility of synthesizing substances with given properties. The potential energy of a material object, during movement of its constituent elements (substances), transforms into kinetic energy, where mechanical work with energy manifestations (heat, light, etc.) can be performed and, with the appropriate hardware design, electric energy is generated. In turn, electric energy is used as a source of heat, light, magnetic phenomena and in other forms of energy transfer. According to the scientific literature, the elementary carriers of light and heat are, respectively, photons and "theplotrons". And there is an interest in the physical nature of the carriers of electric energy and their transformation into heat and light forms of energy transfer. In addition, the magnetic properties of substances due to the flow of an electric current and their interconversion are still debatable. Consequently, the study of the transfer of electric energy in the form of heat, light and magnetic phenomena, and the clarification of the mechanism of equivalent transformation into the corresponding forms are of scientific and practical interest in the accumulation and rational use of energy and characterizes the relevance of work in this direction. The purpose of this article is to clarify the nature of elementary energy carriers between material objects.

2 MATERIALS AND METHODS

To write the article, an analytical-deductive method was used based on the data available in the scientific literature given in the list of references. Conventional formulas and reference data were used to calculate physical quantities.

3 RESULTS AND DISCUSSION

It is well known that during chemical interactions, chemical work is performed and the internal energy of the reacting system changes. At the same time, there is a redistribution of electrons and chemical elements in the chemical bonds of "chemical individuals", however their number before and after the process remains constant. However, the released (absorbed) elementary carriers of heat and light quantitatively characterize the formation of bonds between chemical elements and mean changes in the structural-energy correspondence of "chemical individuals". That is, the amount of "some elementary matter" in the nuclear-electronic system, which carries out their energy interaction, changes. In the scientific literature, almost all types of chemical bonds (covalent, ionic, etc.) are explained by the interaction of electrons (valence bond theory, method of molecular orbitals, etc.). The formation of a chemical bond between atoms or other atoms is usually referred to as the generalization of electron pairs or displacement of electrons with the formation of electronic configurations with a decrease in the energy of the system in comparison with the initial atomic state. The authors (Gankin, Gankin, 1998) proposes "G-theory of chemical bonding" based on the gain in energy in accordance with the structural-energy arrangement of the nuclear-electronic system. However, accepting the interactions of the constituent elements in the form of an electric force between the nucleus and electrons, the physical nature of the connection between nuclear-electronic, and electron-electronic substances, carrying electrically charged

DOI: 10.63550/ICEIP.2025.46.94.026

matters, which determines the energy interaction, is not indicated.

It is known from the physics course that an “electrostatic field” arises around any stationary unbound charge, which does not change its properties over time. According to the experimental data of M. Faraday, it is assumed that the charges are surrounded by an “electric field”, through which the interaction is carried out. That is, Faraday’s works and Maxwell’s theoretical reasoning indicated that charges interact with each other through their fields. However, the nature of the electric field lines, their density is still not revealed, and under stationary conditions the atomic-molecular system is electrically neutral.

In (Erokhin, 2002) conventionally considers an infinitely long straight charged with a filament with a constant linear charge density (ρ) and notes a zero value of the electric field as a result of mutual compensation of the charge field. At the suggestion of the author, the electric field of an infinitely long neutral filament at an arbitrary point P looks as in the figure 1. The vectors of the fields of the elementary sections dx = R0 dα / sin2α lie everywhere in the filament plane, i.e., the vectors of the field force dE lie everywhere in the current plane and ∫dE is everywhere equal to zero. Since energy interaction is a process, i.e. energy

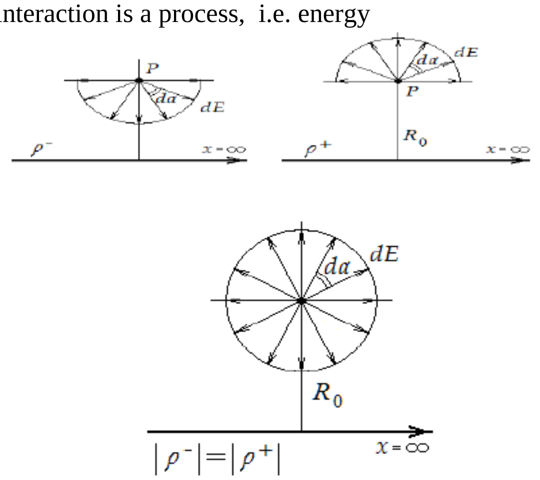
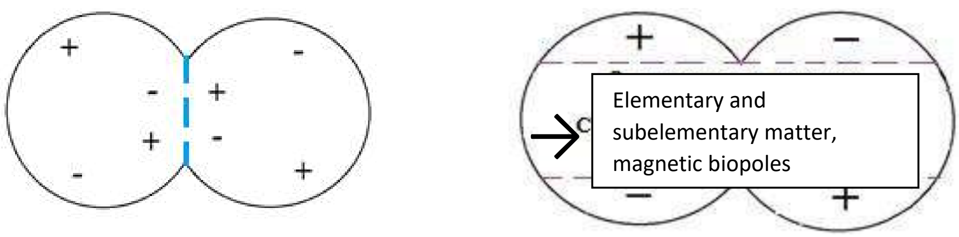


Figure 1: Linear charge density (ρ) and differential change of the electric field (dE).

characterizes as moving a matter, which allows to conclude that the “field lines” represent as moving “some matter”. In addition, the electrical neutrality of the nuclear-electronic system allows to conclude that “some matter” should have the structure of an “electric dipole”, which compensates for their potential difference. As a result of mutual compensation of the potential difference, the electrical neutrality is manifested, although the system consists of oppositely charged matters.

(Gankin, Gankin, 1998), analyzing the formation of chemical bonds, notes that the interpretation of gravitational, intramolecular, intraatomic, intranuclear forces and other types of interactions allows to speak of a single electrical nature of forces. Let’s quote the author: “All material particles are combinations of positive and negative charges, which are themselves complex, that is, the degree of fragmentation of matter and, accordingly, charges, is determined only by the energy that we can transmit to the particles” (Gankin, Gankin, 1998). Analyzing the above, for some "electric matter" it is possible to accept substances that carry out energy interactions between opposite electrical matters, i.e., a combination of opposite electric charges. And when elucidating the physical nature of the combination of opposite electric charges, we studied the structure of the double electric layer of electrodes of the first kind and proposed an elementary structure called "electromagnetic particle" (Utelbaeva, Zhanabay, Suleimenov, Utelbaev, 2021). Unlike the electrode system, where there is an ion interface, in the case under consideration, the interface is created by the dipoles themselves relative to each other, where a potential difference of opposite electric charges occurs (Fig. 2).



a b

Figure 2: Conditional scheme for the formation of an "electromagnetic particle" - an elementary link in the energy field.

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For the conservation of electric charges at the poles of the dipole and the interaction of charges in each of them, there must be at least two positive and two negative charges (Fig. 2a). The interaction of one positive with one negative charge forms a combination of "bound charges" with a change in potential, and the second pairs of charges create an equilibrium value of the system's potential. Taking into account the bi-dipole configuration (Fig. 2a), we use Coulomb's law to estimate the force of interaction of charges:

$$F = 1/(4\pi\varepsilon_0) \cdot |q_1| \cdot |q_2| / r^2$$

Assuming that the radius of the "charges" is $2.0 \cdot 10^{-15}$ - $1.98 \cdot 10^{-13}$ m and at their maximum approximation to the distance of the Planck length ($1.60 \cdot 10^{-35}$ m)

$F \approx 9 \cdot 10^9 \cdot 1,\ 6 \cdot 10^{-19} \cdot 1,\ 6 \cdot 10^{-19} / (1,\ 60 \cdot 10^{-35})^2 = 9 \cdot 10^{41}$N

The enormous value of the interaction force $9 \cdot 10^{41}$N means the destruction of the integrity and fragmentation of the charge masses with the formation of bound charges in the form of "elementary and subelementary matter" (Fig. 2b), which exhibit other properties compared to unbound electric charges according to the axiom noted in (Utelbaeva, Zhanabay, Suleimenov, Utelbaev, 2021).

It is well known that during "discharge" processes (lightning, sparks of discharges, etc.), the interactions of charges upon reaching the "breakdown" voltage appear in the form of electric current, magnetic phenomena, light and heat with the formation of the corresponding photons, "theplotrons" and other particles. The presence of photons, "theplotrons" and "magnetic matter" in the atomic and molecular structure of substances is directly evidenced by the release (absorption) of light, heat and the manifestation of magnetic moments during chemical, biochemical, electrical and electrochemical processes.

In our opinion, "a combination of opposite elementary electric charges" represent a combination of electrical substances, and can be attributed to one of the matters given by Nature, which are part of the atomic structure. It is well known that during the flow of electric current, where the directed movement of electrons under the action of an electric field performs electrical work accompanied by energy manifestations. That is, the electric field induces the electron to move from a stationary state, where their directed movement creates an electric current. It was determined in (Sharipov, 2006) that during the flow of an electric current, the electron velocity for a copper conductor is approximately $5 \cdot 10^{-5}$ m/s, which is in good agreement with the known reference data of the scientific literature. Therefore, the speed of the electric and electromagnetic fields is close to the speed of light, and an electron with a speed of $5 \cdot 10^{-5}$ m/s cannot create an electric field. Usually, processes involving real elementary electrical matters (charges) with corresponding fields are described by J. Maxwell's mathematical equations and experimental confirmation of which is given in Hertz's experiments (Mayer, Varaksina, 2020). The author of (Kelley, 2014), giving deep appreciation to Maxwell's equations, introduces a clarification where the magnetic field, both for alternating and direct currents, is not an independent field. The magnetic field should always be considered only as one of the properties of the electric field - variable or delayed! The author (Basu, 2003) also theoretically explains the electric nature of the magnetic field and the phenomena stated as a separate type of field, but the physical nature of the field remains open. In (Utelbayev, Suleimenov, 2019), it is noted that combustion is a chemical reaction in which there is a change in the force bonds between atoms, and carriers of molecular and intermolecular forces, which represent an electrostatic variety of photons, and for convenience, they propose to call them electrostatic structures. We quote the author: "... the flame in the combustion zone adjacent to the charged electrodes was eliminated in a matter of microseconds." Despite the fact that the author's proposal causes an ambiguous reaction from readers, however, the principle of operation of such fire extinguishing devices makes it possible to clearly confirm the reliability of elementary heat carriers - "theplotrons" proposed by us in (Utelbaev, Suleimenov, Utelbaeva, 2021; Utelbayev, Suleimenov, Utelbayeva, 2020; Bondarenko, 2017). And on the basis of thermochemical and spectroscopic data of reference literature, its mass was calculated, which is $2.4 \cdot 10^{-36}$ - $2.7 \cdot 10^{-36}$kg. Assuming that two electrons and two positrons with masses $9.31 \cdot 10^{-31}$kg are involved in the interaction of charges in bidipoles, their total mass is $37.24 \cdot 10^{-31}$kg (Fig. 2a). At the same time, we assume that in each dipole, charges are spent on the formation of photons, "heattrons" and "subelementary matters" (Fig. 2b). We assume that half of the mass of charges $18.62 \cdot 10^{-31}$kg is spent on the formation of "heattrons" and photons with a mass of $9.3 \cdot 10^{-36}$ kg, i.e., their number is $18.62 \cdot 10^{-31} : 9.3 \cdot 10^{-36} \approx 2 \cdot 10^5$ particles. To determine the mass of "sub-elementary matter" with magnetic properties, we use the unit of elementary magnetic moment "Bohr magneton" (μV) - equal to the intrinsic (spin) magnetic moment of an electron (9.2732 ±

DOI: 10.63550/ICEIP.2025.46.94.026

0.0006)·10-24 J/T. This value means that one Tesla corresponds to approximately 9.27·10-24J of energy action per unit of magnetic induction. It is well known that any energy action is carried out by means of moving matter, which has a certain mass. And to determine the mass of matter exerting 9.27·10-24 J of energy action per unit of magnetic induction, we will use the generally accepted conversion units of physical quantities. Based on the fact that the value of 1a.u.m. equal to 1.66·10-27 kg corresponds to 1.49·10-10J, then for 9.27·10-24J the mass equivalence of 1.03·10-40 kg follows. Therefore, per unit of magnetic induction (T) corresponds to a mass of 1.03·10-40kg, and taking into account the fact that 1T is equal to 1N / (A·m), and 1A is equal to 2·10-7 N/m, then the mass of magnetic matter creating the Bohr magneton effect is equal to 2.06·10-47kg. And from the other half of the mass of charges is formed18.62·10-31 : 2.06·10-47 ≈ 9.1·1016 particles of magnetic matter (magnetic bipoles).

When exposed to an external EMF, the “subelementary matter” of the conductors of the first kind undergoes polarizations, forming an electromagnetic field and causing the flow of an electric current. That is, the electron moves from a stationary state to compensate for the external voltage and changes the pulsation of the "electromagnetic particle", as a result of which heat, light, magnetic phenomena and other forms of energy transfer appear.

Thus, the electrical neutrality of the atomic structure and the structural-energy correspondence of “chemical individuals” allows us to consider that, despite the complexity of the interaction of matters, their electrical properties are the basis for the creation of micro-macroscopic formations.

In favor of what has been said, M. Faraday's statement that regardless of the thermal, light, chemical, physiological, magnetic or mechanical energy source, they can all manifest themselves in the form of the same electricity.

Naturally, with a decrease in the dimension of the material world, it is difficult to judge the forms and structures of micro-objects, which are complicated by the lack of direct measuring instruments. In (Bondarenko, 2017), the conditions for the manifestation of corpuscular-wave properties of elementary particles are suggested. Since it is impossible to predict the exact form of elementary matter, and analyzing the corpuscular-wave properties of elementary particles and the "string theory", we conventionally represent the "electromagnetic particle" in the form of a bidipole configuration (Fig. 2b). The pulsating movement of the "electromagnetic particle" creates a picture of a standing wave, which is taken as a wave - corpuscular dualism of elementary particles. The structure and pulsating nature of the "electromagnetic particle" determines the thermal state - the temperature of the system (T) according to the formula:

$$T = 0.595 \cdot 1011 \cdot v$$

where v - pulsation frequency, s -1; 0.595·1011 – temperature constant, K·s Therefore, changes in the pulsation frequency of the "electromagnetic particle" means a change in the temperature of the system and heating of the conductor during the flow of electric current. Although the transformation of electrical energy into heat and light is considered to be a common phenomenon, however, the mechanism of their transmission is a complex process.

And taking into account the configurations of the "electromagnetic particle", we can assume that the electromagnetic field is formed by its components: "subelementary matter" and the poles of dipoles. With external influences of the EMF, the electron of the conductor makes a directed movement creating an electric current and changes the structural and energy state of the "electromagnetic particle". This leads to a change in the frequency of their pulsations and the performance of work at internal pressure P and a change in volume by dV and the separation of “elementary and subelementary matters”. That is, under microscopic conditions, the electrical work performed equal to pdV is completely converted into heat:

$$\delta W = pdV = \delta QT,$$

where $\delta W = pdV$ is the infinitesimal work of electrical and other types of work of the "electromagnetic particle" during pulsations;

δQT is the equivalent amount of heat during the performance of work.

Thermal and electrically neutral equilibrium is established in the system, and the Mendeleev-Clapeyron equation for an "electromagnetic particle" looks like this:

$$pdV = kT$$

And the perfect work pdV equivalent to the released heat is quantitatively characterized by the temperature, which is proportional to the frequency of pulsations of “elementary substances”, according to the formula:

$$T = hv / \sum xik = 0.959 \cdot 10\text{-}11 \cdot v,$$

where h/∑xi·k =0.959·10-11K·s is the temperature constant of the elementary particle - heat carrier;

v is the frequency of pulsations of "electromagnetic particles".

Hence: pdV = 1.32·10-34·v

Thus, in any process associated with the performance of work, depending on the frequency of pulsations of the “electromagnetic particle” in the system, “elementary and subelementary matters” show the transfer of energy in the form of heat, light and other forms, since the implementation mechanism is identical. In turn, the mechanism of transformation of electrical energy into magnetic energy and vice versa in the scientific literature is still debatable.

In (Erokhin, 2002), on the basis of publicly available mathematical formulas and a critical analysis of Maxwell's equations, he shows the essence of magnetic manifestations during the flow of electric current. We quote the author: “the whole essence of the “thousand-year mystery” of the magnetic field, which lies in the fact that no magnetic field exists in nature. The magnetic field of the current is its ordered electric current field, neutral in statics. With a change in current or with relative motion, the balance of neutrality is disturbed - that's the whole principle of magnetism. According to the author's conclusion, there is only an electric field, however, in this case, the physical nature of the electric field of the charge and the electric current field also remains open. In the scientific literature, the transformation of electrical energy into magnetic energy and vice versa is sufficiently described on the basis of the principle of operation of an oscillatory circuit.

To clarify this phenomenon, consider the principle of operation of an ideal oscillatory circuit consisting only of an inductor (having no own resistance) and a capacitor (-circuit) (Fig. 3).

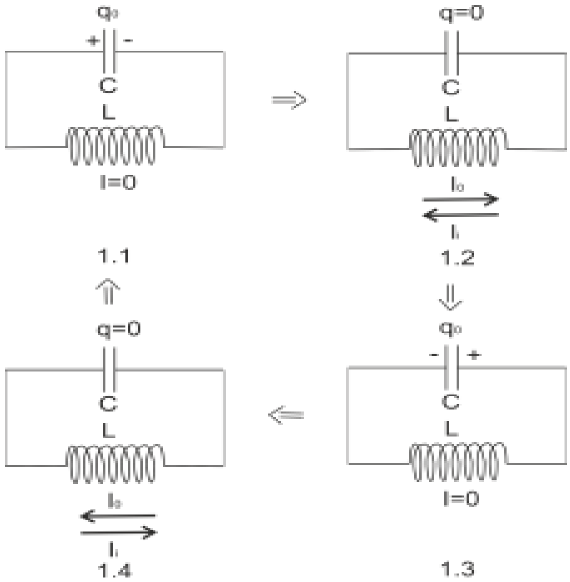

Figure 3: General scheme of the oscillatory circuit.

At the initial moment of time, the entire charge is concentrated on the capacitor plates and there is no electric current on the coil (position 1.1). When the circuit is closed, the potential difference between the capacitor plates (the potential energy of the charges) creates an electromagnetic field due to the magnetic bipoles of "electromagnetic particles", which induces the movement of the valence electrons of the conductor from the stationary state, creating an electric current. The voltage on the capacitor starts to decrease, but the current in the circuit increases. In the scientific literature, it is believed that with the flow of current, magnetic energy appears, which creates an EMF of self-induction, which results in a reverse induction current. The direction of the induction current, according to the Lenz rule, is opposite to the main current, and when the charge of the capacitor becomes equal to zero, the strength of the induction current in the coil will become maximum, i.e., it is assumed that the electrical energy of the capacitor has transferred into the magnetic energy of the coil (position 1.2). In reality, the electromagnetic field increases near the coil and the electric potential difference that has arisen due to “electromagnetic particles” as series-connected “batteries” begins to act on the electrons of the circuit, recharging the capacitor plates (position 1.3). The recharged capacitor again acting on the coil again forms "batteries" connected in series, with the opposite potential (position 1.4). Further charging of the capacitor brings the system to position 1.1.

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Therefore, based on the analysis of the principle of the electrical oscillatory circuit, it can be assumed that the magnetic and electrical manifestation depends on the state of "electromagnetic particles". In this regard, the author of (Erokhin, 2002) notes: “The classical theory rightly notes that the division of the field into electric and magnetic components is conditional, since these components depend on the choice of the reference frame, but immediately inconsistently adds that “as long as charges and currents are constant in statics , then electricity and magnetism are different phenomena, "since Maxwell's equations fall into two separate groups, in one of which only the electric field E appears, and in the other - only the magnetic field B. Alas, these phenomena are not different, they are different manifestations of the same electrical interaction. Here the author (Erokhin, 2002) correctly notes that the magnetic and electric fields are different manifestations of the same electrical interaction. In this relationship, heat and light is also a form of transmission of electrical energy during the flow of current. In this case, energy manifestations take place with the obligatory displacement of electrons from their stationary state under the action of an electric field. As a result of the nature of the electrical work done by electrons, the released components of the "electromagnetic particle" appear in the form of "heat", light, magnetic field and other forms of energy transfer. And these forms of energy transfer, despite the fact that “electromagnetic particles” are common to them, depending on the process and type of movement, its energy manifestations have a separate character with the corresponding physical quantities. For example, the amount of heat released during the passage of current in a conductor is directly proportional to the square of the current strength, the resistance of the conductor and the passage time of the current:

$$Q=I2Rt$$

where Q is the amount of heat, I is the strength of the current; R is the resistance of the conductor; t is the time of passage of the current. Here, heat is a form of transmission of electrical energy, but it has a separate character.

But the same heat can be described through the change in entropy (ΔS) and temperature (T) of the system, related to "electromagnetic particles" differing in the frequency of pulsations and the nature of the movement:

$$Q = T \cdot \Delta S$$

And the work of incandescent lamps is based on the thermal effect of light, that is, on the conversion of electric energy into heat and light, where the power of the lamps (P) is determined by the product of the current strength (I) by the voltage (U):

$$P = UI$$

The energy luminous intensity (radiation intensity Ie) is:

$$Ie = \Phi e / \omega$$

where Φe is radiation flux, ω – space angle

The energy of the magnetic field (Wm) is determined by the current in the coil I:

$$Wm = L \cdot I2 /2.$$

where, L is the inductance of the circuit or the coefficient of self-induction, the value of which depends on the geometric properties of the circuit and on the nature of the conductor. The charge on the capacitor q (and the voltage u) determines its electric field energy (We):

$$We=q2/2C=C \cdot u2/2,$$

Thus, there is electrical energy, and the forms of energy transfer include: the performance of work, heat, light, magnetic phenomena and other energy manifestations. All forms of energy transfer are carried out through the components of "electromagnetic particles", and the energy manifestation depends on the nature and organization of the process. Depending on the degree of polarizations and the frequency of their pulsations and the nature of the process, they manifest themselves in the form of an electric field, light radiation, heat, a magnetic field, and other types of energy transfers.

3 CONCLUSION

In the atomic structure of substances there is an elementary "electromagnetic particle" formed from opposite charges of electrical matter, which is a creation of Nature, which forms an electromagnetic field. The elementary energy carriers are the components of the “electromagnetic particle” photons and theplotrons with mass of 2.4·10-36 - 9.3·10-36 kg and magnetic bipoles with a mass of 2.06·10-47 kg. Magnetic bipoles create the «spin effect» of elementary particles.

The pulsating movement of "electromagnetic particles" creates form of a standing wave and is accepted as a corpuscular-wave property of elementary particles. Their pulsation frequency characterizes the degree of the system's development and reveals the physical meaning of temperature.

The components of "electromagnetic particles" are elementary energy carriers and during the process it manifests itself in the form of magnetic (electromagnetic) phenomena, light radiation, heat and other forms of electrical energy transfer, which depend on the process of frequency of pulsations and their polarizations.

REFERENCES

Ginzburg, V. L., Levin, L. M., Rabinovich, M. S., Sivukhin, D. V., 1965. “Molecular physics and thermodynamics. Molecular Physics, Thermodynamics, Atomic and Nuclear Physics, pp. 3–60.

Sivukhin, D.V., 1990. General course of physics. Sivukhin D.V., Thermodynamics and Molecular Physics, Vol. 2, Moscow: Nauka, p. 591.Russian

Raymer, M.G., 2017. “Quantum Physics,” Quantum Physics.

Pandey, G., 2018. Nanotechnology For Achieving Green-Economy Through Sustainable Energy. *Rasayan Journal of Chemistry* [Internet]. *Rasayan Journal of Chemistry*;**11(3):**94.

Kudabayev, R., Mizamov, N., Zhangabay, N., Suleimenov, U., Kostikov, A., Vorontsova, A., Buganova, S., Umbitaliyev, A., Kalshabekova, E., Aldiyarov, Z., 2022. Construction of a model for an enclosing structure with a heat-accumulating material with phase transition taking into account the process of solar energy accumulation. *East. Eur. J. Enterp. Technol*. *6*, 26–37.

Previsic, M., 2005. “Wave power technologies,” IEEE Power Engineering Society General Meeting.

Zhangabay, N., Baidilla, I., Tagybayev, A., Suleimenov, U., Kurganbekov, Z., Kambarov, M., Kolesnikov, A., Ibraimbayeva, G., Abshenov, K., Volokitina, I., Nsanbayev, B., Anarbayev, Y., 2023. Thermophysical indicators of elaborated sandwich cladding constructions with heat-reflective coverings and air gaps. Case Stud. Constr. Mater. 18, e02161.

Zhangabay, N., Tursunkululy, N., Utelbayeva, A., Abdikerova, A., Sultanov, S., 2025. A Study of Temperature and Humidity Conditions in a New Energy-Efficient Design of a Wall Structure with Air Gaps. Modelling. 6(1), 12.

Zhangabay, N., Oner, A., Rakhimov, M., Tursunkululy, T., Abdikerova, U., 2025. Thermal Performance Evaluation of a Retrofitted Building with Adaptive Composite Energy-Saving Facade Systems. Energies 18(6), 1402.

Tagybayev, A., Utelbayeva, A., Buganova, S., Tolganbayev, A., Tulesheva, G., Jumabayev, A., Kolesnikov, A., Kambarov, M., Imanaliyev, K., Kozlov, P., 2023. Analysis of the influence of thermal insulation material on the thermal resistance of new facade structures with horizontal air channels. Case Studies in Construction Materials. 18, e02026.

Zhangabay, N., Baidilla, I., Tagybayev A., Sultan B., 2023. Analysis of Thermal Resistance of Developed Energy-Saving External Enclosing Structures with Air Gaps and Horizontal Channels. Buildings. 13. 356.

Bonopera, M., Baidilla, I., Utelbayeva, A., Tursunkululy, T., 2023. Research of Heat Tolerance and Moisture Conditions of New Worked-Out Face Structures with Complete Gap Spacings. *Buildings*. 13(11). 2853.

Electronic resource. https://ru.wikipedia.org/wiki/Energy (accessed on 28 March 2025)

Salasnich, L., 2020. “Partition function of photons,” Quantum Physics of Light and Matter - Quantum Properties of Light.

Utelbaev, B.T., Suleimenov, E.N., Utelbaeva, A.B., 2021. Hypothesis about elementary carriers of thermal energy. In book. Modern problems of science and education. M .: Publishing House of the Academy of Natural Sciences v. XX1 p.85.

Kudinov, V. A., Kartashov, E. M., Stefanyuk, E. V., 2011. Technical thermodynamics and heat transfer; Yurayt - Moscow, 560 p.

Glagolev, K. V., Morozov, A. N., 2007. Physical Thermodynamics. -2nd ed., rev. - M.: Publishing house of MSTU im. N. E. Bauman, 270 p.

Borshchevskiy, A., 2016. Physical chemistry. Volume 1. General and chemical thermodynamics. Infra-M Academic Publishing House.

Harnau, L., 2008. Structure and thermodynamics of platelet dispersions. Molecular Physics [Internet]. Informa UK Limited; 20;106(16-18):1975–2000.

Ramya, M, . Senthilkumar, E, . Sivagaami Sundari, G, Thileep Kumar, K., 2019. High Power And Energy Density Of Redox Additive In Microbial Fuel Cell. Rasayan Journal of Chemistry [Internet]. *Rasayan Journal of Chemistry*; 12(1):91–100.

Slater, C.D., 1978. General chemistry. Principles and modern applications, 2nd Edition (Petrucci, Ralph H.). Journal of Chemical Education [Internet]. American Chemical Society (ACS); 55(6):A274.

Herriott, A.W., 1973. Chemistry for changing times (Hill, John W.). *Journal of Chemical Education [Internet]. American Chemical Society (ACS);* Jan;50(1):A44.

Utelbayev, B. T., Suleimenov, E. N., Utelbayeva, A., Zhanabai, N., 2019. Role of Atomic-Molecular Formations in Chemistry. Theory and Applications of Chemistry Vol. 1, 88-97.

Bader, R.F.W., Nguyen-Dang, T.T., 1981. Quantum Theory of Atoms in Molecules–Dalton Revisited. Advances in Quantum Chemistry Volume 14 [Internet]. Elsevier; 63–124.

Available: http://www.books.google.com/ (accessed on 27 March 2025)

Ralph H., Petrucci William, Harwood S., Geoffrey F., 2022. Herring. General chemistry: Principles and modern applications. 8th Ed. Prentice Hall: Pearson Education International.

Nekrasov, B.V., 1962. General course of chemistry. M.: Goskhimizdat, P. 88. 976 p.

Pauling, L., 1947. The nature of chemical bonds / Ed. Ya.K. Syrkin. / translation from English by M.E. Dyatkina. – M.-L.: Goskhimizdat, 440 p.

Tatevsky, V.M., 1999. Atoms in molecules and quantum-mechanical interpretation of the concepts of the classical theory of chemical structure. *Bulletin of Moscow University. Ser. 2, Chemistry.* Vol. 40. No. 2. – P. 75.

Theoretical organic chemistry / ed. R.H. Freidlina. per. from English Yu.G. Bundel. Moscow: Ed. foreign literature, 1963. -365 p. https://books.google.ru/books?id=aKmIdil6P3oC&hl=ru (accessed on 27 March 2025)

Gankin, V., Yu., Gankin, Yu.V., 1998. "How a chemical bond is formed and chemical reactions proceed. ITC Boston.

Faraday, M., 1947. Experimental research on electricity. Vol. 1. – M.: Publishing house of the Academy of Sciences of the USSR, 548 p.

Lehner, G., 2008. Maxwell's Equations. Electromagnetic Field Theory for Engineers and Physicists [Internet]. Springer Berlin Heidelberg; 1–39.

Erokhin, V., 2002. Fundamentals of Constructive Electrodynamics. Part 1. Magnetic field in nonrelativistic approximation.

Utelbaeva, A.B., Zhanabay, N., Suleimenov, E.N., Utelbaev, B.T., 2021. Electric and magnetic components of elementary "electromagnetic particles" / Trends in the development of science and education. December, No. 80. Part 5. pp.167-76.

Novozhilov, Yu. V., Yappa, Yu. A., Electrodynamics, M., 1978. https://archive.org/details/NovozhilovYappaElectrodynamics (accessed on 27 March 2025)

Zhangabay, N., Kudabayev, R.A., Mizamov, N., Imanaliyev, K., Kolesnikov, A., Moldagaliyev, A., Merekeyeva, A., 2023. Study of the model of the phase transition envelope taking into account the process of thermal storage under natural draft and by air injection. Case Stud. Constr. Mater. 18, e02050.

Tagybayev, A., Zhangabay, N., Suleimenov, U., Avramov, K., Uspenskyi, B., Umbitaliyev, A., 2023. Revealing patterns of thermophysical parameters in the designed energy – saving structures for external fencing with air channels. *East.-Eur. J. Enterp. Technol*. 4/8, 32-43.

Zhangabay, N., Tagybayev A., Utelbayeva, A., Buganova, S., Tolganbayev, A., Tulesheva, G., Jumabayev A., Kolesnikov, A., Kambarov, M., Imanaliyev, K., Kozlov, P., 2023. Analysis of the influence of thermal insulation material on the thermal resistance of new facade structures with horizontal air channels. Case Studies in Construction Materials. 18, e02026.

Basic Equations Of Classical Electrodynamics. Conservation Laws and Open Questions of Classical Electrodynamics World Scientific; 1990 Apr;3–8. Available from: http://dx.doi.org/10.1142/9789814439190_0001

Utelbayev, B.T., Suleimenov, E. N., Utelbayeva, A. B., 2020. "Atomic-Molecular Structure of Substances and Energy Manifestations," *Global Journal of Science Frontier Research*, pp. 1–6.

Sharipov, I.Z., 2006. Physics of metals: Practical course on the discipline "Physics of metals". Ufa State Aviation Technical University. 20 p. ISBN 5-86911-503-5.

Mayer, V.V., Varaksina, E.I., 2020. Electrodynamics From Oersted To Hertz In Modern Educational Experiments. Physics in School [Internet]. School Press Publisher; (8):3–11.

Kelley, M.C., 2014. Electric Field Generation Mechanisms. The Earth's Electric Field [Internet]. Elsevier;1–27.

Basu, K.P., 2003. An interesting phenomenon. IEEE Potentials [Internet]. Institute of Electrical and Electronics Engineers (IEEE); 22(2):39–39.

Utelbayev, B.T., Suleimenov, E.N., 2019. Utelbayeva. Temperature and Elementary Carriers of Heat eBook.Theory and Applications of Physical Science. Vol.1 Chapter 8. P.141

Bondarenko, E.A., 2017. Matter and material reality. Problems of Science No. 10 (23) 2017; Here, Matter: the foundations of the theory of the structure of elementary particles and the field theory of the structure of elementary particles.

Scherk, J., Schwarz, J.H., 1985. Dual Models For Non-Hadrons. Superstrings [Internet]. World Scientific; 1985 Sep;191–217.

Bianchi, M., Fucito, F., Marinari, E., Sagnotti, A., 1993. String Theory, Quantum Gravity and the Unification of the Fundamental Interactions. String Theory, Quantum Gravity and the Unification of the Fundamental Interactions [Internet]. WORLD SCIENTIFIC; 1993 Aug.

Barbashov, B.M., Nesterenko, V.V., 1986. Superstrings: a new approach to a unified theory of fundamental interactions. Uspekhi Fizicheskih Nauk Uspekhi Fizicheskikh Nauk (UFN) Journal; 150(12):489.

Kaku, M., 1999. Introduction to Superstrings and M-Theory. Graduate Texts in Contemporary Physics [Internet]. Springer New York.

Koteswararao, P., Vasubabu, M., Suresh, M.B., Rao, P.V.B., 2019. Temperature Dependence Dielectric Behaviour Of 20GDC (CE0.8GD0.2O2-Δ) Effect For Solid Oxide Fuel Cell Application. Rasayan Journal of Chemistry [Internet]. *Rasayan Journal of Chemistry;* 12(03):1518–22.

Trofimova, T.I., 2002. Physics in tables and formulas: Teaching aid for university students. – M.: Drofa, 432 p.

Noad, H.M., 2019. LECTURE VII—ON MAGNETISM. Lectures on Electricity. Cambridge University Press; 281–338.