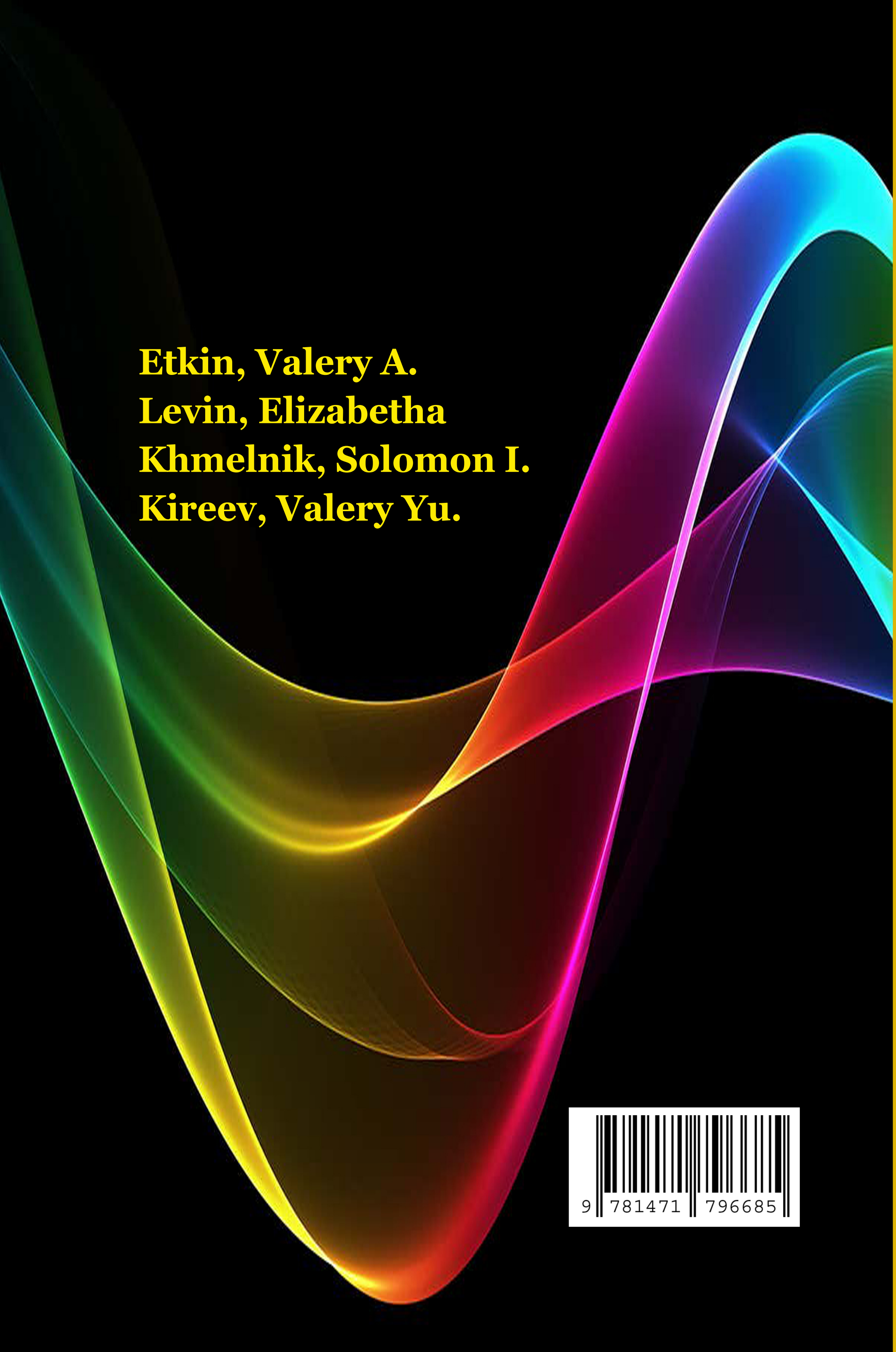

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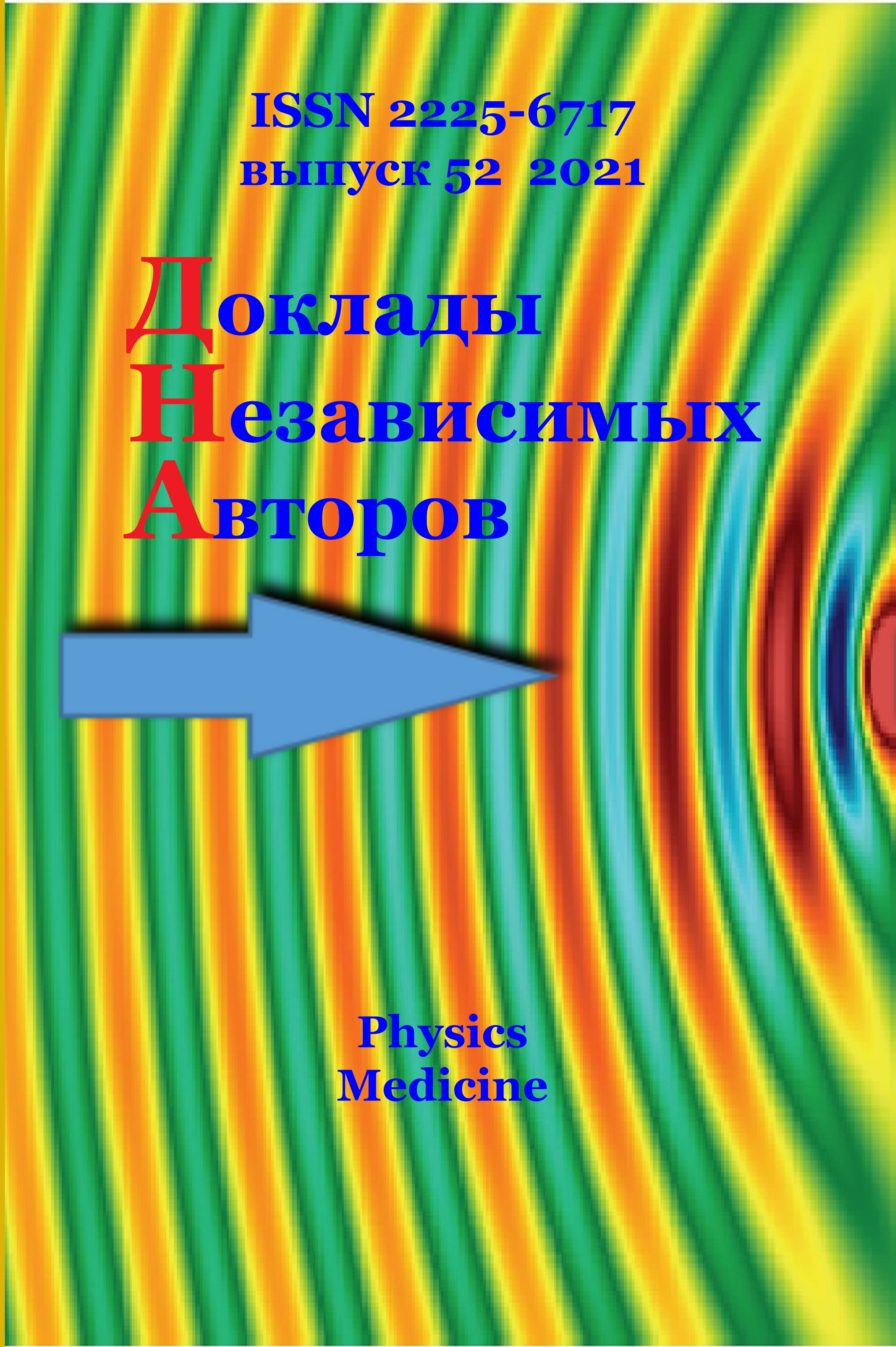

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Truth - the daughter of time, instead of authority

Frensis Bacon

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Solomon I. Khmelnik, 2005

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Series: **PHYSICS**

Valery Yu. Kireev

The Concept of the Graviton Field to Describe Non-Relativistic and Relativistic Mechanics of Substance Objects

It is dedicated to scientists and specialists who want to understand the physical laws of our natural World, and not follow outdated and limited scientific dogmas.

Annotation

The modes of dynamics of a graviton field medium and its possibilities for trans-mitting interactions between substance objects based on the principles of proximity and continuity are considered. It is shown that the equations describing these principles allow us to obtain all the formulas of classical and relativistic mechanics without using Lorentz transformations and special relativity theory (SRT). Differences in understanding the concepts of mass and energy in real physics based on the graviton field and mathematical physics based on SRT are given.

Contents

1. Introduction
2. Modes, properties, parameters and equations of the gravitonic field.
3. Derivation of the formulas of the classical mechanics of motion of substance objects using the concept of the gravitonic field.
4. Derivation of formulas for relativistic mechanics of motion of substance objects using the concept of the gravitonic field.
5. Derivation of formulas for energy, momentum, angular momentum, and force in a gravitonic field for the classical and relativistic cases.
6. Conclusion.
References

1. Introduction

In [1] it is proved that "in the framework of real physics, the physical equivalent of philosophical Matter is self-organizing energy, i.e., the movement of self-organizing energy carriers that forms our natural world, in the form of a set of nested organizational levels that combine energy - related connections, characteristic size, structure and properties of energy-informational system formations-material objects." In our natural world, there is a nesting of energy levels consisting of material objects of different levels of organization. Material objects are understood as both substance objects (objects formed from substance) and field objects, which are energy fields formed by various quanta.

Moreover, energy carriers of more organized energy levels are created in the environment of energy carriers of less organized energy levels, and, consequently, the former will be invested in the latter. To deny the nesting of energy levels means to deny the process of development of material objects, since without the nesting of levels after the decay, any material object would slide to the initial level of organization and could not develop [2].

The nesting of energy levels clearly indicates the existence of the energy level of carriers of a unified physical field, in which the more organized levels of energy carriers of all substance objects are nested.

Thus, all the substance objects of our natural World are formed, develop, interact, disintegrate and disappear (annihilate) in the environment of a unified energy field, most often called the gravitonic field. The quanta (energy carriers) of this field are gravitons, which are torus-shaped vortex energy formations that self-move at the speed of light [3]. At the same time, each substance object of our natural World has an inseparable graviton shell that moves with it, and through which it carries out all its interactions (energy-informational exchange) with other substance objects [1].

The paper [4] presents a set of experiments proving the existence and composition of the components of the gravitonic field in our natural World, in which the gravitonic field should have as many components as substance objects have independent fundamental properties (parameters) [5].

At the same time, it should be taken into account that we are talking only about the fundamental parameters of substance objects, which are equally characteristic of any substance objects, both the microcosm and the meso - and macrocosm. This is true, because the properties of substance objects can only manifest themselves when interacting through the medium of the gravitonic field, i.e. through the gravitons of the inseparable gravitonic shells surrounding the substance objects and forming their gravitational mass and electric charge [6].

The unified nature of mass and charge is confirmed by an experiment in which, at the electric field strength E ≈ 10^{16} V/m, an electron and a positron with charges e and e+ and with masses equal to m_0 are born from this field [7, 8]. This fact also proves the unity of the electromagnetic and gravitational fields [3].

Therefore, a gravitonic field medium must have two components: a longitudinal gravivariational or mass-variational (often called gravitational) one that affects all substance objects, since they always have a gravitational charge (often called gravitational mass), and a transverse electromagnetic one that affects substance objects that have an electric charge [3, 5].

Physical fields are non-local states of Matter in the form of flowing energy (energy-informational) system media that have no shape and volume and are formed by self-moving energy objects (quanta - energy carriers) that do not have longitudinal inertia, i.e., an inert mass at rest or simply an inert mass in the direction of motion.

Substance objects (substances) are local states of Matter in the form of discrete energy (energy – informational) system formations that have a shape and volume and are formed by material objects (energy - carrier particles) that have a longitudinal inertia, i.e., an inert rest mass or simply an inert mass in the direction of motion [1].

In this paper, based on the concept and properties of the gravitonic field, the main formulas of classical and relativistic mechanics of substance objects are derived, without the use of Lorentz transformations and special relativity theory (SRT).

2. Modes, properties, parameters and equations of the gravitonic field.

To describe the interaction of substance objects in a gravitonic field, it is necessary to determine the modes, properties and parameters of the gravitonic field and derive the laws of their change in the presence of moving and resting substance objects.

For a quantitative description of the graviton field medium, the standard formula for the density of a continuous medium can be used [8, 9]:

$$\rho_g = \rho_g(\mathbf{r}, t) = m_{gr} \cdot n_{gr}(\mathbf{r}, t), \qquad (2.1)$$

in general, depending on the coordinates $\mathbf{r} = \mathbf{i} \cdot x + \mathbf{j} \cdot \mathrm{y} + \mathbf{k} \cdot \mathrm{z}$ and time t, where $n_{gr}(\mathbf{r}, t)$ is the concentration of gravitons in the graviton medium; m_{gr} is the average mass of the graviton.

It should be recalled that the graviton does not have a rest mass, i.e., a mass in the direction of motion (in the direction perpendicular to the plane of its energy torus-like vortices), but it has different inertia in all other directions of motion [3].

However, if we consider the dynamics of a graviton field medium associated with a moving field-forming substance object and its subsequent effect on a field (test) substance object, it is better to use the energy density of the graviton field medium [6]:

$$w_g = w_g\{\mathbf{r}, \mathbf{R}(t)\} = w_g(\mathbf{r}, t), \tag{2.2}$$

in which the dependence of the position $\mathbf{R}$ of the field-forming substance object is replaced by the dependence on time using the trajectory formula $\mathbf{R} = \mathbf{R}(t)$. If the field-forming substance object is stationary, then the dependence $\mathbf{R} = \mathbf{R}(t)$ disappears, and the density configuration of the graviton field medium $w_g(\mathbf{r})$ is static.

Based on the dimension of physical quantities, the energy density of the gravitonic field w_g [J/m^3] is equal to its pressure p_g [N/m^2] on substance objects:

$$w_g(\mathbf{r}, t) = p_g(\mathbf{r}, t) = n_{gr}(\mathbf{r}, t) \cdot k_B \cdot T_{gr,} \tag{2.3}$$

because [J/m^3] = [N·m/m^3] = [N/m^2]; where k_B is the Boltzmann constant; T_{gr} is the temperature of the gravitons.

As shown in [10, 11], the ratio of the energy density of the gravitonic field medium w_g (formulas (2.2) and (2.3)) to its density ρ_g (expression (2.1)) is a constant value equal to the square of the speed of light c^2:

$$w_g / \rho_g = c^2. \tag{2.4}$$

According to [10], the density of the graviton field ρ_g is an indicator of its specific inertia, and inertia is a physical phenomenon of the reaction (resistance) of the medium of the graviton field to the change in the motion of substance objects in it.

In the framework of real physics, we can distinguish two fundamentally different modes of dynamics of a gravitonic field medium - two models of its behavior in the interaction of substance objects [6].

The first mode is the classical one, which implies that the field medium does not have its own dynamics and is based on the model of independent separate (isolated) field graviton shells for substance objects, which is typical for classical physics.

The separation of the field graviton shells of substance objects occurs when there are few substance objects and the distances between them are large, which means that the magnitude of the field connection - the intensity of interactions is also small. Under these conditions, the unified environment of the gravitonic field, which causes interactions between all substance objects as elements of the system at once, is divided between individual substance objects. As a result, each substance object received its own piece of the gravitonic field environment - its independent separate field shell.

Such a separate field shell has limited dynamics, since it is connected with a substance object, and can only move together with it or experience elementary deformation. The field medium in the field shell should have the highest density at the surface of the substance object and decrease as it moves away from it. As a result, the interaction effect should decrease with distance.

As can be seen from [8, 9], the laws of Coulomb and Newton's universal gravitation are similar and are determined by geometry, because they describe the electrostatic and gravistatic components of a unified graviton field [5]. But the discovery of the true nature of electricity and gravity does not consist in finding the dependence of the force of interaction on distance, which is what official (academic) physics was satisfied with. It consists in understanding the causes of the properties of electric and gravitational charges in substance objects, as well as in identifying the structure of charges and finding factors to control their values.

In a model independent field shells all disturbances graviton field environment are due solely to the motion of the considered substance objects, and the field environment itself turns out to be like a sea in calm weather, when every ship on the water leaves its mark, only slightly perturbing it.

For the classical regime, it is not necessary to consider the dynamics of the gravitonic field medium at all points in space, but only to calculate it at the location of the object under study. In this case, the energy density function of the graviton field medium $w_g\,(\mathbf{r}, t)$ is transformed into the field coupling function of substance objects $W_g(R)$, which depends only on their relative distance R and has in classical physics the meaning of the potential energy of interaction of substance objects in the graviton field W_{pg}, therefore [6]:

$$w_g\,(\mathbf{r}, t) = W_g(R) = W_{pg}. \tag{2.5}$$

The second mode - quantum or wave is associated with the assumption of the possibility of the existence of proper perturbations in a graviton field medium and is based on the model of a single field graviton shell for interacting substance objects.

The quantum mode occurs when the gravitonic field environment of a group of substance objects (usually microparticles) located at a small distance from each other is a unified connected system with complex general properties. At short distances, the bonds between substance microparticles are much stronger, and the role of the gravitonic field medium as a carrier of interactions increases markedly. This means that for small distances between substance objects, it is necessary to switch from the model of separate graviton field shells to the model of a single graviton field medium.

Indeed, in a single graviton field medium, the motion of the field medium itself is of paramount importance. And all substance particles begin to move collectively under the influence of this environment. Such a model leads to the emergence of collective effects, the presence of selected stable states forming a discrete spectrum, as well as to a change in the properties of a system of substance particles by a sharp transition from one stable qualitative state to another, which is characteristic of quantum physics.

This is especially true for substance microparticles, which are much more affected by the gravitonic field environment compared to substance macroobjects. The gravitonic field environment in the quantum or wave mode becomes like a raging ocean, when all the ships lose the individuality of their movement and become puppets of the general storm waves.

In the bound state with a group of substance microparticles, the graviton field medium has a certain configuration of its energy density, in which each microparticle occupies its own place or has its own stationary orbit. This corresponds to the formation of a unified system in a stable quality condition. Therefore, it is possible to change the state of a single substance microparticle only under the influence of significant factors, and this change will be associated with the transition (jump) of the entire unified system to another qualitative stable state.

The quantum (or wave) mode is much more diverse and more complex than the classical one. It is necessary to calculate the dynamics of the field environment at all points of the considered area. The density function of the field medium in this case turns out to be very consonant with the wave function (psi-function) [7-9] or the probability density from quantum mechanics. This allows us to arrive naturally at discrete quantum effects for continuous fields and to approach a unified field theory [12].

In relation to the graviton field medium, the term "intensity" is used along with the term "density"(formula (2.1)). In the model of individual field shells (classical mode), the intensity corresponds to the function of the source of the gravitonic field (field-forming charge) and reflects the amount of the field medium that is inseparable connected with a given particle of substance. In other words, the intensity characterizes the magnitude and saturation of the field shell of a particle, and its classical analog is the charge (electric or gravitational).

In the model of a single field shell (quantum mode), the intensity value is a characteristic of the common field shell of interacting substance particles and corresponds in the classical representation to the product of charges (electric or gravitational) of interacting substance particles [6].

The concept of the gravitonic field as an intermediary in the transmission of interactions between substance objects arose as an alternative to the Newtonian mechanism of long-range action, i.e., direct, without any intermediate agent, interaction of substance objects at a distance.

According to the long-range hypothesis, the force between two substance objects, such as particles with electric and / or gravitational charges, occurs only in the presence of both particles. At the same time, the space between the particles is not assigned any role in the transmission of the interaction [8, 9].

It was the mathematical formalism of the long-range hypothesis, which requires the presence of both a field-forming charge and a field (test, investigated) charge, that led to the inconsistency of classical mechanics and electrodynamics at the turn of the XIX - XX centuries. Because of this discrepancy, we had to switch from the real Galilean transformations to the abstract Lorentz transformations and use the formal dependence of mass on velocity and other relativistic corrections [6].

In the framework of real physics, the concept of a gravitonic field implies that the very presence of a field-forming substance particle changes the energy (state) in the space around it.) the corresponding component (electromagnetic or gravivariational) of the existing gravitonic field [5], i.e. creates an energy density gradient (wave perturbation) of the field. The region of the gradient of the energy density of the gravitonic field has the potential ability to manifest the action of a force.

To do this, it is enough to place a second test substance object in this region, for example, a particle with an electric and/or gravitational test charge. The field (test) charge does not interact directly with the field - forming charge (field-forming particle) - the creator of the energy density gradient of the gravitonic field, but with the energy density gradient of the gravitonic field in the region where this test charge is located.

The gravitonic field plays the role of an intermediary: it transmits the action of one electric charge on another or one gravitational mass on another through a wave change in its energy density. Such a mechanism of interaction of substance objects is called short-range interaction [6, 7, 13].

When one substance particle moves in the medium of a gravitonic field, the force acting on it due to the change in the energy density of the field from the second substance particle changes. Therefore, its energy will also change, for example, decrease. Having shifted, the first electrically and/or gravitationally charged substance particle transmits to the corresponding component of the gravitonic field, as a signal about its displacement, the fraction of energy that it has lost.

Consequently, the energy density of the gravitonic field itself changes in the region where the first particle is located. This change in the energy density will begin to propagate along the field from point to point in the form of longitudinal gravivariational (gravitational) waves and transverse electromagnetic (electrovariational) waves [5]. After reaching the second substance particle after a certain time, the waves transfer energy from the first particle to it. From this moment on, the force acting on the second substance particle will begin to change.

Thus, according to real physics, the nature of the interaction of substance objects in the environment of a gravitonic field is that each of them perturbs the surrounding field environment-creates an energy density gradient. These perturbations from each substance object propagate in the field gravitonic medium as energy waves and reach other substance objects, distorting the energetically gravitonic medium around them-creating energy density gradients. These energy distortions (energy density gradients) of the field gravitonic medium in the vicinity of each object lead to a change in the nature of its motion, which is interpreted as the action of forces [6].

In the mechanism of interaction transmission based on the principle of short-range interaction, the gravitonic field is a physical reality, and during the entire time of delay of interaction (signal) transmission, it owns the share of energy already given by the first real particle, but not yet received by the second [3].

The principle of short-range interaction is formalized in real physics in the form of the wave equation of the gravitonic field [6]:

$$\partial^2 w_g/\partial t^2 = c^2 \cdot \Delta w_g = c^2 \cdot \nabla^2 w_g, \tag{2.6}$$

where $w_g = w_g(\mathbf{r}, t)$ is the energy density of the gravitonic field; Δ is the Laplace operator; ∇ is the symbolic nabla vector; c is the speed of light.

If the graviton field medium is inseparable connected with the moving substance field-forming charge $Q = Q(\mathbf{r}, t)$, then equation (2.6) is supplemented by the source function $U(\mathbf{r}, t)$ and takes the form [6]:

$$\Delta w_g - 1/c^2 \cdot \partial^2 w_g/\partial t^2 = -\mathrm{U}(\mathbf{r}, t). \qquad (2.7)$$

The source function is a term that describes the number of graviton field environment, which is an inseparable belongs to a given substance particle. From the expression (2.6), the ratio of the second derivatives of the energy density of the gravitonic field in time and in space is equal to the square of the speed of light, and from the comparison of equations (2.4) and (2.6) it follows:

$$(\partial^2 w_g/\partial t^2)/\Delta w_g = w_g/\rho_{\mathrm{g}} = c^2. \qquad (2.8)$$

The principle of conservation of energy, which is characteristic of the motion of discrete substance objects, in relation to the motion of continuous media was transformed into the principle of preserving the continuity of the medium [7, 8]. For a gravitonic field medium in terms of real physics, it has the following formulation [6]:

"The material graviton field environment, which determines all the interactions and movements of substance objects in our natural World, cannot be born out of nothing and disappear into nowhere, so the change in the density (energy density) of the graviton field environment in a certain region of space, associated with the movement of a substance object, can only occur due to its redistribution to neighboring regions".

In mathematical form, the principle of preserving the continuity of the field medium means that the energy density of the gravitonic field medium $w_g = w_g(\mathbf{r}, t)$ corresponds to the continuity equation [7-9]:

$$w_g/\partial t + \mathrm{div}(w_g \cdot \mathbf{v}) = \partial w_g/\partial t + \nabla \cdot (w_g \cdot \mathbf{v}) = 0, \qquad (2.9)$$

where ∇ is the symbolic nabla vector.

The gravity field flux density vector $\mathbf{j}_g$ is related to the velocity of the field-forming substance object $\mathbf{v}$ moving in the gravitonic field by the following relation [11]:

$$\mathbf{j}_g = \mathrm{d}\mathbf{J}_g/\mathrm{d}\sigma = w_g \cdot \mathbf{v}, \qquad (2.10)$$

where $\mathbf{J}_g$ - the flow of energy gravitonic field; σ - single area of the control surface; $w_g = W_g/V$ - energy density of the gravitonic medium; W_g - energy gravitonic environment volume V.

Taking into account the expression (2.10), the formula (2.9) can be rewritten as:

$$\partial w_g/\partial t + \mathrm{div}\mathbf{j}_g = 0, \qquad (2.11)$$

where div is a scalar linear differential divergence operator?

In the right-hand side of the continuity equation (2.9), zero is written, because energy is an indestructible quantity. Therefore, the divergence of the vector flux density of energy equal to the rate of change of the energy density of gravitonic environment with the opposite sign, i.e. energy (energy carriers, which serve graviton field quanta) can only be moved across borders some amount of gravitonic field to accumulate it or leave it.

Thus, according to real physics, if energy formations appear or disappear somewhere, it is only with equal and opposite directed energy values.

According to the rules for calculating the divergence [7], taking into account $\mathbf{v} = \text{const}$, equation (2.9) can be rewritten as:

$$\partial w_g/\partial t + \mathbf{v}\cdot\mathbf{grad}w_g = \partial w_g/\partial t + \mathbf{v}\cdot\nabla w_g = 0, \qquad (2.12)$$

where **grad** is vector linear gradient differential operator.

3. Derivation of the formulas of the classical mechanics of motion of substance objects using the concept of the gravitonic field.

According to expression (2.5), for the classical mode of motion and interaction of substance objects in a graviton field, the density function of the graviton field medium $w_g\,(\mathbf{r}, t)$ turns into the field coupling function of substance objects $W_g(R)$. This function depends only on their relative distance R and has in classical mechanics the meaning of the potential energy of interaction of substance objects in the gravitonic field W_{pg}.

Substituting W_{pg} instead of w_g in the wave equation (2.6), taking into account that $\partial^2 W_{pg}/\partial t^2 = 0$, we can obtain the equation $\Delta W_{pg} = 0$, which has the following general solution [6]:

$$W_{pg} = \text{const}/R. \qquad (3.1)$$

Expression (3.1) describes, in general, the potential field, and is applicable to both the electrostatic and gravistatic components of the graviton field [5].

In the framework of real physics, to obtain the equation of motion of substance objects in a gravitonic field (the field equation of motion), replacing w_g with W_{pg}, take the time derivative of the expression (2.9) and substitute it into the formula (2.6), then it is easy to get:

$$\partial^2 W_{pg}/\partial t^2 = \nabla\cdot[\partial(W_{pg}\cdot\mathbf{v})/\partial t] = c^2\cdot\nabla^2 W_{pg} = \nabla\cdot[(1/c^2)\partial(W_{pg}\cdot\mathbf{v})/\partial t - \nabla W_{pg}] = 0. \qquad (3.2)$$

The expression in square brackets is the rotor of a certain function, and the rotor in the potential field is always zero, since the potential field is vortex-free. Therefore, the field equation of motion, which defines the relation of the acceleration $\mathbf{a} = \mathrm{d}\mathbf{v}/\mathrm{d}t$ of the motion of the studied field (test) substance object in the gravitonic field environment of the field-forming substance object, in the classical mode of motion has the following form [6]:

$$(1/c^2) \cdot d(W_{pg} \cdot \mathbf{v})/\mathrm{d}t = \mathbf{grad}W_{pg} = \nabla W_{pg}, \qquad (3.3)$$

where c is the speed of light.

It is important to note that equation (3.3) is written in a coordinate system in which the origin of coordinates coincides with the position of the field-forming substance object, i.e. in the field system when the field source is stationary.

According to real physics, the values of mass and force do not appear explicitly in the field equation of motion, because these characteristics do not belong to a substance object, but are determined by the gravitonic field environment in its vicinity [6].

The field equation of motion (3.3) indicates that the change in the velocity of a field (test) substance object during interaction is determined by the function of its field connection with the field-forming substance object (the potential energy of interaction W_{pg}).

In order to get the expressions for mass and force in a graviton field that are familiar to the equation of motion of substance objects, multiply the right and left sides of equation (3.3) by -1 and enter the usual notation [6]:

$$\mathrm{d}[(-W_{pg}/c^2) \cdot \mathbf{v}]/\mathrm{d}t = -\mathbf{grad}W_{pg}. \qquad (3.4)$$

According to the definition [8, 9], the force F acting on any substance object from the side of the potential physical field is equal to the gradient of the potential energy of this field, taken with the opposite sign, i.e. the force in the gravitonic field is defined as:

$$\mathbf{F} = -\mathbf{grad}W_{pg}. \qquad (3.5)$$

Then the equation (3.4) can be written in the form:

$$\mathrm{d}[(-W_{pg}/c^2) \cdot \mathbf{v}]/\mathrm{d}t = \mathbf{F}, \qquad (3.6)$$

and comparing the expression (3.6) with the equation describing Newton's second law [9]:

$$\mathrm{d}\mathbf{p}/\mathrm{d}t = m \cdot \mathrm{d}\mathbf{v}/\mathrm{d}t = m \cdot \mathbf{a} = \mathbf{F}, \qquad (3.7)$$

where m is the inert mass of the substance object; $\mathbf{a} = \mathrm{d}\mathbf{v}/\mathrm{d}t$; $\mathbf{v}$ and $\mathbf{p}$ are the acceleration, velocity, and momentum of the substance object, respectively.

One can obtain a formula for the observed total inert mass m_{tot} of a substance object in a gravitonic field:

$$m_{tot} = -W_{pg}/c^2. \quad (3.8)$$

After substituting the expression for the total inert mass into the formula (3.6), the field equation of motion (3.3) takes on the well-known form of Newton's second law (3.7) [6]:

$$\mathrm{d}[m_{tot} \cdot \mathbf{v}]/\mathrm{d}t = \mathbf{F}. \quad (3.9)$$

Thus, in the framework of real physics, both the force and the mass of substance objects are determined by the dynamic characteristics of the gravitonic field. The force is determined by the change in the energy density of the gravitonic field medium in space, and the mass is determined by the change in the energy density of the gravitonic field medium in time.

The formula (3.9) is an illustration of the principle of double action, according to which the interaction in the medium of a gravitonic field, on the one hand, is associated with the action of a force on a substance object, and on the other - with a change in inertia (total inert mass) this object [6].

Thus, when a substance object moves in a gravitonic field with a changing potential energy, its inertia, characterized by the total inert mass, will also change [6].

The potential energy of the interaction of the gravitonic field W_{pg} with a substance object has the gravistatic (gravitational) W_g and electrostatic (electric) W_e components, determined by the product of the gravitational q_g and electric q_e charges of the object on the potentials of the gravitational φ_g and electric φ_e fields in the area of the object, i.e.:

$$W_g = q_g \cdot \varphi_{g,} \quad (3.10)$$

$$W_e = q_e \cdot \varphi_{\mathrm{e}}. \quad (3.11)$$

According to the provisions of real physics, in the general case for all substance objects on our Earth and with a high probability in the entire Solar System, the potential energy of interaction with the gravitonic field consists of two parts [6]:

- the global potential energy W_{gb}, created by the gravistatic (gravitational) field of all substance objects in the Universe;
- and the local potential energy W_{lc}, which is formed in the vicinity of the investigated (test, field) substance object due to local electric and gravistatic (gravitational) fields, i.e.:

$$W_{pg} = W_{gb} + W_{lc}. \quad (3.12)$$

Substituting the expression (3.12) into equation (3.4), it is easy to get the most general form of the equation of motion of a substance objects in our natural World:

$$\mathrm{d}[(-\{W_{gb} + W_{lc}/c^2) \cdot \mathbf{v}]/\mathrm{d}t = -\mathbf{grad}W_{gb} - \mathbf{grad}W_{lc}. \quad (3.13)$$

Important conclusions can be drawn from equation (3.13) [6]:

1. At a constant potential energy of interaction of substance objects $W_{pg}(\mathbf{r}) = W_{lc} + W_{gb} = \text{const}$, they acquire a constant mass characterized by their passive inertia, and their motion is determined only by the action of forces.

2. With a variable potential energy of interaction of substance objects $W_{pg}(\mathbf{r}) = \text{var}$, they acquire a mass that changes during their movement and characterizes their active inertia, which depends both on the action of forces and on the change in mass.

3. For an isolated substance object, the potential energy of interaction $W_{pg}(\mathbf{r}) \equiv 0$, i.e., the isolated substance object has no mass, and its equation of motion turns into the trivial identity $\mathbf{0} \equiv \mathbf{0}$. In other words, the movement of an isolated substance object is completely devoid of physical meaning. This means that completely isolated substance objects simply do not exist in our natural World.

In addition, it should be emphasized that the equation of motion (3.13) is written in the field system associated with the field-forming substance object. And since there are two field-forming sources that create global and local potential energy, they must rest relative to each other. The source of the local interaction must be stationary relative to the center of mass of the Universe, Galaxy, system of fixed stars, or, in some approximation, relative to the Earth.

As can be seen from equation (3.13), a substance object has two components of the observed total inert mass m_{tot}: the constant classical inert mass m, determined by the global potential:

$$m = -W_{gb}/c^2 \qquad (3.14)$$

and the variable local field mass m_f, determined by the local potential:

$$m_f = -W_{lc}/c^2, \qquad (3.15)$$

so

$$m_{tot} = -W_{pg}/c^2 = -W_{gb}/c^2 - W_{lc}/c^2 = m + m_f \qquad (3.16)$$

The global potential energy in our Solar System is usually much greater than the local potential energy [6], i.e.:

$$|W_{gb}| \gg |W_{lc}|, \qquad (3.17)$$

and its gradient is much smaller than the gradient of the local potential energy, i.e.:

$$|\mathbf{grad}W_{gb}| \ll |\mathbf{grad}W_{lc}|, \qquad (3.18)$$

or in other words, $W_{gb} \approx \text{const}$ within the Solar system.

Taking into account the conditions (3.17) and (3.18), equation (3.13) is modified into the field equation of motion of substance objects in classical mechanics [6]:

$$\mathrm{d}[(-W_{gb}/c^2)\cdot\mathbf{v}]/\mathrm{d}t = \mathrm{d}[m\cdot\mathbf{v}]/\mathrm{d}t = -\mathbf{grad}W_{lc} = \mathbf{F}, \quad (3.19)$$

for which all the masses are determined exclusively by the global interaction, and all the forces are exclusively local in nature.

For classical mechanics, under the conditions $W_{gb} = \mathrm{const}$ and the absence of local fields $W_{lc} = 0$, a substance object will move in a gravitonic field uniformly and rectilinearly in accordance with the equation of motion:

$$\mathrm{d}[(-W_{gb}/c^2)\cdot\mathbf{v}]/\mathrm{d}t = \mathrm{d}[m\cdot\mathbf{v}]/\mathrm{d}t = m\cdot\mathrm{d}\mathbf{v}/\mathrm{d}t = 0. \quad (3.20)$$

It can be seen from equation (3.20) that the Galilean principle of preserving the uniform and rectilinear motion of a substance object will be valid only if the global potential energy of the interaction $W_{gb} = \mathrm{const}$ is strictly constant. Otherwise, even in the absence of any external forces, when a substance object moves from a region of stronger potential energy to a region of weaker potential energy, or vice versa, its speed will change due to a change in the mass value associated with a change in the potential energy value [6].

As can be seen from the comparison of the formulas (3.14) and (3.15), the nature of the classical inert mass is dynamic, completely analogous to the nature of the local field mass, and consists in the fact that each substance object participates in a global interaction with the collective gravitonic (gravitational) field of the Universe, which makes the main contribution to its inertia [6].

The scale of the Earth and even the Solar System is very small compared to the scale of the Universe, so the global interaction potential φ_{gb} in the vicinity of the Earth can be considered constant with high accuracy. So, is constant and the potential energy of interaction of any substance object in the Solar system with the global field W_{gb}, i.e.:

$$W_{gb} = m_g\cdot\varphi_{gb} = \mathrm{const}, \quad (3.21)$$

where m_g is the gravitational mass of a substance object, which carries the meaning of its gravitational charge and is included in the formula of Newton's law of universal gravitation.

Therefore, although mass is dynamic in nature, it behaves as a constant in all phenomena on Earth. It creates the illusion that mass is an unchanging "innate" property of the substance object itself, and not the result of external influence. The masses of all the bodies (substance objects) on Earth would gradually change if the Solar System were moving towards the center of our Galaxy, or away from it.

Thus, the inert mass m of any substance object is determined by the potential energy W_{gb} of its interaction with the gravitonic field of the Universe, which, in turn, is the product of the gravitational mass m_g of the same object by the potential of the global field φ_{gb} in a given region of the Universe.

As a result, the inert mass of any substance object on the Earth is proportional to its gravitational mass (gravitational charge), i.e. [6]:

$$m = -W_{gb}/c^2 = -m_g \cdot \varphi_{gb}/c^2 = k \cdot m_g \qquad (3.22)$$

where k is the coefficient of proportionality between the two types of mass.

This is the nature of the "mass equivalence principle" observed in terrestrial conditions. For all real objects on the Earth, the appearance of equality of the inert and gravitational mass is created. This is due to the fact that the inert mass of such an object is determined by the interaction with the gravitational field of the Universe, and the magnitude of this interaction is determined by the gravitational mass of this object. As a result, there is proportionality between the two types of mass, which, with the proper choice of constants, can be converted into equality.

Thus, according to real physics, the equivalence of inert and gravitational mass is not a fundamental principle [6].

It should be noted that the introduction of any additional local interaction, such as an electric one, which adds a local field component to the classical inert mass of a substance object, destroys the equality and even proportionality between the two types of mass.

In other regions of the Universe, the potential of the global field φ_{gb} differs from its value characteristic of the Earth. Therefore, the ratio between the inert and gravitational mass types of the same substance object in other parts of the Galaxy is not the same as on Earth.

This means that the principle of mass equivalence is another local rule, unfairly elevated by official (academic) science to the rank of a fundamental principle [6].

4. Derivation of formulas for relativistic mechanics of motion of substance objects using the concept of the gravitonic field.

In the framework of real physics, the second modification of the field equation of motion of a graviton medium (3.13) is based on taking into account the local interaction potential W_{lc} in the mass value at a constant global potential $W_{gb} = \text{const}$ [6]:

$$\mathrm{d}[(-\{W_{lc}+W_{gb}\}/c^2)\cdot\mathbf{v}]/\mathrm{d}t=-\mathbf{grad}W_{lc}. \quad (4.1)$$

In this case, the substance object has two components of the observed total inert mass m_{tot}: the constant classical inert mass m, determined by the global potential, and the variable local field mass m_f, determined by the local potential (formulas (3.14) – (3.15)).

Therefore, in equation (4.1), the mass can no longer be taken out from under the sign of the derivative, and the equation takes the form [6]:

$$\mathrm{d}(m_{tot}\cdot\mathbf{v})/\mathrm{d}t=d[(m-W_{lc}/c^2)\cdot\mathbf{v}]/\mathrm{d}t=-\mathbf{grad}W_{lc}=\mathbf{F}, \quad (4.2)$$

that is, the force **F** no longer leads to a change in the velocity of a substance object, but to a change in its momentum.

If we expand the derivative of the product in equation (4.2), we can obtain the expression:

$$m_{tot}\cdot\mathrm{d}\mathbf{v}/\mathrm{d}t=-\nabla W_{lc}-\mathbf{v}\cdot\mathrm{d}m_{tot}/\mathrm{d}t=-\nabla W_{lc}+(1/c^2)\cdot\mathbf{v}\cdot\mathrm{d}W_{lc}/\mathrm{d}t, \quad (4.3)$$

where $\mathbf{F}=-\mathbf{grad}W_{lc}=-\nabla W_{lc}$ and ∇ is the symbolic nabla vector (formula (3.5)).

For the classical mode of interaction of substance objects in a gravitonic field, the potential energy of interaction depends only on the distance $\boldsymbol{R}$ between them (equation (2.5)). Therefore, the relation $\mathrm{d}W_{lc}/\mathrm{d}t=\mathbf{v}\cdot\nabla W_{lc}$ [9, 14] is fulfilled, taking into account which equation (4.3) takes the form [6]:

$$m_{tot}\cdot\mathrm{d}\mathbf{v}/\mathrm{d}t=\mathbf{F}-(1/c^2)\cdot\mathrm{v}\cdot(\mathbf{v}\cdot\mathbf{F})=\mathbf{F}\cdot(1-\mathrm{v}^2/c^2)+(1/c^2)\cdot\mathbf{v}\times(\mathbf{F}\times\mathbf{v}), \quad (4.4)$$

where $\times$ is the sign of the vector product.

Equation (4.4) is the field equation of motion of substance objects in a graviton field environment for the **relativistic case** when their velocity approaches the speed of light in magnitude, i.e. $\mathrm{v}\rightarrow c$.

Thus, the presence of a variable additive to the mass of a substance object, determined by the local interaction potential, leads to corrections to the force having the order v^2/c^2. If the force is parallel to the velocity $\mathbf{F}\parallel\mathbf{v}$**,** then it changes the latter in magnitude, and equation (4.4) turns into the expression:

$$m_{tot}\cdot\mathrm{d}\mathbf{v}/\mathrm{d}t=\mathbf{F}\cdot(1-\mathrm{v}^2/c^2) \quad (4.5)$$

that is, there is an effect of reducing the force or increasing the inertia of a substance object:

$$[m_{tot}/(1-\mathrm{v}^2/c^2)]\cdot\mathrm{d}\mathbf{v}/\mathrm{d}t=\mathbf{F}. \quad (4.6)$$

If the force is perpendicular to the velocity $\mathbf{F}\perp\mathbf{v}$, and changes only its direction, and not the absolute value, then the equation of motion takes the usual classical form:

$$m_{tot}\cdot\mathrm{d}\mathbf{v}/\mathrm{d}t=\mathbf{F}. \quad (4.7)$$

The relativistic dependence of mass on velocity leads to exactly the same expressions as those obtained in formulas (4.6) and (4.7). Indeed, if instead of the formula for the field mass, we introduce a formal relativistic dependence [9]:

$$m_{tot}(\mathrm{v}) = m_0/(1 - \mathrm{v}^2/c^2)^{1/2}, \tag{4.8}$$

where m_0 is the rest mass, then by differentiating the expression $\mathrm{d}[m_{tot}(\mathrm{v}) \cdot \mathbf{v}]/\mathrm{d}t$ it is easy to obtain for $\mathbf{F} \parallel \mathbf{v}$ and for $\mathbf{F} \perp \mathbf{v}$ expressions similar to formulas (4.6) and (4.7), respectively.

Consequently, the field equation of motion, taking into account the variable addition to the mass (4.4), is completely equivalent to the relativistic equation of motion with a velocity-dependent mass [9]:

$$\mathrm{d}[m_0 \cdot \mathbf{v}/(1 - \mathrm{v}^2/c^2)^{1/2}]/dt = \mathbf{F}. \tag{4.9}$$

Thus, it is proved that **relativistic physics** is a consequence of **real physics**, i.e. the physics of motion and interaction of substance objects in the energetic material environment of the gravitonic field. At the same time, all the calculations performed were carried out exclusively within the framework of Euclidean geometry, and did not require the introduction of space contraction, time dilation, or their unification into space-time. And the special theory of relativity (SRT) is a mathematical formalism introduced in physics by A. Einstein, after he removed from it the concept of "ether" or the gravitonic field in terms of this work [6].

The rest mass of a substance particle m_0 plays an important role in the special theory of relativity (SRT) and, according to equation (3.16), consists of two parts:

- the classical inert mass m, determined by the global potential energy of the interaction W_{gb} and constant under terrestrial conditions;

- and an additional local field mass m_{ad}, determined by the local potential energy of the interaction W_{lc} at the point where the particle velocity v is zero.

This additional local field mass m_{ad} is also constant, since it is only the value of the local field mass m_f at one of the points in the trajectory of the substance particle with $\mathrm{v} = 0$, i.e.:

$$m_0 = m + m_{ad} = m - W_{lc}/c^2 \,\Big|_{\mathrm{v}=0} \tag{4.10}$$

Therefore, the rest mass of the substance particle m_0, in contrast to the classical mass m, although constant for a single motion, depends on the value of the potential energy of the local field W_{lc} at the rest point of the particle $\mathrm{v} = 0$, corresponding to this particular motion.

The dependence of the rest mass of a substance particle on the potential energy of the local field W_{lc} at one of the points of its trajectory with $\mathrm{v} = 0$ is extremely important, because it means that the same substance particle under different physical conditions (at different values of W_{lc}) will have a different rest mass.

At low values of W_{lc}, the field additive in the rest mass of the substance particle is negligible, but the stronger the fields in which the substance particle motion is studied, the higher the rest mass will result in a relativistic calculation [6].

Indeed, in the absence of local external fields $(W_{lc} = 0)$, the rest mass of the electron m_{0e} is determined only by the potential energy of the global interaction (W_{gb}) and is equal to the classical inert mass m, given in all reference books. But if an electron is born and begins its movement in the region of a very strong local field, as a result of the calculation according to relativistic formulas, its rest mass will be much larger than the classical one.

The application of the formulas of classical relativistic mechanics (SRT) to the calculation of the experimental results leads to the fact that under different conditions the same substance particle has a different rest mass. As a result, instead of one substance particle, whole groups of them appear, differing only in the magnitude of the rest mass and the lifetime.

For example, mesons are born at particle accelerators with a local field energy of hundreds of MeV, which is two orders of magnitude higher than the energy of 0.511 MeV, which causes the rest mass of an ordinary electron m_{e0} [9]. As a result, the rest masses of the mesons are also hundreds of times greater than the rest mass of the electron.

Thus, according to real physics, the rest mass does not characterize the substance particle itself, but only the initial conditions of motion in which this particle participates at a given moment, and, therefore, cannot serve as an unambiguous identifier of the observed particles. This requires a serious revision of the entire system of currently known elementary particles [6].

It should be noted that testing the conclusion of **real physics** about the dependence of the rest mass of a substance particle on the potential energy of the local field at the rest point of its trajectory requires much simpler and cheaper experiments than those conducted at the Large Hadron Collider. Indeed, it is only necessary to register the resulting substance particles at different values of the electric field potential in the registration region during the interaction reaction of identical particles [15].

The expression (4.10) allows us to clearly and simply understand the mass defect effect – an experimentally established phenomenon, which consists in the fact that the mass of the decaying nucleus is always less than the total mass of the decay products, and in this phenomenon an energy is released equal to the mass difference (defect) multiplied by the square of the speed of light [8, 9].

If we consider the mass of the nucleus as a whole, it is determined exclusively by external fields and, above all, by the global interaction. When the mass of each individual nucleon is determined during the decay of the nucleus, it increases due to the internal interactions of the nucleons.

The value of this additional mass m_{ad} can be determined by the formula for the second term in expression (4.10), in which the local potential energy of interaction W_{lc} is replaced by the potential energy of interaction (binding) of nucleons in the nucleus W_{nuc}, i.e.:

$$m_{ad} = -W_{nuc}/c^2. \qquad (4.11)$$

In the process of nuclear decay, the potential binding energy W_{nuc} is converted into the kinetic energy of the decay products W_k in accordance with the law of conservation of energy $W_k = -W_{nuc}$. That is why there is a well-known connection between the mass defect m_{ad} caused by local fields inside the nucleus and the energy of the nuclear decay reaction W_k [9]:

$$W_k = -W_{nuc} = m_{ad} \cdot c^2. \qquad (4.12)$$

Equation (4.12) creates the illusion that part of the mass of substance has been converted into energy. But what actually happens is the following.

The interaction between substance objects (bodies, particles) determines a certain amount of inertia for each of them. However, this inertia manifests itself only when these objects move relative to each other. If we consider the movement of these objects as a single system, then everything changes.

In the framework of real physics, the total mass of a system of substance objects will be determined only by external interactions for this system. And all internal interactions do not affect the mass of a substance object in any way [6], which is always a system (composite) material (energy-informational) formation.

Indeed, the property of mass is associated with the presence of changes in the medium of the gravitonic field, with which each substance object is connected through its inseparable field shell. If a substance object moves as a whole, then its field shell remains on average unchanged, although it may experience fluctuations. In other words, the movement of a substance object as a whole (as a system) neutralizes the contribution to its mass of all internal (within the system) interactions.

If a substance object begins to disintegrate into its component parts, then with the relative movement of its parts, additional inertia will begin to manifest itself, associated with internal interactions between them. The components of any stable substance object are connected by internal forces of attraction. These forces cause an additional positive mass to all the constituent parts of this substance object.

Thus, according to **real physics**, the mass of any substance object as a whole will always be less than the algebraic sum of the masses of its constituent parts due to the additional inertia caused by internal interactions. This additional inertia is called the internal or latent mass [6].

The example given in [16] can serve as a clear confirmation of this position, which is the cornerstone of the **level approach**, in addition to the mass defect effect observed during the decay of nuclei.

If the whole solid (substance system) of a volume divided into many separate substance particles, each of which has a small enough volume, the sum of the volumes of this set of substance particles will be less than the volume of the initial whole body, but the density and weight of separate small particles will increase. The volume of a single particle of substance is less than the fraction of the volume that falls on the same particle when it is part of a whole solid, i.e., a volume defect occurs.

The contraction of a substance particle, the decrease in its volume, and the increase in its density and mass is due to the energy of the system's decay (the energy released when the parts of a solid body connected by internal forces of attraction break apart).

In modern official physics, there is a scientific position that as a result of the annihilation phenomenon, a substance particle and an antiparticle destroy each other, and their entire mass is converted into energy. However, according to **real physics**, in the process of annihilation, two substance particles with opposite properties form a bound state (a new system, a new object), in which their interaction with the surrounding external substance World is compensated.

As a result, this pair ceases to interact with external substance objects, and, consequently, loses all inertia that could be caused by external fields for each particle separately. And their interaction with each other is internal and also does not create any total inertia. It is clear that it becomes practically impossible to register such a new object, so the illusion is created that as a result of annihilation, the particles simply disappear. Certain external influences, such as intense fluctuations in the gravitonic field medium, known as gamma quanta (γ-quanta), can again break this pair, which is interpreted as the "birth" of particles [6].

5. Derivation of formulas for energy, momentum, angular momentum, and force in

a gravitonic field for the classical and relativistic cases.

In classical physics, when moving substance objects (systems), the laws of conservation of their energy, momentum, and angular momentum are fulfilled, i.e. these quantities are integrals of the equation of motion in general form. Moreover, the law of conservation of energy determines the uniformity of time, and the laws of conservation of momentum and angular momentum determine the uniformity and isotropy of space, respectively [8, 9].

One of the integrals of the equation of motion of a substance object in a gravitonic field, which determines its energy, is quite simple to obtain. It is necessary to multiply the field equation of motion (3.3) by the velocity $\mathbf{v}$, taking into account the equality $\mathbf{v}\cdot\mathbf{grad}W_{pg} = \mathrm{d}W_{pg}/\mathrm{d}t$:

$$(\mathbf{v}/c^2)\cdot\mathrm{d}(W_{pg}\cdot\mathbf{v})/\mathrm{d}t = \mathbf{v}\cdot\mathbf{grad}W_{pg} = \mathrm{d}W_{pg}/\mathrm{d}t, \qquad (5.1)$$

and integrate the resulting expression (5.1). This expression can be written as a complete differential [14]:

$$\mathrm{d}[W_{pg}\cdot(1-\mathrm{v}^2/c^2)^{1/2}]/\mathrm{d}t = 0. \qquad (5.2)$$

Therefore, in the process of motion of any substance object in the gravitonic field, the value in square brackets in the formula (5.2) remains constant, which should be defined as its total energy or simply the energy W [6]:

$$W = W_{pg}\cdot(1-\mathrm{v}^2/c^2)^{\frac{1}{2}} = \mathrm{const.} \qquad (5.3)$$

From the analysis of expression (5.3), it can be seen that in **real physics**, the energy W of a substance object in a graviton field is proportional to the potential energy of interaction of substance object in a graviton field W_{pg} or, in the general case, the field coupling function of substance object $w_g\,(\mathbf{r},t)$ (formula (2.5)).

The energy of a substance object in a gravitonic field cannot be divided into kinetic energy (energy of motion) and potential energy (energy of interaction), because the mass of a substance object depends on the value W_{pg}. In the absence of interactions $W_{pg} = 0$, the total energy of the substance object is identically equal to zero, i.e. $W \equiv 0$. This once again confirms the conclusion that there are no isolated substance objects in our natural World.

In addition, it follows from formula (5.3) that in the field medium of a gravitonic field, the speed of relative motion of substance objects cannot exceed the speed of propagation of transverse perturbations of the medium itself in the form of electromagnetic waves, i.e., the speed of light

c. Moreover, the rest point $\mathrm{v} = 0$ corresponds to the minimum absolute value of the potential energy of the interaction W_{pg}.

An increase in the velocity of a substance object leads to a decrease in the value of the root expression in formula (5.3), and to preserve the value of the energy W, an increase in the absolute value of the potential interaction energy W_{pg} is required. In the field of infinite function values W_{pg} substance object can accelerate to the speed limit c, whereas in the domain of small modulo values of the function W_{pg}, smaller module constants of the energy W, the movement of the substance object may never occur, because of (5.3) it follows that $\mathrm{v} = \mathrm{c} \cdot (1 - W^2/W_{pg}^2)^{1/2}$ [6].

Taking into account the formula (3.12), the expression (5.3) can be written as:

$$W = \left(W_{gb} + W_{lc}\right) \cdot \; (1 - \mathrm{v}^2/c^2)^{\frac{1}{2}} = \mathrm{const}, \tag{5.4}$$

where W_{gb} and W_{lc} are, respectively, the global and local potential energies of the interaction of a substance object with a gravitonic field.

For classical mechanics $W_{gb} = \mathrm{const}$, $W_{gb} \gg W_{lc}$ and $\mathrm{v} \ll \mathrm{c}$, so the following decomposition of the radical $(1 - \mathrm{v}^2/c^2)^{1/2} \approx 1 - \mathrm{v}^2/2c^2$, then the expression (5.4) can be written as:

$$W \approx \left(W_{gb} + W_{lc}\right) \cdot (1 - \mathrm{v}^2/2c^2) = W_{gb} + W_{lc} - [(W_{gb} + W_{lc}) \cdot \mathrm{v}^2]/2c^2. \tag{5.5}$$

Introducing for a substance object the classical inert mass $m = -W_{gb}/c^2 \approx -(W_{gb} + W_{lc})/c^2$, as well as some classical energy W_{cl}, which, given that $W_{gb} = \mathrm{const}$, simply shifts the energy level by a constant value:

$$W_{cl} = W - W_{gb} = \mathrm{const} \tag{5.6}$$

from the formula (5.5), it is easy to get the expression [6]:

$$W_{cl} = (m \cdot \mathrm{v}^2)/2 + W_{lc} = \mathrm{const}. \tag{5.7}$$

The separation of energy into kinetic and potential became possible due to the fact that in the classical approximation, the mass of substance objects are due to the global interaction, and the forces are due to local fields. Expression (5.7) also shows that the introduced field coupling function W_{lc} really coincides with the classical concept of potential energy.

For relativistic mechanics, due to the fact that the velocities of substance objects become sufficiently large, it is impossible to decompose the radical $(1 - \mathrm{v}^2/c^2)^{1/2}$ in a series, but it is necessary to introduce some auxiliary quantity, called the rest mass m_0, of the substance object and defined by the expression (4.10). Then equation (5.4) can be rewritten in the form [6]:

$$W = (W_{gb} + W_{lc}) \cdot (1 - v^2/c^2)^{1/2} = -m_0 \cdot c^2 = \text{const} \quad (5.8)$$

or

$$[m_0 \cdot c^2/(1 - v^2/c^2)^{\frac{1}{2}}] + W_{lc} = -W_{gb} = \text{const.} \quad (5.9)$$

By introducing the relativistic energy W_{rl}, as well as extracting the kinetic energy by adding to both parts of equation (5.9) the value $-m_0 \cdot c^2$, we can obtain:

$$W_{rl} = W - W_{gb} = [m_0 \cdot c^2/(1 - v^2/c^2)^{1/2}] - m_0 \cdot c^2 + W_{lc}\ . \quad (5.10)$$

For relativistic mechanics taking into account equation (4.8), the kinetic energy W_{rlk} is determined by the formula:

$$W_{rlk} = [m_0 \cdot c^2/(1 - v^2/c^2)^{\frac{1}{2}}] - m_0 \cdot c^2 = m_{tot}(v) \cdot c^2 - m_0 \cdot c^2, \quad (5.11)$$

which at $v \ll c$ becomes an expression for the kinetic energy in the classical approximation:

$$W_{clk} = m_0 \cdot v^2/2. \quad (5.12)$$

The expression for the momentum **p** of a substance object in a gravitonic field environment directly follows from the field equation of motion (3.6) [6]:

$$\mathrm{d}\mathbf{p}/\mathrm{d}t = \mathrm{d}[(-W_{pg}/c^2) \cdot \mathbf{v}]/\mathrm{d}t = \mathbf{F}, \quad (5.13)$$

$$\mathbf{p} = -W_{pg} \cdot \mathbf{v}/c^2 = -(W_{gb} + W_{lc}) \cdot \mathbf{v}/c^2. \quad (5.14)$$

Like energy, the momentum of a substance object characterizes its motion in a gravitonic field, and its physical meaning is that the action of forces on a substance object leads to a change in its momentum. If there are no forces acting on a substance object at all, or the action of all forces is compensated, then the momentum of the substance object is preserved.

For the **classical mechanics** $W_{gb} = \text{const}$, $W_{gb} \gg W_{lc}$ и $v \ll c$, and from (5.14) it is easy to get the familiar expression for the momentum of a substance object $\mathbf{p}_{cl}$:

$$\mathbf{p}_{cl} = m \cdot \mathbf{v}. \quad (5.15)$$

In the **relativistic mechanics**, the value of the momentum of the substance object $\mathbf{p}_{rl}$ will be, according to the formulas (5.9) and (4.8), equal to:

$$\mathbf{p}_{rl} = [m_0 \cdot c^2/(1 - v^2/c^2)^{1/2}] \cdot (\mathbf{v}/c^2) = m_0 \cdot \mathbf{v}/(1 - v^2/c^2)^{1/2} = m_{tot}(v) \cdot \mathbf{v}. \quad (5.16)$$

From expressions (5.3) and (5.14), it is easy to obtain in relativistic mechanics the relationship between the energy and momentum of a substance object in a gravitonic field [6]:

$$W^2 = W_{pg}^2 \cdot (1 - v^2/c^2) = W_{pg}^2 \cdot (1 - p^2 \cdot c^2/W_{pg}^2) = W_{pg}^2 - p^2 \cdot c^2 \quad (5.17)$$

or

$$W^2 + \mathrm{p}^2 \cdot c^2 = W_{pg}^2. \quad (5.18)$$

The expression (5.18) is an analog of the relativistic connection in the special theory of relativity (SRT) [9], which is determined by the equations [17, 18]:

$$W^2 - \mathrm{p}^2 \cdot c^2 = m^2 \cdot c^4, \quad (5.19)$$

$$\mathbf{p} = \mathbf{v} \cdot W / c^2. \quad (5.20)$$

But in equations (5.19) – (5.20), according to official (academic) science, the rest mass of a substance object m_0 is considered to be the equivalent of the classical inert mass m [18].

And this, as follows from **real physics**, which describes the theory of motion of substance objects in a gravitonic field, is not so at all, so we should rewrite the expression (5.19) taking into account the rest mass:

$$W^2 = \mathrm{p}^2 \cdot c^2 + m_0^2 \cdot c^4. \quad (5.21)$$

The comparison of expressions (5.18) and (5.21) clearly shows the difference between the real field and abstract relativistic approaches to the concept of energy. In real physics, based on the gravitonic field, the total energy of a substance object W is a constant that characterizes its motion, which, according to the formula (5.8), can be expressed in terms of the mass of the object at rest $W = -m_0 \cdot c^2 = \mathrm{const}$. Therefore, the total energy in the field coupling equation (5.18) actually corresponds to the term $m_0^2 \cdot c^4$ in the relativistic equation (5.21).

In the special theory of relativity (SRT), the use of the value $m_{tot}(\mathrm{v}) \cdot c^2$ (formula (5.11)) leads to the substitution of two concepts of energy. The kinetic energy of motion begins to be interpreted as the total energy, which increases with the speed of movement of a substance object. In this case, the potential energy, which should compensate for the change in kinetic energy and make the total energy unchanged, generally falls out of sight. This substitution of concepts led to the fact that in SRT, the total energy of a moving substance object turned from a constant that characterizes the movement into a measure of the energy content of the substance object itself [6].

In real physics, according to the formula (5.3), the mass property of a substance object is a consequence of the existence of a gravitonic field medium and is determined by the potential energy that characterizes this medium. In SRT, from the relation $W_0 = m_0 \cdot c^2$, it follows that the presence of a certain mass m_0 means the existence of a certain energy W_0.

Thus, there is a basis for replacing mass with energy, and energy with mass, and there is no obvious physical mechanism behind this relationship that causes such a connection. And the logical emptiness just serves as a reason for completely ridiculous interpretations of this relation. For example, the possibility of any energy, even if it is not associated with substance objects, to match a certain mass [6].

In order to obtain the last integral of the equation of motion of a substance object in a gravitonic field – the angular momentum, it is necessary to perform a vector multiplication of the field equation of motion (3.3) by the distance **R** between the interacting substance objects:

$$\mathbf{R} \times \mathrm{d}(W_{pg} \cdot \mathbf{v}/c^2)/\mathrm{d}t = \mathbf{R} \times \mathrm{grad}W_{pg}, \quad (5.22)$$

where × is the sign of the vector product.

The right-hand side of equation (5.22) is zero, because the potential energy in the gravitonic field has the form $W_{pg} = \mathrm{const}/R$ (formula (3.1)), and the gradient of this value is co-directed with the vector **R**. The left-hand side of equation (5.22) can be transformed using the product derivative formula [14]:

$$\mathbf{R} \times \mathrm{d}(W_{pg} \cdot \mathbf{v}/c^2)/\mathrm{d}t = \mathrm{d}\,(W_{pg} \cdot \mathbf{R} \times \mathbf{v}/c^2)/\mathrm{d}t - \mathrm{d}\mathbf{R}/\mathrm{d}t \times (W_{pg} \cdot \mathbf{v}/c^2) = 0. \quad (5.23)$$

The second term in equation (5.23) is zero, because $\mathrm{d}\mathbf{R}/\mathrm{d}t = \mathbf{v}$. As a result, during the movement of substance objects in the gravitonic field, a constant value remains, which is called the angular momentum and is determined by the expression:

$$\mathbf{M} = -(W_{pg} \cdot \mathbf{R} \times \mathbf{v})/c^2 = -[(W_{gb} + W_{lc}) \cdot \mathbf{R} \times \mathbf{v}]/c^2 = \mathbf{R} \times \mathbf{p} = \mathrm{const} \quad (5.24)$$

If we assume that $W_{pg} = k/R$, where $k = \mathrm{const}$, then the law of conservation of angular momentum in the medium of the gravitonic field takes the form:

$$\mathbf{M} = -(k \cdot \mathbf{R} \times \mathbf{v})/R \cdot c^2) = -(k/c^2) \cdot \mathbf{e}_R \times \mathbf{v} = -(k/c^2) \cdot \mathrm{v}_\tau = \mathrm{const}\ , \quad (5.25)$$

where $\mathbf{e}_R$ is the unit vector in the direction **R**; v_τ is the tangential component of the velocity of the substance object.

Thus, **in real physics**, the law of conservation of angular momentum in the motion of substance objects in a gravitonic field is transformed into the law of conservation of the rotational velocity v_τ of a substance object [6].

For **classical mechanics**, $W_{gb} = \mathrm{const}$, $W_{gb} \gg W_{lc}$ and $\mathrm{v} \ll \mathrm{c}$, and from (5.24) it is easy to get a familiar expression for the angular momentum of a substance object $\mathbf{M}_{cl}$:

$$\mathbf{M}_{cl} = m \cdot \mathbf{R} \times \mathbf{v} = \mathbf{R} \times \mathbf{p}_{cl}. \quad (5.26)$$

In **relativistic mechanics**, the value of the angular momentum $\mathbf{M}_{rl}$ will, according to formulas (5.9) and (4.8), be equal to:

$$\mathbf{M}_{rl} = [m_0/(1 - \mathrm{v}^2/c^2)^{\frac{1}{2}}] \cdot \mathbf{R} \times \mathbf{v} = m_{tot}(\mathrm{v}) \cdot \mathbf{R} \times \mathbf{v} = \mathbf{R} \times \mathbf{p}_{rl}. \quad (5.27)$$

From formulas (3.5) and (3.7) it is possible to express the force $\mathbf{F}$ acting on any substance object from the gravitonic field, not only through the potential energy gradient of the gravitonic field W_{pg}, but also through the momentum flux $\mathbf{p}_g$ of the gravitonic field:

$$\mathbf{F} = -\mathbf{grad}W_{pg} = -\nabla W_{pg} = \mathrm{d}\mathbf{p}_g/\mathrm{d}t. \quad (5.28)$$

In [19], it is proved that the equations (5.28) are valid for any substance objects of our natural World, regardless of the reference systems and coordinate representations. In this case, the plus sign before the gradient symbol reflects the internal force acting from the side of the substance object on the environment of the gravitonic field, and the minus sign is characteristic of the equivalent external force acting from the side of the gravitonic field on the substance object. Equation (5.28) generalizes Newton's second law (expressions (3.7)), applicable to abstract material points, to real substance objects characterized by continuous spatially distributed physical parameters.

From equations (2.10), (3.3), and (5.28) , we can obtain a formula that relates the energy flow of the gravitonic field $\mathbf{J}_g$ in the selected volume of a substance object to the energy gradient of the gravitonic field in this volume $\mathbf{grad}W_{pg}$:

$$\mathrm{d}(W_{pg} \cdot \mathbf{v})/\mathrm{d}t = \mathrm{d}\mathbf{J}_g/\mathrm{d}t = -c^2 \cdot \mathbf{grad}W_{pg}. \quad (5.29)$$

Equations (5.28) and (5.29) are governed by an arbitrarily allocated volume of any substance object of our natural World (any physical system), containing energy of any forms and types. The energy flux density of the gravitonic field (the energy carriers are the quanta of the gravitonic field – gravitons [3]) in the unit volume of a substance object is directed in the direction opposite to the gradient of its density.

6. Conclusion.

In the framework of real physics, based on the concept of the existence of a gravitonic field in our natural World, all the basic formulas of non-relativistic and relativistic mechanics of substance objects are obtained without the use of Lorentz transformations and special relativity theory.

It is proved that both the force and the mass do not belong to substance objects, but are determined by the dynamic characteristics of the gravitonic field. The force is determined by the change in the energy density of the graviton field medium in space, and the mass is determined by the change in the energy density of the graviton field medium in time.

It is shown that the equivalence of the inert and gravitational mass is not a fundamental principle, since the introduction of any additional local interaction, for example, an electric one, which adds a local field component to the classical inert mass of a real object, destroys equality and even proportionality between the masses.

It is revealed that the rest mass does not characterize the substance particle itself, but only the initial conditions of motion in which the particle participates at the moment, and, therefore, cannot serve as an unambiguous identifier of the observed particles. This requires a serious revision of the entire system of currently known elementary particles.

It is shown that any force in our natural world is caused by the presence of the energy gradient of the gravitational field in the substance object under consideration. In the absence of external influences, a free substance object can be at rest or move uniformly and rectilinearly only when the energy gradient in its entire volume is zero. Any external force acting on a substance object is characterized by its corresponding energy gradient inside this object.

Thus, an arbitrary substance object, both free and under the influence of an external force, moving with acceleration, has in its volume the energy gradient of the gravitonic field corresponding to this acceleration.

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To the problem on vacuum structure

Annotation

It is proposed such vacuum structure that follows **only** from solutions of Maxwell's equations, i.e. any additional suppositions are not allowed. Casimir's effect is explained on the framework of the proposed vacuum structure.

Contents

1. Introduction
2. Typification of waves-AND-particles
3. Vacuum structure
4. Casimir's effect
References

1. Introduction

The vacuum structure is studied by quantum field theory, which does not tire of presenting it as very complex structure. Indeed, this theory does not offer anything consistent with the concepts of classical physics to describe the structure of a vacuum.

It is offered below some structure that follows **only** from a solution of Maxwell's equations without any extra propositions.

In Section 2, it will be proved (as a solution of Maxwell's equations) that it can exist a wave-AND-particle (WAP) representing a cubic volume of a vacuum, in which a volumetric standing wave pulses. It is important to state that this volume has neither physical boundaries nor the boundaries formed by some environmental inhomogeneity. The WAP does not radiate across the faces of the cube but on each edge there is some electric field strength, the vector of which is directed perpendicular to this face.

The values of energy, frequency, and strength at the faces of the cube are some functions only of the size of the cube. There exists obviously the smallest volume of the cube that can be determined by minimum of energy quantum.

Many these WAPs can occupy the space entirely, without gaps. Namely such structure is described below. Such structure is actually met in nature [4]: the square waves at the sea surface are shown in Figures A and B. However, let's treat the structure and properties of the WAPs at first.

Fig. A.

Fig. B.

2. Typification of waves-and-particles

So, in [1] it is proposed a model of wave-AND-particle (WAP) that will be applied here. For the reader convenience, let's introduce below a concise description of this model.

The strengths of both the electric and magnetic fields found as solutions of Maxwell's equation can be written in the following forms:

$$E_x(x, y, z, t) = e_x \cos(\alpha x)\sin(\alpha y)\sin(\alpha z)\sin(\omega t), \quad (1)$$
$$E_y(x, y, z, t) = e_y \sin(\alpha x)\cos(\alpha y)\sin(\alpha z)\sin(\omega t), \quad (2)$$
$$E_z(x, y, z, t) = e_z \sin(\alpha x)\sin(\alpha y)\cos(\alpha z)\sin(\omega t), \quad (3)$$
$$H_x(x, y, z, t) = h_x \sin(\alpha x)\cos(\alpha y)\cos(\alpha z)\cos(\omega t), \quad (4)$$
$$H_y(x, y, z, t) = h_y \cos(\alpha x)\sin(\alpha y)\cos(\alpha z)\cos(\omega t), \quad (5)$$
$$H_z(x, y, z, t) = h_z \cos(\alpha x)\cos(\alpha y)\sin(\alpha z)\cos(\omega t), \quad (6)$$

where $e_x, e_y, e_z, h_x, h_y, h_z$ are the constant amplitudes of the functions, α, ω are some constants. These amplitudes are coupled by the following equations:

$$h_z = 0, \quad (7)$$
$$h_y = -h_x, \quad (8)$$
$$h_x = -\frac{\varepsilon\omega}{\alpha} e_x, \quad (9)$$
$$e_y = e_x, \quad (10)$$
$$e_z = -2e_x \quad (11)$$

And they can be determined for <u>a fixed value of the parameter e_x</u>. Also, the angular frequency is

$$\omega = c\alpha\sqrt{4.5}. \quad (12)$$

These equations describe a volumetric standing wave that exists inside the cubic volume with the following edge length:

$$L = \pi/\alpha. \quad (13)$$

For this wave, the density of electromagnetic energy is

$$\boldsymbol{W = \varepsilon E^2 + \mu H^2}. \quad (14)$$

Also, the following condition must be fulfilled for this wave:

$$U = \varepsilon \left|E^2\right| = \mu \left|H^2\right|. \quad (15)$$

The total electromagnetic energy of the wave in the cube is

$$\boldsymbol{W_o = U \cdot L^3}. \quad (16)$$

Note that this energy **does not change in time**.

The coordinate components of the density of energy flow can be written down as follows:

$$S = \begin{bmatrix} S_x \\ S_y \\ S_z \end{bmatrix} = \begin{bmatrix} E_y H_z - E_z H_y \\ E_z H_x - E_x H_z \\ E_x H_y - E_y H_x \end{bmatrix}. \tag{17}$$

Let's treat the following expression:

$$\begin{bmatrix} E_y \cancel{H_z} - E_z \cancel{H_y} \\ \cancel{E_z} \cancel{H_x} - E_x \cancel{H_z} \\ E_x \cancel{H_y} - E_y \cancel{H_x} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \tag{17a}$$

We note that

$$\cos(\alpha x) = \cos\left(\alpha \frac{L}{2}\right) = \cos\left(\alpha \frac{\pi}{2\alpha}\right) = 0. \tag{17b}$$

Therefore, the strength components, for which the cosine of a certain coordinate occurs in the definition of functions (1)-(6) on the face perpendicular to this coordinate, are equal to zero. As a result, formula (17a) contains crossed out components of the electric and magnetic fields' strengths that depend on cosine of the corresponding coordinate. It is clearly seen that the components in (17a) are equal to zero. Therefore, the following condition is fulfilled on all faces of the cube:

$$\begin{bmatrix} E_y H_z - E_z H_y \\ E_z H_x - E_x H_z \\ E_x H_y - E_y H_x \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \tag{18}$$

This means that **the cube does not radiate energy**.

On each face of the cube there is such magnetic field strength, the vector of which is perpendicular to this face. For instance, vector (4) located on the face perpendicular to the *x*-axis (see also formula (13)) is equal to

$$H_x \equiv \sin(\alpha x) = \sin\left(\alpha \frac{L}{2}\right) = \sin\left(\alpha \frac{\pi}{2\alpha}\right) = 1, \tag{19}$$

So, the energy flow does not come out of this face. However, there is a magnetic field strength perpendicular to this face. A similar conclusion can be made about the other faces of the cube.

Figure 1 shows the magnetic field strengths outgoing from the faces of the cube. It is important to note that in this case the strength H_z is absent due to condition (7) but shown in Figure 1. For the faces located at the negative values of the coordinates, the strengths are directed towards the negative values because there is $\sin(\alpha x)$=-1.

The energy flow does not come out of the face perpendicular to the *x*-axis. However, the flow circulates along this face because the components S_y and S_z of the flow density do not equal to zero on this face. For instance, $S_y = E_z H_x - E_x H_z$ in (17). Here there are $H_z = 0$,

$E_z \neq 0$, $H_x \neq 0$ in (19). Therefore, $S_y \neq 0$. In this face similar to the whole volume there is an energy with density U that does not change in time. Therefore, on this face and moreover **on all faces there continuously exists some pressure** equal to the density U.

The above-considered type of WAP can be designated as **WAP-1**.

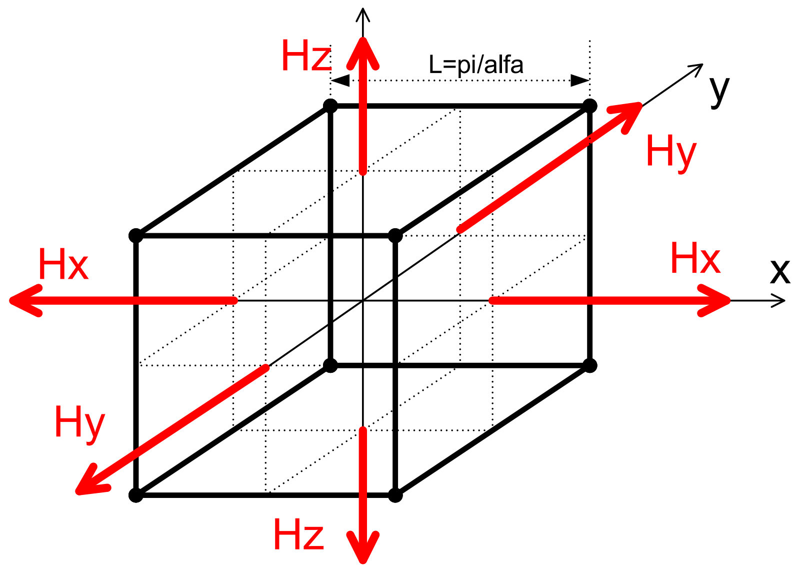

Fig. 1.

Using an analogy to the results obtained in [1], it is natural to treat another solution for Maxwell's equations. This solution is differed by the way that the following form of solution instead of solution (7)-(11) is used:

$$e_z = 0. \tag{28}$$

$$e_y = -e_x, \tag{29}$$

$$e_x = -\frac{\mu\omega}{\alpha} h_x, \tag{30}$$

$$h_y = h_x, \tag{31}$$

$$h_z = -2h_x. \tag{32}$$

Similar to the previous case, conditions (18) are also fulfilled on all faces of the cube, i.e. **the cube does not emit energy**. On each face of the cube there is a magnetic field strength, the vector of which is perpendicular to this face. The difference is that the strength H_z is also present, since condition (32) is fulfilled in this case.

Similar to the WAP-1 and WAP-2, it is possible to consider two other solutions of Maxwell's equations. The peculiarity of these two solutions is that the following components of the magnetic and electric field strengths are exploited instead of components (1)-(6):

$$H_x(x,y,z,t) = h_x\cos(\alpha x)\sin(\alpha y)\sin(\alpha z)\sin(\omega t), \quad (41)$$
$$H_y(x,y,z,t) = h_y\sin(\alpha x)\cos(\alpha y)\sin(\alpha z)\sin(\omega t), \quad (42)$$
$$H_z(x,y,z,t) = h_z\sin(\alpha x)\sin(\alpha y)\cos(\alpha z)\sin(\omega t), \quad (43)$$
$$E_x(x,y,z,t) = e_x\sin(\alpha x)\cos(\alpha y)\cos(\alpha z)\cos(\omega t), \quad (44)$$
$$E_y(x,y,z,t) = e_y\cos(\alpha x)\sin(\alpha y)\cos(\alpha z)\cos(\omega t), \quad (55)$$
$$E_z(x,y,z,t) = e_z\cos(\alpha x)\cos(\alpha y)\sin(\alpha z)\cos(\omega t), \quad (46)$$

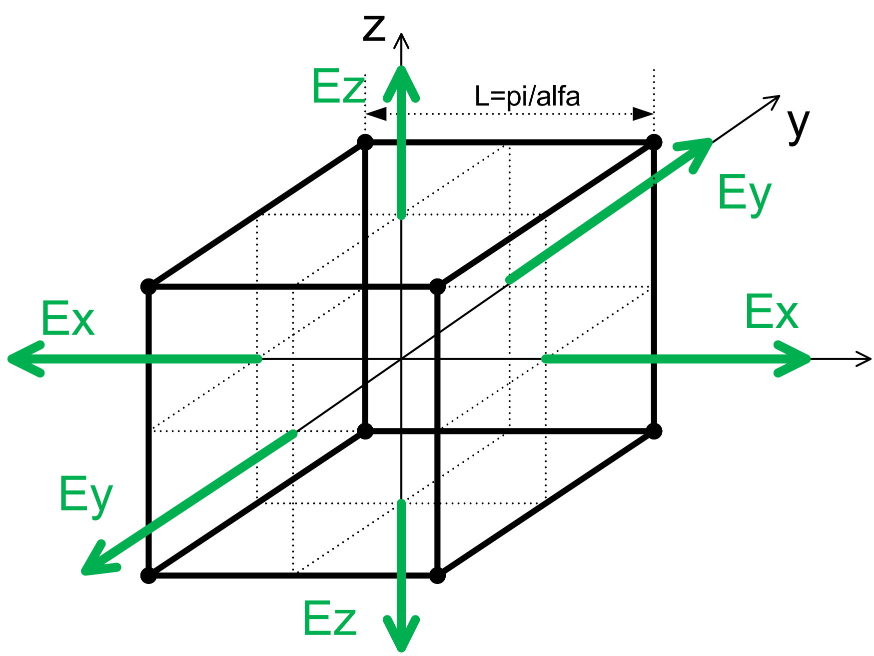

Fig. 2.

It is easy to see that new solutions can be obtained from the old ones by replacing the notations E and e with the notations H and h, and Vice versa. The fundamental difference will be that the electric field strengths will appear instead of magnetic field strengths coming out of the cube perpendicular to the faces. This is shown in Figure 2.

To draw Figure 1, the following assumptions were used: at some initial moment of time, the phases of sine-functions of time defined by expressions (1), (2), and (3) were equal to zero but the ones defined by (4), (5), and (6) were maximum. Figure 1 shows the direction of the vectors of the magnetic field strengths namely for this moment of time. Such WAP can be called the WAP with a phase of $\varphi = 0$. Let's assume that this corresponds to the initial value of $e_x > 0$.

The results graphically shown in Figure 2 were obtained in the assumption that at some initial moment of time, the phases of sine-functions of time defined by expressions (1), (2), and (3) were maximal but the ones defined by (4), (5), and (6) were equal to zero. Figure 2 shows the direction of the vectors of the electric field strengths namely for this moment of time. Such WAP can be called the WAP with a phase of $\varphi = \pi/2$. This corresponds to the initial value of $h_x > 0$.

Extra four variants of WAPs can be obtained by using the values of $e_x < 0$ and $h_x < 0$ at the same moment of time. In this case, the vectors of the strengths must be directed inside the face but not outside the face of the cube.

Table 1 lists all the variants of the WAPs.

Table 1

WAP	Formulas for E and H	Initial data	Formulas for e and h	Figure	Strengths
1	(1)-(6)	$h_z = 0$ $e_x > 0$ $\varphi = 0$	(7)-(11)	Fig. 1	$H_z = 0$ $H_{x,y} > 0$
	Asymmetric WAP. The H-vectors are directed outside the cube				
2	(1)-(6)	$e_z = 0$ $h_x > 0$ $\varphi = \pi/2$	(28)-(32)	Fig. 1	$H_{x,y,z} > 0$
	Symmetric WAP. The H-vectors are directed outside the cube				
3	(41)-(46)	$e_z = 0$ $h_x > 0$ $\varphi = \pi/2$	(7)-(11)	Fig. 2	$E_z = 0$ $E_{x,y} > 0$
	Asymmetric WAP. The E-vectors are directed outside the cube				
4	(41)-(46)	$h_z = 0$ $e_x > 0$ $\varphi = 0$	(28)-(32)	Fig. 2	$E_{x,y,z} > 0$
	Symmetric WAP. The E-vectors are directed outside the cube				
5	(1)-(6)	$h_z = 0$ $e_x < 0$ $\varphi = \pi/2$	(7)-(11)	Fig. 1	$H_z = 0$ $H_{x,y} < 0$
	Asymmetric WAP. The H-vectors are directed inside the cube				

6	(1)-(6)	$e_z = 0$ $h_x < 0$ $\varphi = 0$	(28)-(32)	Fig. 1	$H_{x,y,z} < 0$
	Symmetric WAP. The H-vectors are directed inside the cube				
7	(41)-(46)	$e_z = 0$ $h_x < 0$ $\varphi = 0$	(7)-(11)	Fig. 2	$E_z = 0$ $E_{x,y} < 0$
	Asymmetric WAP. The E-vectors are directed inside the cube				
8	(41)-(46)	$h_z = 0$ $e_x < 0$ $\varphi = \pi/2$	(28)-(32)	Fig. 2	$E_{x,y,z} < 0$
	Symmetric WAP. The E-vectors are directed inside the cube				

3. Vacuum structure

Let's consider now a set of WAPs. The cubic form of WAP allows us to assume that a set of WAPs forms a continues volume. This is shown in Figure 3. For this case, a WAP with a phase of $\varphi = 0$ and a WAP with $\varphi = \pi/2$ must alternate in all directions of space.

Different combinations of WAPs are also possible.

A space can exist that is filled with WAPs creating only magnetic field strengths on the faces or only electric field strengths on the faces.

A space can also exist that is filled with only symmetric WAPs or only asymmetric WAPs. In the latter case, there should be a space direction in which there is no any strength in any direction. Such a vacuum must somehow exhibit anisotropic properties.

We can assume that nature uses all the variants and there are heterogeneous spaces.

Thus, each WAP remains autonomous but together they form a continuous volume of a vacuum.

It can be assumed that all the WAPs have the same volume and then there is a single vacuum frequency. It can also be assumed that there are different areas of space with different (but common for certain area) volume of WAPs. Then these regions must have different frequencies of a vacuum.

Some face of WAP may be on the border of an empty area of space. Then there will be strength on the border of this area, namely the strength that is present on the specified border of WAP. This strength is the certain strength that forms the standing wave, see notes after formula (11). Thus, the strength on the cubic face of some WAP generates a standing wave in an empty space and thus creates a new WAP. In this way, **WAPs multiply**, filling the entire vacuum. We can assume that the universe originated from a single WAP.

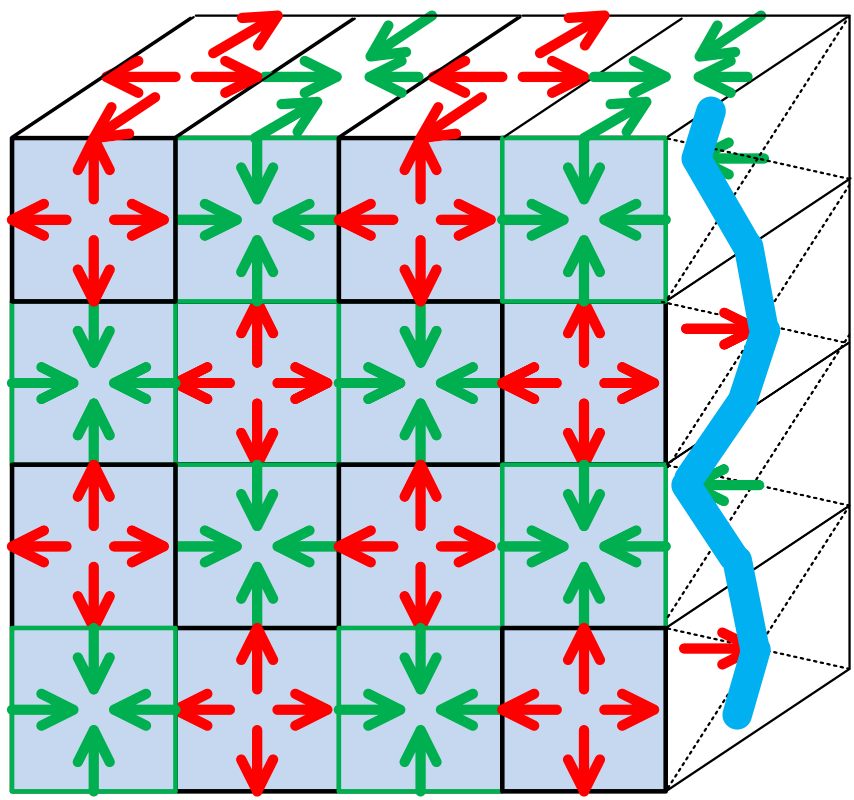

Fig. 3.

4. Casimir's effect

Consider the right-side lateral surface of the vacuum fragment in Figure 3. Assume that this surface is the boundary of the WAP region. On the open surfaces of the WAPs, at the center of the surfaces there are shown the field strengths' vectors entering and exiting these surfaces. The thick line wrapping around the ends of these vectors conventionally depicts a wave of strengths on the open surfaces. These strengths change sinusoidally over time. Thus, there is a standing wave of the strengths on the surface of the border of the WAP region.

It is very important to state that on the open surfaces of the WAPs there continuously exists some the pressure U mentioned above. If a body is adjacent to these surfaces, it must experience this pressure. Thus, a body in a vacuum filled with WAPs experiences a vacuum pressure from all sides. Each area of WAP also creates pressure on the neighboring area. Therefore, WAP seeks to fill internal voids. Following Torricelli, it can be argued that "a vacuum does not tolerate emptiness".

The pressure gradient in a continuous array of WAPs is determined by the following formula:

$$g = \frac{2U}{L}, \tag{47}$$

where U, L are the pressure on the faces of the cube and the length of the cubic face, respectively, defined in [1]. As a result, some change in the pressure at certain distance A in a vacuum is

$$\Delta p_o = g \cdot A. \tag{48}$$

Taking this into account, we will place two parallel mirror surfaces at a small distance from each other. They can start move closer to each other by the pressure of an infinite number of WAPs outside the plates and move apart by negligible pressure (2) of internal WAPs. And therefore, the pressure of external WAPs should bring the mirrors closer together.

The reader has already grasped that what has been said is the proposed explanation of the Casimir effect, namely there is an attraction of two parallel mirror surfaces located at short distances in a vacuum.

In the existing model of a vacuum [2], Casimir's effect is caused by "*some energetic oscillations of physical vacuum due to continuous creation and annihilation of virtual particles in it…. This happens due to the fact that only standing waves can exist in the space between the plates, the amplitude of which is equal to zero on the plates. As a result, the pressure of virtual photons from the inside on two surfaces is less than the pressure on them from the outside, where the birth of photons is unlimited.*" In addition, the explanation of this effect recognizes the existence of negative energy [3].

These references are given in order to note the obvious contradiction between the proposed theory (PT) and existing theory (ET).

In the proposed theory, it is proved that there is a volumetric standing wave with certain strengths at the nodes. In the existing theory, it is stated that the amplitude of the strengths at the nodes (on the plates) is equal to zero (it can be proved that the law of conservation of energy does not hold.)

The proposed theory proves that the real particles fill a vacuum, and the existing theory assumes the existence of virtual particles, the birth of which is not limited and the disappearance of which is inexplicable.

In the proposed theory, it is proved that there is a constant vacuum pressure on bodies. In the existing theory, it is assumed that such pressure is created by waves of virtual particles that constantly arise and disappear.

In the existing theory, the existence of negative energy is proved, and in the proposed theory, respect for the law of conservation of energy is preserved.

The reader is asked to choose what the reader likes best.

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Series: **PHYSICS**

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On the nature of electric charge and static electric field

Annotation

First, it is shown that in the capacitor, which is included in the DC circuit, there is there is a flow of electromagnetic energy, which continues to circulate even after disconnecting from the DC voltage source, and even when the metal plates are removed. Taking this fact into account, further, by analogy with the wave-AND-particle (WAP), the field-AND-particle (FAP) is described, which can be an electric charge or a holder of a static field.

Contents

1. Introduction
2. Mathematical model of charge
3. The structure of the static electric field
4. The appearance of a static electric field
5. Coulomb's law
References

1. Introduction

In [1] it is shown that in the capacitor included in the DC circuit there are both an **electromagnetic** field and flows of electromagnetic energy. It was also shown theoretically in [1] and experimentally in [2] that the flow of electromagnetic energy continues to circulate even after disconnecting from the DC voltage source. It remains even when the metal plates are removed, i.e. energy is stored in the capacitor-dielectrics even in the absence of charges. The energy contained in the capacitor (as potential energy) represents electromagnetic energy stored in the capacitor in the form of a stationary flow.

In [3], the wave-and-particle (WAP) is described as an alternative to the wave-particle in quantum mechanics, in contrast to which the WAP exhibits the properties of both waves and particles simultaneously (and not alternately, depending on the conditions interpreted in quantum mechanics). In [3], it is assumed that real elementary particles are WAP. WAP itself is a standing electromagnetic wave in the volume of a cube, which has no physical boundaries but retains its shape, volume, energy, mass, and momentum.

In particular, a photon is a WAP. An alternating electromagnetic field is carried by photons. For a static field, no real carrier particles (or "holders") of this field were found. In quantum mechanics, a virtual photon serves these purposes.

However, if we want to "close all questions" with real particles, then it is necessary to find (except for WAP) the holder of the static field. In addition, WAP cannot be an electrical charge because an alternating electromagnetic wave pulsates in it. Both of these functions are performed by the "construction" described below. This turns out to be possible if we take into account the fact noted above such as the existence of a stationary flow of electromagnetic energy in a capacitor disconnected from the voltage source.

2. Mathematical model of charge

Consider a cube-shaped capacitor and a solution to the **static** Maxwell equations similar to that proposed in [3] for other purposes. So, the strengths of the electric and magnetic fields found as a solution to Maxwell's equations have the following forms:

$$H_x(x,y,z,t) = h_x\cos(\alpha x)\sin(\alpha y)\sin(\alpha z), \tag{1}$$
$$H_y(x,y,z,t) = h_y\sin(\alpha x)\cos(\alpha y)\sin(\alpha z), \tag{2}$$
$$H_z(x,y,z,t) = h_z\sin(\alpha x)\sin(\alpha y)\cos(\alpha z), \tag{3}$$
$$E_x(x,y,z,t) = e_x\sin(\alpha x)\cos(\alpha y)\cos(\alpha z), \tag{4}$$
$$E_y(x,y,z,t) = e_y\cos(\alpha x)\sin(\alpha y)\cos(\alpha z), \tag{5}$$
$$E_z(x,y,z,t) = e_z\cos(\alpha x)\cos(\alpha y)\sin(\alpha z), \tag{6}$$

where $e_x, e_y, e_z, h_x, h_y, h_z$ are the constant amplitudes of the functions, α is some constant. The amplitudes are related by equations of the following forms:

$$h_z = 0, \tag{7}$$
$$h_y = -h_x, \tag{8}$$
$$h_x = -\frac{\varepsilon\omega}{\alpha} e_x, \tag{9}$$
$$e_y = e_x, \tag{10}$$
$$e_z = -2e_x \tag{11}$$

and can be determined for a fixed value of e_x. These equations describe a static field that exists in the volume of a cube whose edge has the following length:

$$L = \pi/\alpha. \tag{13}$$

The density of the electromagnetic energy of this wave is defined by

$$W = \varepsilon E^2 + \mu H^2. \tag{14}$$

Moreover, in this wave there is the following condition:

$$U = \varepsilon \left|E^2\right| = \mu \left|H^2\right|. \tag{15}$$

The total electromagnetic field energy in a cube is

$$W_o = U \cdot L^3. \tag{16}$$

The energy flux densities written by the corresponding coordinates' components are determined by the following formula:

$$S = \begin{bmatrix} S_x \\ S_y \\ S_z \end{bmatrix} = \begin{bmatrix} E_y H_z - E_z H_y \\ E_z H_x - E_x H_z \\ E_x H_y - E_y H_x \end{bmatrix}. \tag{17}$$

Consider the following formula:

$$\begin{bmatrix} \cancel{E_y} H_z - \cancel{E_z} H_y \\ \cancel{E_z} H_x - \cancel{E_x} H_z \\ \cancel{E_x} H_y - \cancel{E_y} H_x \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} \tag{17a}$$

Notice that

$$\cos(\alpha x) = \cos\left(\alpha \frac{L}{2}\right) = \cos\left(\alpha \frac{\pi}{2\alpha}\right) = 0. \tag{17b}$$

Consequently, the strengths are vanish, which in the definition of functions (1)-(6) are cosine-dependent of some coordinate, on the face perpendicular to this coordinate. In formula (17a), those strengths are crossed out which depend on the cosine of the corresponding coordinate. It can be seen that the components in this formula are equal to zero. Therefore, the following conditions can be used on all faces of the cube:

$$\begin{bmatrix} E_y H_z - E_z H_y \\ E_z H_x - E_x H_z \\ E_x H_y - E_y H_x \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \tag{18}$$

i.e. **the cube does not emit energy**.

On each face of the cube there is an electrical field strength, the vector of which is perpendicular to this face. For instance, on a face perpendicular to the *x*-axis, vector (4) takes the value of

$$E_x \equiv \sin(\alpha x) = \sin\left(\alpha \frac{L}{2}\right) = \sin\left(\alpha \frac{\pi}{2\alpha}\right) = 1, \tag{19}$$

See also formula (13). So, the flow of energy does not leave this face but there is an electrical field strength perpendicular to this face. A similar conclusion can be made regarding the rest of the cube faces.

Figure 1 shows the electric field strengths coming out of the cube faces. On the faces with a negative sign, the strength coordinates are directed in the negative numbers' direction because $\sin(\alpha x)$=-1.

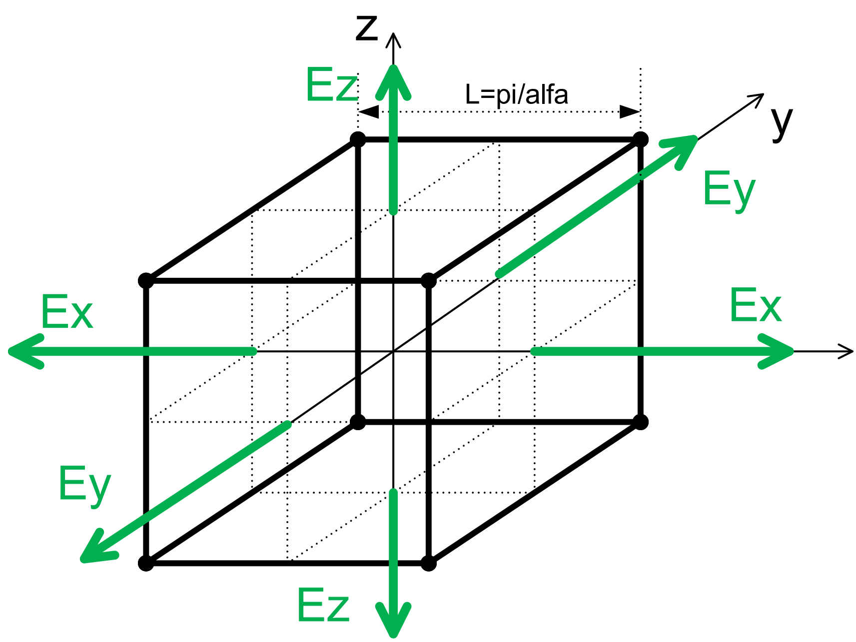

Fig. 1.

Let's take a look at figure 1. In front of us there is a cubic charge, on ALL faces of which there are electric field strengths of the same sign. Consequently, an electric charge is stored in a given cubic volume of an electromagnetic field. This charge can have any sign. If the vectors of electrical field strengths are directed outside the cube, then the charge has a positive sign. If they are directed inside the cube, then the charge has a negative sign.

Such a charge has much in common with the wave-AND-particle (WAP). It does not have any boundaries such as physical or formed by the inhomogeneity of the environment. It also has energy, an internal flow of electromagnetic energy (not going outside) as well as both momentum and mass as a consequence of the existence of this flow. Both the amount of energy and the strength of the external field are functions of the size of the cube only. In turn, the size of the charge is determined by both the size of the cube and the strength on the edges of the cube. Apparently, there is the smallest volume of the cube that can be determined by both the minimum energy quantum and the minimum charge. In what follows, we will call it the field-AND-particle (FAP). Let's find the following average electrical field strength on the surface of the FAP from (10) and (11), taking into account the uneven distribution of the strength along the face:

$$E \approx \left(e_y + e_x + e_z\right)/3 \approx e_x. \tag{20}$$

To determine the FAP charge, we represent it approximately as a ball with a diameter defined by expression (13) and use the following formula for the strength on the surface of the ball charge:

$$E = \frac{q}{4\pi\varepsilon_o r^2} \tag{21}$$

or, taking into account formulae (20) and (13) and the fact that $r = L/2$, the charge can be expressed as follows:

$$q = 4\pi\varepsilon_o \left(\frac{\pi}{2\alpha}\right)^2 E = \pi^3\varepsilon_o e_x/\alpha^2. \tag{22}$$

3. The structure of the static electric field

FAP can be a part of particles. It can be assumed that the composition of the electron and proton includes the FAP.

However, the FAP can exist independently. A space filled with a multitude of FAPs, like a multitude of scattered electric charges, forms a static electric field. These FAP charges repel each other. What prevents them from scattering into infinity? Here we must remember that the FAP is a mass. The masses are attracted. Consequently, there is such a boundary of the electric field, where, for a given density of the FAP, the forces of their electrical repulsion and gravitational attraction are equal.

An extraneous electric charge caught in such an electric field will be pushed out by the field charges in one direction or another, depending on the sign of the field and the sign of the extraneous charge.

A foreign charge is a particle larger than the FAP field. When the signs of the field and the charge coincide, the charge is repelled from the set of FAPs and moves towards the weakened field.

When the signs of the field and the charge are opposite, the charge moves towards the enhanced field. At the same time, it is "pulled away" from those FAP charges, with which it has joined forces of attraction of opposite charges, towards a denser arrangement of FAP charges.

When moving through a field of charges that resists this movement, an extraneous charge, of course, changes mutual position of FAP but then the field charges return to their equilibrium state representing the state, in which the FAPs are distributed like repulsive electric charges. Therefore, it can be argued that the potential energy of an extraneous charge is the additional energy of an electric field, distorted by the presence of an extraneous charge and tending to pass into a normal state.

4. The appearance of a static electric field

As indicated, an alternating electromagnetic field is carried by photons, and no particles have been found for a static field. These particles can be called "holders" of this field. And this, it would seem, does not create problems. But in the general picture of electromagnetic fields, the absence of such particles violates the perfection of this picture. The FAP completes this picture.

It is clear that the static field appears when the disturbance of the alternating electromagnetic field stops. The tie of electromagnetic-field-to-the-electromagnetic-wave "freezes". In this state, it should turn into a standing wave, and the photons should turn into a resting particle. However, we first observe only an electric field or only a magnetic field and second, we do not see any particles. In addition, an electromagnetic wave cannot "freeze" in its entire volume at once and turn into a standing wave of a gigantic volume.

The FAP is perhaps what a photon turns into when a wave turns into a field. The process of transformation of an alternating electromagnetic field into a static field, as well as the process of disappearance of a static field, is not considered (simply because the author has nothing to say on this topic).

One can imagine such a picture. The charge moves and at the same time the photon dust scatters from it (“from under the wheels”) that flies at the speed of light as long as the charge moves. And then it settles where it flew and turns into motionless dust. Each photon (WAP) turns into a stationary FAP. For this, in the WAP cube, the electromagnetic wave must stop pulsing in time and "freeze" in a certain position. However, in this position, the energy flux, constant in magnitude, continues to move along a closed trajectory.

5. Coulomb's law

In our interpretation, an electrostatic field is a set of electric charges of the same name distributed in space by forces of mutual repulsion in accordance with Coulomb's law.

If the density of the distribution of charges of the FAP is known, then the distribution of the strength of the electric field created by these

FAP can be found. The inverse problem such as the determination of the density of the FAP distribution with a known distribution of the electric field strength can also be solved. Therefore, it can be argued that the natural distribution density of the FAP corresponds to the natural distribution of the electric field strength, i.e. it is determined by Coulomb's law.

Obviously, the interaction of charge 1 with charge 2 is equivalent to the interaction of charge 1 with the electric field of charge 2. Therefore, the field created by a set of FAPs under the influence of charge 2 is a medium that creates the Coulomb forces acting on charge 1. In other words, **an electric field, like the set of FAPs is the environment that implements the Coulomb law**.

This means that all interactions (including those discussed above) between electric charges are performed by a set of FAPs. Explaining these interactions does NOT need to involve the concept of long-range action.

It should be noted in this connection that the gravitational interaction is similar to the Coulomb interaction and a similar explanation can be found for it.

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Series: **PHYSICS**

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Theoretical substantiation of the Meissner effect

Annotation

It is shown on the basis of the analysis of the experiment [2] that the Meissner effect requires an explanation not only of the fact of repulsion but also of the attraction of a magnet and a superconductor. It is proved on the basis of resolving Maxwell's equations (without additional assumptions) that the field of a permanent magnet creates in a superconductor a direct current, the structure of which is a solenoid. This solenoid interacts with the magnet in such a way that the superconductor at a certain distance from the magnet finds a stable position in which the planes of the end face of the magnet and the superconductor coincide.

Contents

1. Introduction
2. Conductive disc next to the magnet
3. Appendix: constant electric current structure
References

1. Introduction

The Meissner effect, *by definition*, is that the magnetic field is completely displaced from the volume of the superconductor [1]. It is generally accepted that this effect serves as experimental proof that there is a fundamental difference between the internal structures of a superconductor and an ordinary conductor. Further, it will be proved that this effect is a consequence of high electric currents, and not the specificity of the material.

First of all, consider a great experiment [2]. A superconducting disk hangs over a flat ring of magnets and moves along this ring, as if along rails, if the experimenter pushes it slightly. This is shown in Figure 1. The superconductive disc also hangs under the ring of magnets, and is also held next to the tilted magnet at any angle of inclination of this magnet. This is shown in Figure 2. It is quite obvious that neither repulsion nor attraction between the disk and the magnet can explain this experiment. The concept of magnetic expulsion does not help to find an explanation. The effect exists but the generally accepted definition of this effect was contrived for a contrived explanation. This is what is called result fitting.

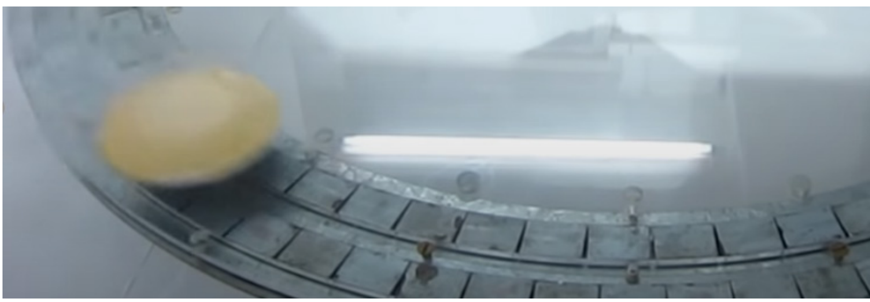

Fig. 1.

Fig. 2.

Thus, the Meissner effect should be defined as *the position of a conductor next to a magnet without any touch between them, stable and independent of the orientation of the magnet and the relative velocity of movement of the conductor*.

This means that <u>not only the fact of repulsion but also the fact of attraction between the magnet and the conductor needs to be explained</u>. Gravitational force cannot be an explanation for the attraction of the conductor from below and from the side. Therefore, further we will neglect the force of gravity.

2. Conductive disc next to the magnet

The following section proves that in a conducting disk under the action of a **constant** external magnetic field

- there is a **constant** electric current,
- this constant electric current in the cylindrical coordinates propagates along the radius, along the circumference, and along the axis of the disk,
- the current arises despite the fact that the disc is not a closed conductor along both the radius and the axis,
- streamlines have a spiral structure,
- around the circumference, the current can rotate in one direction or another, or not at all.

Thus, we can say that a conducting disk in the field of a permanent magnet is a solenoid. This solenoid interacts with the magnet, i.e. the magnet creates the solenoid that interacts with this magnet.

Ring electric currents generated in the disk create an axial magnetic field strength directed against the magnetic field strength of the magnet and therefore, the disk is repelled from the magnet. This is consistent with Lenz's rule. As the distance between the disk and the magnet increases, the external strength acting on the disk decreases and the magnitude of the currents decreases. First of all, the magnitude of the ring currents decreases and the force of repulsion of the disk from the magnet decreases. At some point, the ring currents become equal to zero. If the disc continues to move away from the magnet, then the ring currents reappear but directed in the opposite direction, and the disc is attracted to the magnet. Thus, the position of the disc at the point of zero ring current is stable.

So, in the disk contains a solenoid with a current. Each element of the conductor with a current is affected by the Lorentz force as the result of the vector product of the current element and the induction of the magnet.

The horizontal projections of the Lorentz forces are summed up. The reader can be convinced that the sum of these forces becomes equal to zero when these forces are located symmetrically relative to the solenoid axis. This position is created when the axis of the solenoid coincides with the axis of the magnet. Consequently, **the Lorentz forces position the solenoid so that its axis coincides with the axis of the magnet.**

From the above it follows that a solenoid with a current arising under the action of a magnetic field is located at a certain distance from the magnet, and its axis coincides with the axis of the magnet. Thus, a conductor located next to a permanent magnet can exhibit the Meissner effect. This effect will be the greater, the lower the resistance of the conductor. Not surprisingly, this effect has been discovered in experiments with superconductors. However, this effect is NOT a consequence of superconductivity.

3. Appendix: constant electric current structure

In Chapter 5 of Ref. [1], it is shown that in a constant electric current wire the distribution of both the current densities J and the magnetic strengths H is described by Maxwell's equations, which in this case have the following form:

$$\mathrm{rot}(H) = 0, \quad (1)$$
$$\mathrm{div}(H) = 0. \quad (2)$$
$$\mathrm{rot}(J) = 0, \quad (3)$$
$$\mathrm{div}(J) = 0, \quad (4)$$

In our modeling, we will use the cylindrical coordinates r, ϕ, z. Then these equations will take the following forms:

$$\frac{H_r}{r} + \frac{\partial H_r}{\partial r} + \frac{1}{r} \cdot \frac{\partial H_\phi}{\partial \phi} + \frac{\partial H_z}{\partial z} = 0, \quad (5)$$
$$\frac{1}{r} \cdot \frac{\partial H_z}{\partial \phi} - \frac{\partial H_\phi}{\partial z} = J_r, \quad (6)$$
$$\frac{\partial H_r}{\partial z} - \frac{\partial H_z}{\partial r} = J_\phi, \quad (7)$$
$$\frac{H_\phi}{r} + \frac{\partial H_\phi}{\partial r} - \frac{1}{r} \cdot \frac{\partial H_r}{\partial \phi} = J_z, \quad (8)$$
$$\frac{J_r}{r} + \frac{\partial J_r}{\partial r} + \frac{1}{r} \cdot \frac{\partial J_\phi}{\partial \phi} + \frac{\partial J_z}{\partial z} = 0, \quad (9)$$
$$\frac{1}{r} \cdot \frac{\partial J_z}{\partial \phi} - \frac{\partial J_\phi}{\partial z} = 0, \quad (10)$$
$$\frac{\partial J_r}{\partial z} - \frac{\partial J_z}{\partial r} = 0, \quad (11)$$
$$\frac{J_\phi}{r} + \frac{\partial J_\phi}{\partial r} - \frac{1}{r} \cdot \frac{\partial J_r}{\partial \phi} = 0. \quad (12)$$

The solution to this set of equations is:

$$H_r = h_r(r)\sin(\alpha\varphi + \chi z), \quad (13)$$
$$H_\varphi = h_\varphi(r)\cos(\alpha\varphi + \chi z), \quad (14)$$
$$H_z = h_z(r)\sin(\alpha\varphi + \chi z), \quad (15)$$
$$J_r = j_r(r)\cos(\alpha\varphi + \chi z), \quad (16)$$
$$J_\varphi = j_\varphi(r)\sin(\alpha\varphi + \chi z), \quad (17)$$
$$J_z = j_z(r)\cos(\alpha\varphi + \chi z), \quad (18)$$

where α, χ are some constants, $h(r)$, $j(r)$ are some functions of the coordinate r. These functions are defined by the following equations:

$$h_z''(r) + h_z'(r) - h_z(r)\left(\frac{\alpha^2}{r^2} + \chi^2\right) = 0, \qquad (19)$$

$$h_\varphi(r) = -\frac{\alpha}{\chi}\left(\frac{h_z(r)}{r} + j_r(r)\right), \qquad (20)$$

$$h_r(r) = -\frac{1}{\chi}\left(h_z'(r) + j_\varphi(r)\right), \qquad (21)$$

$$j_z''(r) + j_z'(r)\frac{1}{r} - j_z(r)\left(\frac{\alpha^2}{r^2} + \chi^2\right) = 0, \qquad (22)$$

$$j_\phi(r) = -\frac{\alpha}{\chi} \cdot \frac{j_z(r)}{r}, \qquad (23)$$

$$j_r(r) = -\frac{1}{\chi} \cdot j_z'(r). \qquad (24)$$

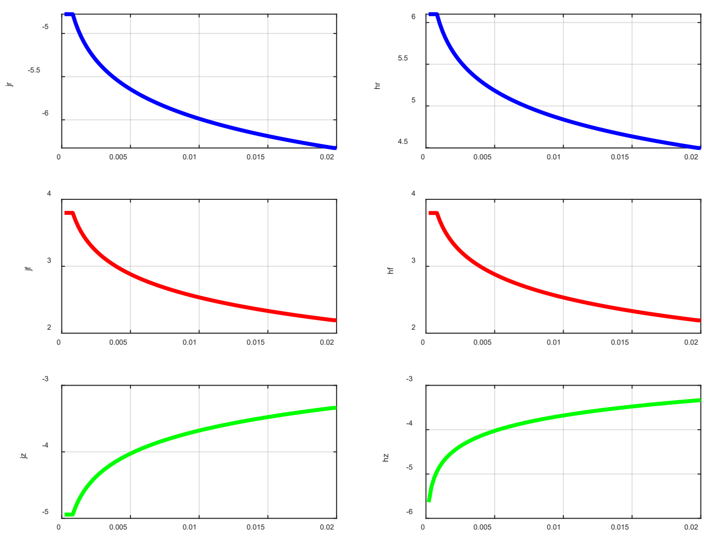

Fig. 3.

It is important to note that in this case, eight equations (5)-(12) also have a unique solution in the form of six equations (19)-(24) for fixed values of the parameters α, χ. Figure 3 shows the graphs of the logarithms of these functions for $\alpha = 0.5, \chi = 0.1, R = 0.02$.

Both the currents and the magnetic strengths are **always** distributed this way, even if only thermal currents exist in the wire. This is so because the currents interact with each other by the Lorentz forces and Maxwell's equations describe namely this interaction. If the conduction current is added to the thermal currents, then in the mathematical description only the values of the constants α, χ change. Exactly the same happens when the wire enters an external magnetic field: only the values of the constants α, χ change. A change in the magnetic field only changes the values of the constants. It is important, however, that the magnetic field strength is uneven. In Chapter 5d of book [3], various experiments are described that demonstrate the phenomenon of the appearance of a constant electric current under the influence of a constant magnetic field.

Thus, the magnetic field in the wire is not displaced but is created again and the currents are created along with this field. When the internal resistance of the disk is low, the currents take on large values.

The current in the wire has a solenoidal structure. Therefore, the reader can consider it as a solenoid. Figure 4 shows three helical streamlines: the thick blue line for $\alpha = 2, \chi = 0.8$, the middle green line for $\alpha = 0.5, \chi = 2$, and the thin red line for $\alpha = 2, \chi = 1.6$. The helical lines are shown for the functions J determined by (17) and (18), namely for the total current with the projections J_φ and J_z for $r = \text{const}$. These functions are defined for $\alpha > 0$.

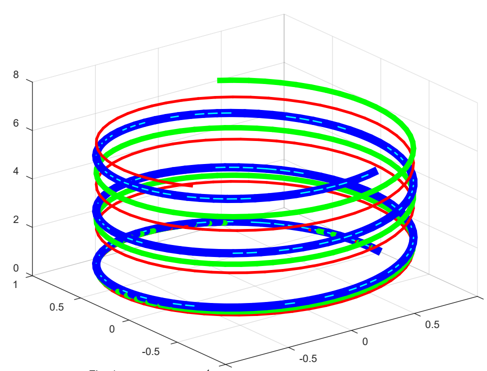

Fig. 4.

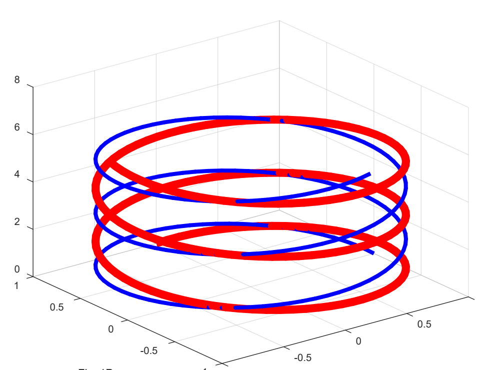

Fig. 5.

Figure 5 shows the helical lines

- for the functions J defined for $\alpha > 0$ (similar to the case shown in Figure 4) and shown by the thin blue line in Figure 5 and
- for functions J defined for $\alpha < 0$ and shown by the thick red line in Figure 5.

For $\alpha > 0$, the circumferential currents disappear: see the function $j_\phi(r)$ in formula (23). However, equation (4) is still valid. For $\alpha > 0$, the sign of the function H_z also changes, see (15).

All equations are also valid for a wire of limited length, for instance, for a disk in our case. Figure 6 shows functions (13)-(18) on the wire of the length of $L = \frac{2\pi}{\chi}$. It can be seen that the axial current J_z (solid red line) is equal to zero at the ends of the wire. Also, both the axial magnetic strengths H_z and the circular current J_φ (dashed blue line) at the ends of the wire take maximum and opposite values.

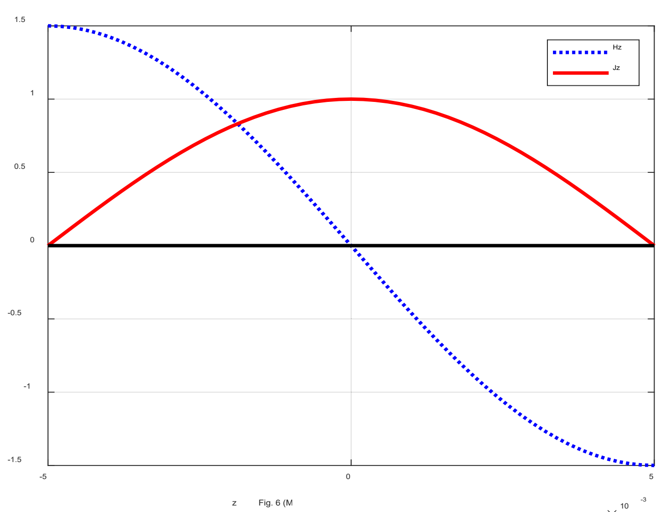

Fig. 6. (Meissner.m)

In fig. 7 shows the various functions for the three positions of the disc, assuming the magnet is on top, with the functions for the stable position shown in the middle windows. Functions shown for only one radius value. The right-hand windows show the streamline spiral, while the right-hand windows show the Z-dependent function J_z (solid line) and the H_z , J_φ functions (dashed line).

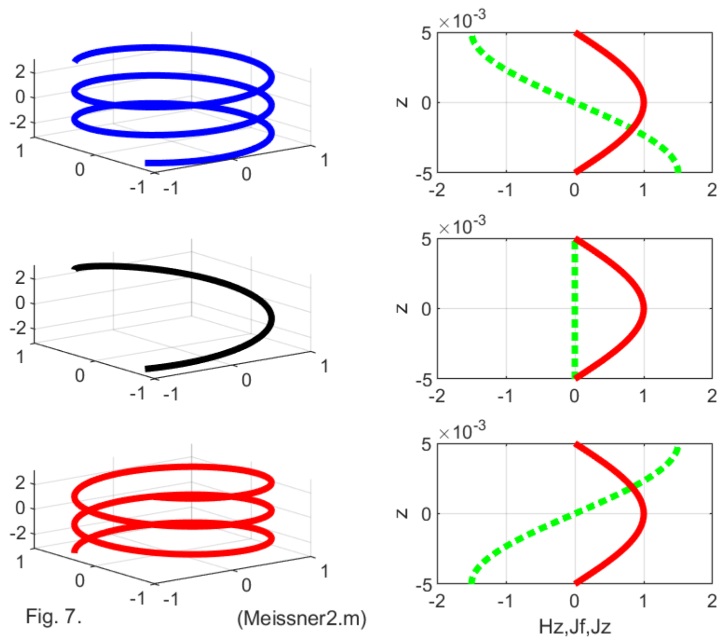

Fig. 7.

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Series: **PHYSICS**

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Wave equation is NOT an electromagnetic wave equation

Annotation

It is shown that the wave equation only in the first approximation can be considered the equation of an electromagnetic wave, and therefore it is offered a new equation is proposed for electromagnetic wave, which also follows from the system of Maxwell's equations. This equation demonstrates the strict observance of the law of conservation of energy, the phase shift between electric and magnetic intensities, the conversion of energy from magnetic to electric and vice versa, the twist of an electromagnetic wave.

First of all, we note that the Maxwell system of equations (MSE) is a system of differential equations and therefore can have many correct mathematical solutions. Among them there may be those that correspond to experiments and physical laws, and those that contradict experiments and physical laws. The wave equation is one of the latter.

The MSE solution for vacuum should

1. not contradict the law of conservation of energy at every moment of time, i.e. establish the constancy of the flux density of electromagnetic energy in time,

2. demonstrate a phase shift between electric and magnetic intensities,

3. demonstrate the conversion of energy from magnetic to electrical and vice versa,

4. explain the twist light, i.e. the appearance of an orbital angular momentum, at which the energy flow does not just fly forward, but rotates around the axis of motion.

However, the solution in the form of the wave equation

- contradicts the law of conservation of energy, because in it, the energy flux changes in time and retains its value only on average, which, in principle, cannot be considered compliance with the conservation law - see Fig. 1;

- demonstrates the inphase of electrical and magnetic intensities - see Fig. 1;
- does not explain the twist light.

In [1], a solution of the Maxwell equations for vacuum in the cylindrical coordinate system $\{r,\varphi,z\}$ was found, which has the following form:

$$H_{r\cdot} = h_r(r)\mathrm{co}, \quad (1)$$
$$H_{\varphi\cdot} = h_\varphi(r)\mathrm{si}, \quad (2)$$
$$H_{z\cdot} = h_z(r)\mathrm{si}, \quad (3)$$
$$E_{r\cdot} = e_r(r)\mathrm{si}, \quad (4)$$
$$E_{\varphi\cdot} = e_\varphi(r)\mathrm{co}, \quad (5)$$
$$E_{z\cdot} = e_z(r)\mathrm{co}, \quad (6)$$

where

$$\mathrm{co} = \cos(\alpha\varphi + \chi z + \omega t), \quad (7)$$
$$\mathrm{si} = \sin(\alpha\varphi + \chi z + \omega t), \quad (8)$$
$$\chi = \omega\sqrt{\mu\varepsilon}/c, \quad (9)$$
$$e_z(r) = 0, \quad (10)$$
$$h_z(r) = 0, \quad (11)$$
$$e_r(r) = e_\varphi(r) = 0.5Ar^{(\alpha-1)}, A - \mathrm{const}, \quad (12)$$
$$h_\varphi(r) = \sqrt{\frac{\varepsilon}{\mu}}e_r(r), \quad (13)$$
$$h_r(r) = -\sqrt{\frac{\varepsilon}{\mu}}e_r(r), \quad (14)$$
$$A, \alpha, \omega - \mathrm{const}.$$

The same system of equations in the Cartesian coordinate system $\{x,y,z\}$ has the form

$$E_x = e_x\sin((\alpha+1)\varphi + \chi z + \omega t), \quad (15)$$
$$E_y = e_y\cos((\alpha-1)\varphi + \chi z + \omega t), \quad (16)$$
$$H_x = h_x\cos((\alpha+1)\varphi + \chi z + \omega t), \quad (17)$$
$$H_y = h_y\sin((\alpha-1)\varphi + \chi z + \omega t), \quad (18)$$

where

$$e_x(r) = e_y(r) = 0.5Ar^{(\alpha-1)}, \quad (19)$$
$$h_x(r) = h_y(r) = -\sqrt{\frac{\varepsilon}{\mu}}e_x(r), \quad (20)$$
$$r = \sqrt{x^2+y^2}, \quad (21)$$

$$\boldsymbol{\varphi} = \mathbf{arctg}\big((\boldsymbol{y}/\boldsymbol{x})\big). \tag{22}$$

In these decisions

- the energy flux density along the $\boldsymbol{z}$ coordinate at each radius $\boldsymbol{r}$ retains its value at each moment of time - the energy conservation law is observed,
- there is a continuous process of converting energy from magnetic to electrical and vice versa,
- the locus of points of equal intensity (magnetic or electrical) at each radius is a spiral - see Fig. 2
- there is a phase shift between the electric and magnetic intensities - see Fig. 3,
- the twist of the electromagnetic wave is observed - see Fig. 4.

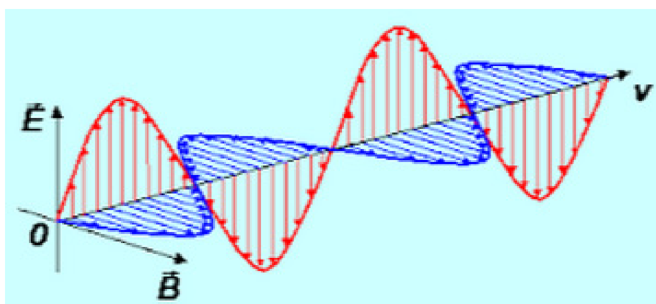

Fig. 1.

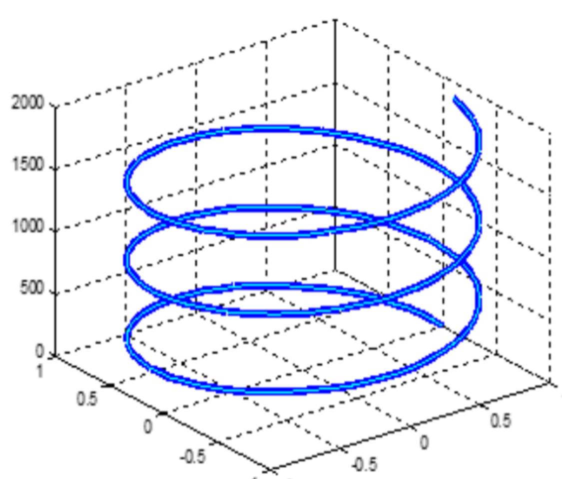

Fig. 2.

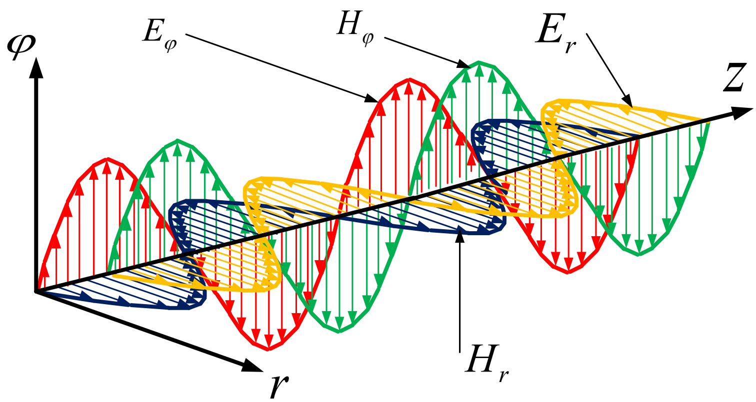

Fig. 3.

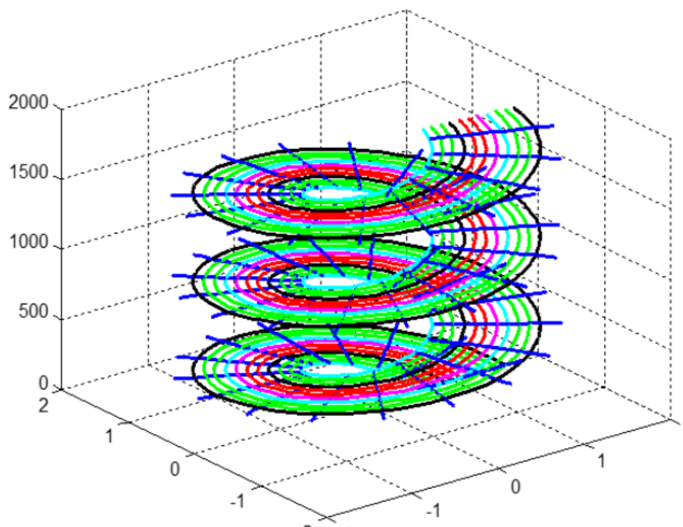

Fig. 4.

Consider also the spherical coordinate system $\{\boldsymbol{\rho}, \boldsymbol{\theta}, \boldsymbol{\varphi}\}$. In this case, the solution of Maxwell's equations for vacuum has the following form:

$$E_\varphi = e_\varphi \mathrm{Kh}(\rho, \theta) \sin(\propto \varphi + \chi\rho + \omega t), \tag{23}$$

$$E_\theta = e_\theta \mathrm{Kh}(\rho, \theta) \cos(\propto \varphi + \chi\rho + \omega t), \tag{24}$$

$$\boldsymbol{E_\rho} = \boldsymbol{0}, \tag{25}$$

$$H_\varphi = h_\varphi \mathrm{Kh}(\rho, \theta) \cos(\propto \varphi + \chi\rho + \omega t), \tag{26}$$

$$H_\theta = h_\theta \mathrm{Kh}(\rho, \theta) \sin(\propto \varphi + \chi\rho + \omega t), \tag{27}$$

$$\boldsymbol{H_\rho} = \boldsymbol{0}, \tag{28}$$

where $\mathrm{Kh}(\rho, \theta)$ is a definite function, $e_\varphi, e_\theta, h_\varphi, h_\theta$ are constants, and

$$\boldsymbol{h_\varphi} = \sqrt{\frac{\boldsymbol{\varepsilon}}{\boldsymbol{\mu}}}\boldsymbol{e_\theta}, \tag{29}$$

$$h_\theta = \sqrt{\frac{\varepsilon}{\mu}} e_\varphi, \tag{30}$$

$$\chi = \frac{\omega}{c}\sqrt{\varepsilon\mu}. \tag{31}$$

The function $\text{Khm}(\theta, \propto)$ is defined by an equation of the form

$$(\cos(\theta) \pm \propto)\text{Khm}(\theta, \propto) + \sin(\theta)\frac{\partial}{\partial\theta}\text{Khm}(\theta, \propto) = 0, \tag{32}$$

In the general case, this differential equation has no analytical solution. In fig. 5 shows the functions $\text{Khm}(\theta, \propto)$ for different values of $\propto$. For comparison, the $\sin(\theta)$ function is shown as dots.

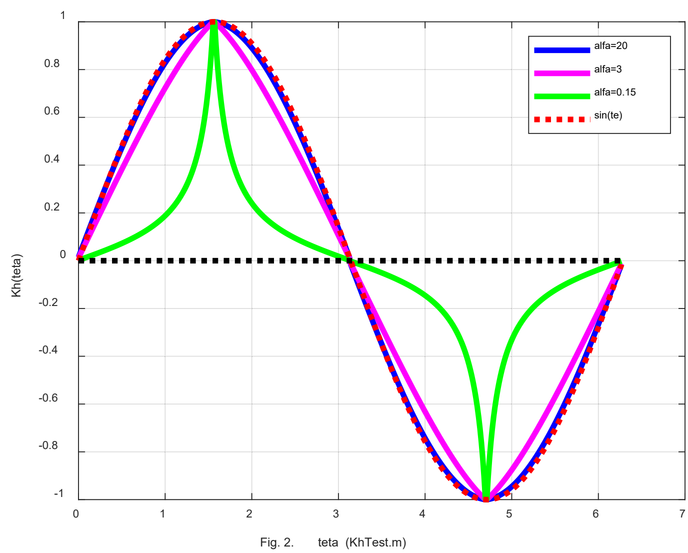

Fig. 5.

In this decision

- the density of the energy flux passing through the sphere does not depend on the radius and does not depend on time; this flux has the same magnitude on a spherical surface of any radius at any time; in other words, the energy flux directed along the radius retains its value with increasing radius and does not depend on time, which corresponds to the energy conservation law;
- there is a phase shift between electric and magnetic intensities;
- the twist of the electromagnetic wave is observed.

A huge number of theoretical conclusions in electrodynamics are made based on the use of the wave equation. These conclusions were obtained in violation of the law of conservation of energy and had to put up with it. Now that the exact solution to Maxwell's equations has been found, it is necessary to revise and refine the previously obtained results. This is necessary because some of the results may turn out to be fundamentally incorrect (and not just erroneous with some error).

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Series: **PHYSICS**

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Mathematical description of Euler disk and experiments with him

Annotation

It is pointed out that at present there is no complete theory of the Euler disk. A complete mathematical description of the Euler disk in statics is given. Some experiments are described.

Contents

1. Introduction
2. Equations of state
3. Disc sustainability
4. Conclusions
Appendix 1
Appendix 2
Appendix 3
Appendix 4
References

1. Introduction

The classical theory does not allow one to explain the behavior of the Euler disk without invoking additional forces. In [1] it is shown that taking into account the influence of air also does not allow finding an acceptable explanation. Hope is pinned on the effect of sliding friction, but there is no strict solution, and intuitive hopes only for this friction are poorly substantiated - see, for example, [2]. There is, apparently, no explanation for the transition from rotation of the disk around the vertical diameter to rotation in a circle in an inclined position. If the disc slides in a circle, then it is apparently necessary to take into account also the centrifugal force. But, the main thing that surprises us is why the disc does not fall, but rotates long enough?

Below is an attempt to find answers to these questions. The article is a revised version of article [6]. We warn the reader in advance that the answers were obtained on the condition that the centrifugal force and the

Coriolis force are real, and not fictitious, forces. A mathematical proof of this fact is given in [3].

2. Equations of state

In fig. 1 shows the Euler disk. Table 1 of Appendix 1 lists the parameters of the state of the disc at the initial moment 1 and at the moment 2, when the disc is in a position at which the angle $\propto < \pi/2$. The definition of these parameters is given in Appendix 1. At moment 1, there is only rotation around the vertical axis of the disk. At moment 2, partial rotation appears additionally. The force of gravity mg also appears, the vector of which passes the point of rotation O. Because of this, a decrease in the potential energy of the top appears

$$W_P = mgh(1 - \sin \propto) \tag{1}$$

- see the formula or (clause 2.7) in Appendix 2.

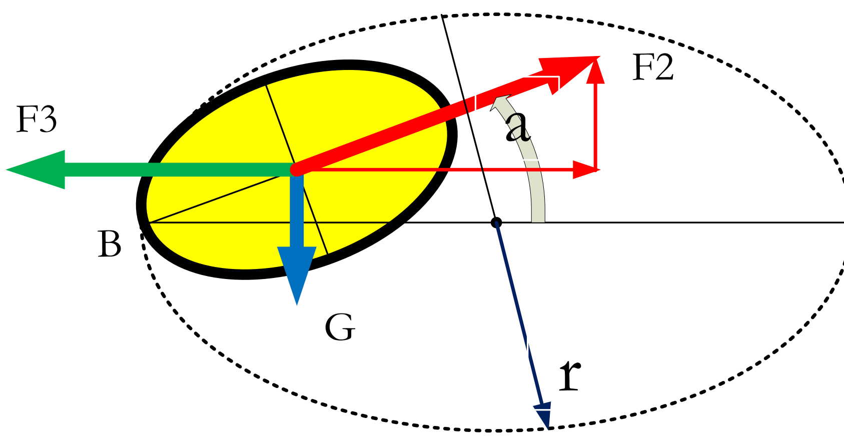

Fig. 1.

We write for moment 2 the equations of the laws of conservation of momentum L and energy W, which do not depend on how and by what forces the disk entered this state:

$$\boldsymbol{L_2} + \boldsymbol{L_4} = \boldsymbol{L_1}, \tag{2}$$

$$\boldsymbol{W_2} + \boldsymbol{W_4} + \boldsymbol{W_P} = \boldsymbol{W_1}. \tag{3}$$

Substituting the equations from table. 1 into equations (1, 2), we obtain:

$$J_2\omega_2 + J_3\omega_3 = J_1\omega_1, \tag{4}$$

$$\frac{1}{4}J_2\omega_2^2 + \frac{1}{4}J_3\omega_3^2 + W_P = \frac{1}{4}J_2\omega_1^2. \tag{5}$$

where ω_1, ω_2 are the angular speeds of rotation of the disk at times 1 and 2, ω_3 is the angular speed of partial rotation. From (4) we find:

$$\omega_3 = \frac{J_2}{J_3}\left(\frac{1}{2}\omega_1 - \omega_2\right). \tag{6}$$

Substituting (6) into (5), we find:

$$\frac{1}{4}J_2\omega_2^2 + \frac{1}{4}J_3\left(\frac{J_2}{J_3}\left(\frac{1}{2}\omega_1 - \omega_2\right)\right)^2 + W_P = \frac{1}{4}J_2\omega_1^2. \tag{7}$$

Appendix 2 shows (see (item 2.9)) that

$$W_P = qJ_2\omega_3^2 \tag{8}$$

where q is a constant - see (item 2.10) in Appendix 2. From (7, 8) we obtain:

$$\frac{1}{4}J_2\omega_2^2 + \frac{1}{4}J_3\omega_3^2 + qhJ_2\omega_3^2 = \frac{1}{4}J_2\omega_1^2 \tag{9}$$

We denote

$$a = \frac{J_2}{J_3}, \tag{10}$$

$$b = (1 + 4qa). \tag{11}$$

Then from (9, 10, 11) we get:

$$a\omega_2^2 + b\omega_3^2 = a\omega_1^2. \tag{12}$$

From (10, 6, 12) we find

$$a\omega_2^2 + b(\omega_1 - \omega_2)^2 = a\omega_1^2, \tag{13}$$

or

$$(b + a)\omega_2^2 - 2b\omega_1\omega_2 + (b - a)\omega_1^2 = 0, \tag{14}$$

Solving (14), we get:

$$\omega_2 = \frac{\omega_1}{(b+a)}(b \pm a). \tag{16}$$

It follows from experiments that $\omega_2 \neq \omega_1$. Then

$$\omega_2 = \frac{(b-a)}{(b+a)}\omega_1. \tag{17}$$

From (6, 17) we find

$$\omega_3 = a\left(\frac{1}{2}\omega_1 - \omega_2\right) = \frac{a(3a-b)}{2(b+a)}\omega_1. \tag{18}$$

From (18) we find

$$\omega_1 = \frac{2(b+a)}{a(3a-b)}\omega_3. \tag{18a}$$

From (18a, 17) we find

$$\omega_2 = \frac{(b-a)}{(b+a)}\frac{2(b+a)}{a(3a-b)}\omega_3 = \frac{2(b-a)}{a(3a-b)}\omega_3. \tag{18b}$$

The disc is tilted by gravity mg. The transformation of this energy into the kinetic energy of the rotational motion of the top occurs due to the fact that in the process of falling on it, as is known, the Coriolis force F_1 acts, which creates a torque and the corresponding angular velocity of precession ω_3.

The fall of the disk is counteracted, as you know, by another Coriolis force F_2. The disc falls very slowly. This means that the force F_2 is approximately equal to the force of gravity - see Appendix 2. Obviously, with such deceleration, the source of this force consumes energy approximately equal to W_P. Therefore, there is a source of energy for this force. But this assumption is thwarted by the persistent modern view that the Coriolis force is a fictitious force. And a fictitious force cannot deliver energy ...

3. Disc sustainability

In Appendix 2 it is shown that for some $\propto=\propto_0$ the Coriolis force F_2 balances the horizontal centrifugal force F_3 and the vertical gravity mg - see (item 2.3) and (item 2.5).

Until this speed is reached, the disk gradually falls under the action of the force F_4, determined from (p2.6a) and calculated as a result of the interaction of the Coriolis force and the force of gravity. When $F_4 = 0$, the fall process stops. But for this, the disc must start to fall.

At $\propto = 0$ it is seen that $F_4 = mg$. But this force is directed vertically and cannot cause falls. Thus, to start the fall, an external force must bring it out of its vertical position.

4. Conclusions

So, the action of the Coriolis forces leads to the fact that

- when the disk falls, it loses the kinetic energy received during launch, but replenishes it due to potential energy;
- there is such an inclined position of the disk, in which the Coriolis force balances the horizontal centrifugal force and vertical gravity;
- in this position, the kinetic energy of the disk remains unchanged and equal to the kinetic energy obtained during launch;
- the fall of the disc from the specified stable position is caused by a gradual decrease in its kinetic energy due to deceleration;
- the slow fall of the disc is due to the braking due to the second Coriolis force, which must consume energy for this (like the braking engine of a descending satellite),

Such an action of these Coriolis and centrifugal forces is possible only if they can do work, i.e. are real powers. This proves the reality of these forces. On the other hand, a mathematical proof of this fact is given in [1]. It is shown there that these forces can be substantiated as a consequence of Maxwell's equations for gravitomagnetism, and the source of energy for this force is the Earth's gravitational field. But even in the absence of such evidence, there are many doubts in the assertion that these forces are fictitious [2].

In Appendix 2 it is shown that the inequality $r \geq R$ follows from the equations of the disk. Modeling shows that for $r > R$ there is a certain angle ∝, where all parameters of the disk state take an infinite value. Thus, the condition

$$r = R. \tag{19}$$

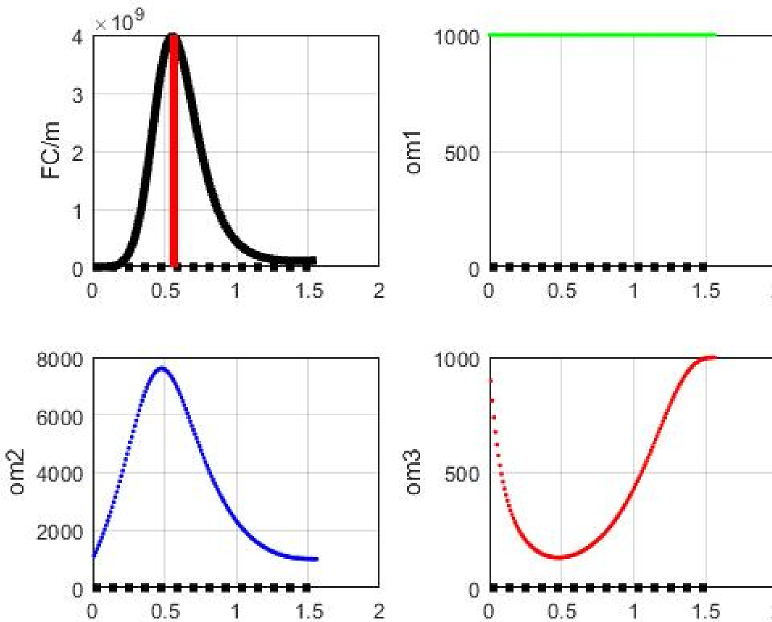

Fig. 2 (Disk88.m)

The above equations make it possible to find all the parameters of the disk for a given m and R. In table. 1 shows some examples in system SI. The graphs of the functions $\omega_1,\ \omega_2,\ \omega_3$ and the specific Coriolis force F_2/m at $\omega_1 = 1000$ and $R = 0.25$ are shown below - see Fig. 2. It can be seen that there is a sharp maximum at $\propto\approx \pi/2$, where the Coriolis force takes the greatest value. At this point, the disc remains in a stable state for a long time - see fig. 3 from [5].

Another experiment is considered in Appendix 4, where it is shown that the considered forces act on each element of the disk.

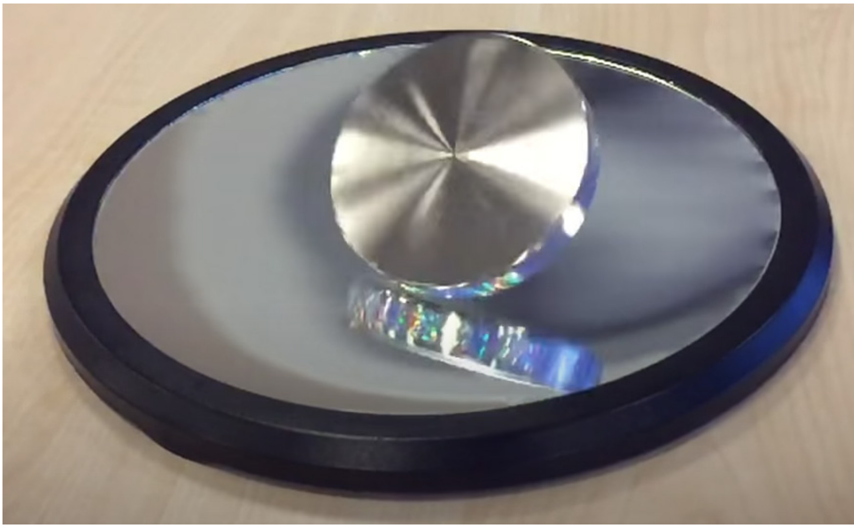

Fig. 3.

Appendix 1

Here we will determine the parameters of the state of the disk at moments 1 and 2. In table. 1 shows the basic formulas, where the following designations are adopted

$\propto$ is the angle of inclination of the disk to the rolling plane,
m is the mass of the disk,
g is acceleration of gravity,
mg is gravity,
R is the radius of the disk,
h is the height of the center of the disc - see fig. 1,
ω_1 is angular velocity of rotation of the disk around the vertical diameter at the moment 1,
ω_2 is angular speed of rotation of the disk around the vertical diameter at the moment 2,
ω_3 is angular velocity of partial rotation at moment 2,
v is linear speed of precession,
J is angular momentum,
W is energy.

From fig. 1 follows:

$$h = R\mathrm{tg}(\propto). \quad (п1.0)$$

From table. 1 follows:

$$a = \frac{J_2}{J_3} = 1/1.5, \quad (п1.1)$$

The linear speed of precession is the speed of movement of pixel B at the radius AB, rotating with the angular speed ω_3 (see Fig. 1):

$$v = \omega_3\big(r - R\cos(\propto)\big). \quad (п1.3)$$

Table 1.

	Angular speed	Moment of inertia	Moment of momentum	Kinetic energy
Rotation of the disc around its own vertical axis	ω_1	$J_1 = \frac{1}{4}mR^2$	$L_1 = J_1\omega_1$	$W_1 = \frac{1}{2}L_1\omega_{12} = \frac{1}{8}J_1\omega_1^2$
Rotation of a disk inclined at an angle $\propto$ to the plane around the proper axis	ω_2	$J_2 = \frac{1}{2}mR^2$	$L_2 = J_2\omega_2$	$W_2 = \frac{1}{2}L_2\omega_2 = \frac{1}{4}J_2\omega_2^2$
Partial motion of a top inclined at an angle $\propto$ to the plane.	ω_3	$J_3 = J_2 + mR^2$ (Steiner's theorem) $J_3 = a \cdot mR^2$, when $a = 1.5$	$L_3 = J_3\omega_3 = \frac{1}{2a}mR^2\omega_3$	$W_3 = \frac{1}{2}L_3\omega_3 = \frac{1}{4}J_3\omega_3^2 = \frac{1}{4a}mR^2\omega_3^2$

Appendix 2

The fall of the disk is counteracted by the Coriolis force.

$$F_2 = -2m\omega_2 \times v, \quad (п2.1)$$

where v is the linear speed of precession (p1.3), and the centrifugal force

$$F_3 = -m\omega_3^2\big(r - R\cos(\propto)\big) \quad (п2.2)$$

In the steady state, the force F_3 and the force of gravity mg are balanced by the force F_2 - see fig. 1. Therefore, from (item 2.1, item 2.2, item 1.3) we find:

$$F_2 = -\frac{F_3}{\sin(\propto)} = m\omega_3^2\big(r - R\cos(\propto)\big)/\sin(\propto), \qquad (п2.4)$$

$$mg = -F_2\cos(\propto) = m\omega_3^2\big(r - R\cos(\propto)\big)\cdot \mathrm{ctg}(\propto) \qquad (п2.5)$$

or

$$g = \omega_3^2 R\left(\frac{r}{h} - \cos(\propto)\right)\cdot \mathrm{ctg}(\propto). \qquad (п2.6)$$

If this equality is not satisfied, then the disk falls under the action of the force determined from (item 2.5):

$$F_4 = mg - m\omega_3^2\big(r - R\cos(\propto)\big)\cdot \mathrm{ctg}(\propto) \qquad (п2.6a)$$

It is seen that the solution to this equation exists only for

$$r \geq R. \qquad (п2.6a).$$

Consequently, condition (п2.6a) is always satisfied for the Euler disk.

When tilted at an angle $\propto$, the disk is displaced vertically by $R(1 - \sin\propto)$ and, therefore, loses potential energy

$$W_P = mgR(1 - \sin\propto). \qquad (п2.7)$$

Combining this formula with (item 2.6), we find:

$$W_P = m\omega_3^2 R\left(\frac{r}{R} - \cos(\propto)\right)\mathrm{ctg}(\propto)(1 - \sin\propto). \qquad (п2.8)$$

Next, we will combine this formula with the formula for J_2 from table. 1. Then we find

$$W_P = \frac{2J_2}{mR^2} m\omega_3^2 R^2\left(\frac{r}{R} - \cos(\propto)\right)\mathrm{ctg}(\propto)(1 - \sin\propto).$$

or

$$W_P = qJ_2\omega_3^2 \qquad (п2.9)$$

where

$$q = 2\left(\frac{r}{R} - \cos(\propto)\right)\mathrm{ctg}(\propto)(1 - \sin\propto). \qquad (п2.10)$$

Appendix 3

Here we will consider in more detail the Coriolis force F_2, determined by (п2.1):

$$F_2 = 2m\omega_2\omega_3\omega_3^2 R\left(\frac{r}{R} - \cos(\propto)\right), \qquad (п3.1)$$

From (item 3.1, 18b) we find

$$F_2 = -2m\omega_3^2 R\left(\frac{r}{R} - \cos(\propto)\right)\omega_3^2\frac{2(b-a)}{a(3a-b)} \qquad (п3.2)$$

or

$$F_2 = -2m\omega_3^2 R\left(\frac{r}{R} - \cos(\propto)\right)\omega_1^2\frac{2(b-a)}{a(3a-b)}\left(\frac{2(b+a)}{a(3a-b)}\right)^2$$

or

$$F_2 = -2m\omega_1^2 R a_f, \quad (п3.3)$$

where

$$a_f = 2\left(\frac{r}{R} - \cos(\propto)\right)(b-a)(b+a)^2\left(\frac{2(b+a)}{a(3a-b)}\right)^3. \quad (п3.4)$$

Appendix 4

An experiment is known from the Internet, shown in Fig. 4. "Chain circle" - the CC spins up on a cylinder at high speed and collides from this cylinder. In this case, the CC continues to move like a Euler disk, **retaining its shape**. Here, forces A and B act on each link in the chain.

From the previous it follows (see Fig. 1) that the force F_2 acts in the direction of the vector A, and the force F_3 acts in the direction of the vector B.

In addition, centrifugal force F_5 acts on each link of the chain, caused by the rotation of the CC around its own axis. This force is added to the force F_2 and ensures that the CC remains in shape. Thus, $A = F_2 + F_5$ and $B = F_3$. Both of these forces keep the CC from dropping.

This means that the considered forces act on each element of the Euler disk, and in this case, on the links of the chain.

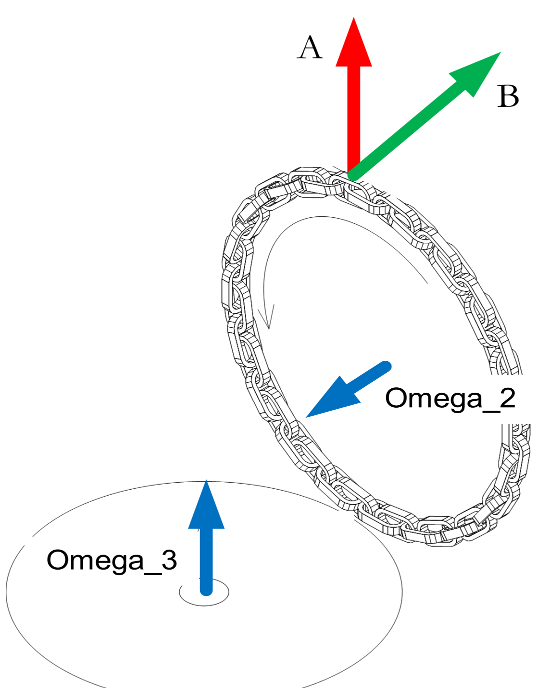

Fig. 4.

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Series: PHYSICS

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Solving Maxwell's Equations for a Cylindrical Wave in Vacuum

Annotation

It is proved, as a consequence of the solution of Maxwell's equations, that theoretically possible cylindrical waves of different radii and different frequencies, carrying a flux of electromagnetic energy of different magnitude. The question remains open whether there are natural processes that create such waves.

Contents

1. Introduction
2. On the method for solving Maxwell's equations
3. About the flow of energy
4. Solving Maxwell's equations
5. Second solution of Maxwell's equations
References

1. Introduction

In [1] "a cylindrically symmetric wave function $\psi(\rho, t)$is considered, where $\rho = (x^2 + y^2)^{1/2}$ is the standard cylindrical coordinate. Assuming that this function satisfies the three-dimensional wave equation, which can be rewritten as

$$\frac{\partial^2\psi}{\partial t^2} = v^2\left(\frac{\partial^2\psi}{\partial\rho^2} + \frac{1}{\rho}\frac{\partial\psi}{\partial\rho}\right), \tag{538}$$

it can be shown that a sinusoidal cylindrical wave with a phase angle φ, wave number k, and angular frequency $\omega = kv$ has an approximate wave function

$$\psi(\rho, t) \approx \psi_o\rho^{-1/2}\cos(\omega t - k\rho - \varphi) \tag{539}$$

in the limit $\omega = kv$. Here $\psi_o\rho^{-1/2}$ is the wave amplitude. The corresponding wavefronts (that is, surfaces with constant phase) are a set of concentric cylinders that propagate radially outward from their common axis $\rho = 0$ with phase velocity $\omega/k = v$ - see Fig. 1. The wave amplitude decays as $\rho^{-1/2}$. This behavior can be understood as a consequence of the conservation of energy, according to which the power flowing through various surfaces $A \propto \rho = \text{const.}$ (The areas of such surfaces are scaled as $A \propto \rho$. Moreover, the power flowing through them is proportional to $\psi^2 A \psi^2$, because the energy flux associated with the wave is usually proportional to ψ^2, and is directed perpendicular to the wave fronts.) the wave indicated in expression (539) is such that it is generated by a homogeneous linear source located at the point $\rho = 0$- see Fig. 1."

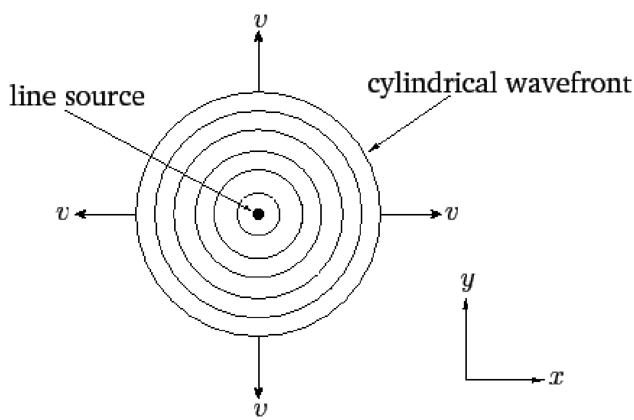


Fig. 1.

It is strange that the author would call such waves cylindrical. They should be called conical, because in them, wave fronts are a set of concentric cylinders that propagate radially outward, and also propagate along the axis: the fronts that appeared earlier continue to expand, while the emerging cylinders begin to expand. The justification would be that really cylindrical waves, in which these cylinders retain their radius, do not exist in nature. But look at the magnifying glass with which the boy makes a fire at noon - see fig. 2. The sunbeam that enters the magnifying glass is obviously a cylindrical wave. Another example is a Fresnel loop [3] that creates a cylindrical output wave - see fig. 3 from [4]. Cylindrical lenses are also known, the feature of which is the presence of an axis in the direction of which the optical effect does not manifest itself (i.e., there is no refraction, reflection and scattering of radiation) [2].

Thus, cylindrical waves (as well as conical ones) cannot be represented by a wave function. Therefore, we will consider a new function that describes cylindrical waves and is a solution to Maxwell's equations.

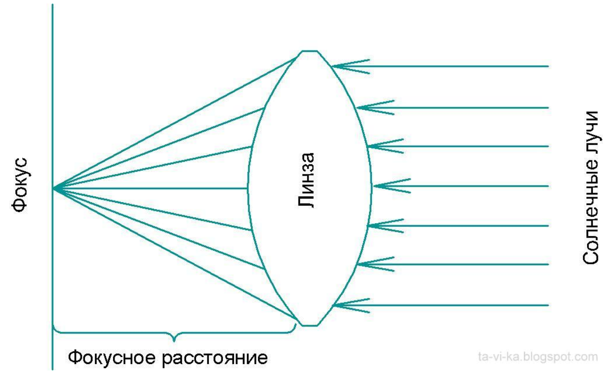


Fig. 2.

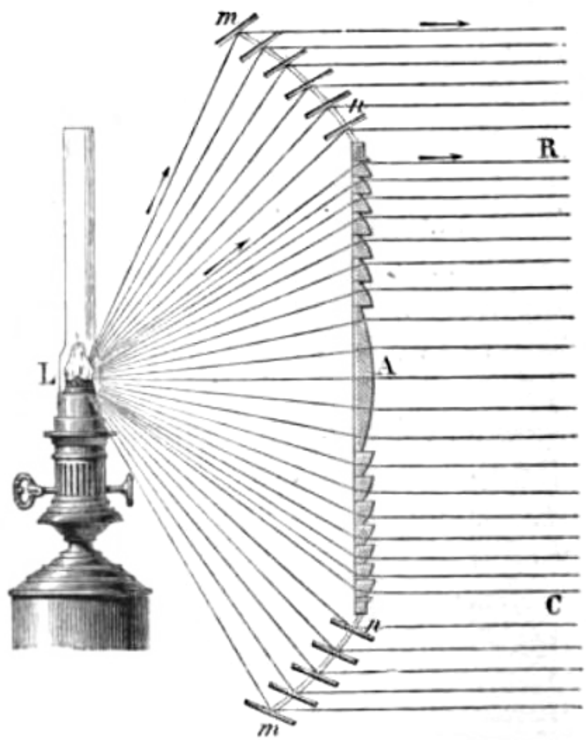


Fig. 3.

Further, it will be proved that for the system of Maxwell's equations there is a solution that describes a cylindrical wave in vacuum. This solution maintains a constant flow of energy in such a wave and the shape of this wave.

2. Solving Maxwell's Equations

Consider the system of Maxwell equations for vacuum, which has the form

$$\mathrm{rot}(E) + \frac{\mu}{c}\frac{\partial H}{\partial t} = 0, \quad \text{(a)}$$

$$\mathrm{rot}(H) - \frac{\varepsilon}{c}\frac{\partial E}{\partial t} = 0, \quad \text{(b)}$$

$$\mathrm{div}(E) = 0, \quad \text{(c)}$$

$$\mathrm{div}(H) = 0. \quad \text{(d)}$$

In the system of cylindrical coordinates r, φ, z, these equations have the form [4]:

$$\frac{E_r}{r} + \frac{\partial E_r}{\partial r} + \frac{1}{r}\cdot\frac{\partial E_\phi}{\partial \phi} + \frac{\partial E_z}{\partial z} = 0, \quad (1)$$

$$\frac{1}{r}\cdot\frac{\partial E_z}{\partial \phi} - \frac{\partial E_\phi}{\partial z} = \frac{\mu}{c}\frac{dH_r}{dt}, \quad (2)$$

$$\frac{\partial E_r}{\partial z} - \frac{\partial E_z}{\partial r} = \frac{\mu}{c}\frac{dH_\phi}{dt}, \quad (3)$$

$$\frac{E_\phi}{r} + \frac{\partial E_\phi}{\partial r} - \frac{1}{r}\cdot\frac{\partial E_r}{\partial \phi} = \frac{\mu}{c}\frac{dH_z}{dt}, \quad (4)$$

$$\frac{H_r}{r} + \frac{\partial H_r}{\partial r} + \frac{1}{r}\cdot\frac{\partial H_\phi}{\partial \phi} + \frac{\partial H_z}{\partial z} = 0, \quad (5)$$

$$\frac{1}{r}\cdot\frac{\partial H_z}{\partial \phi} - \frac{\partial H_\phi}{\partial z} = \frac{\varepsilon}{c}\frac{dE_r}{dt}, \quad (6)$$

$$\frac{\partial H_r}{\partial z} - \frac{\partial H_z}{\partial r} = \frac{\varepsilon}{c}\frac{dE_\varphi}{dt}, \quad (7)$$

$$\frac{H_\phi}{r} + \frac{\partial H_\phi}{\partial r} - \frac{1}{r}\cdot\frac{\partial H_r}{\partial \phi} = \frac{\varepsilon}{c}\frac{dE_z}{dt}, \quad (8)$$

where E_r, E_φ, E_z are electrical strengths, H_r, H_φ, H_z are magnetic strengths. In this chapter, we will look for these functions as follows:

$$H_r. = \widehat{H}_r(r)\cdot \mathrm{co}, \quad (9)$$

$$H_\varphi. = \widehat{H}_\varphi(r)\cdot \mathrm{si}, \quad (10)$$

$$H_z. = \widehat{H}_z(r)\cdot \mathrm{si}, \quad (11)$$

$$E_r. = \hat{E}_r(r)\cdot \mathrm{si}, \quad (12)$$

$$E_\varphi. = \hat{E}_\varphi(r)\cdot \mathrm{co}, \quad (13)$$

$$E_z. = \hat{E}_z(r)\cdot \mathrm{co}, \quad (14)$$

where

$$\mathrm{co} = \cos(\alpha\phi + \chi z + \omega t), \quad (15)$$

$$\mathrm{si} = \sin(\alpha\phi + \chi z + \omega t), \tag{16}$$

and α, χ, ω are some constants. Let us briefly consider the method for solving this system of equations [5], since further some modification of this method will be proposed

We will differentiate functions (15, 16) with respect to the arguments r, φ, z to obtain partial derivatives of functions (9-14). These derivatives will be substituted into equations (1-8). In this case, it turns out that in each equation, all terms will have the same trigonometric function, which can be canceled. Then equations (1-8) will take the form:

$$\frac{e_r(r)}{r} + e_r'(r) - \frac{e_\varphi(r)}{r}\alpha - \chi \cdot e_z(r) = 0, \tag{17}$$

$$-\frac{1}{r} \cdot e_z(r)\alpha + e_\varphi(r)\chi - \frac{\mu\omega}{c} h_r = 0, \tag{18}$$

$$e_r(r)\chi - e_z'(r) + \frac{\mu\omega}{c} h_\varphi = 0, \tag{19}$$

$$\frac{e_\varphi(r)}{r} + e_\varphi'(r) - \frac{e_r(r)}{r} \cdot \alpha + \frac{\mu\omega}{c} h_z = 0, \tag{20}$$

$$\frac{h_r(r)}{r} + h_r'(r) + \frac{h_\varphi(r)}{r}\alpha + \chi \cdot h_z(r) = 0, \tag{21}$$

$$\frac{1}{r} h_z(r) \propto -h_\varphi(r)\chi - \frac{\varepsilon\omega}{c} e_r(r) = 0, \tag{22}$$

$$-h_r(r)\chi - h_z'(r) + \frac{\varepsilon\omega}{c} e_\varphi(r) = 0, \tag{23}$$

$$\frac{h_\varphi(r)}{r} + h_\varphi'(r) + \frac{h_r(r)}{r} \propto + \frac{\varepsilon\omega}{c} e_z(r) = 0. \tag{24}$$

Let's pretend that

$$h_r = k e_r, \tag{25}$$

$$h_\varphi = -k e_\varphi, \tag{26}$$

$$h_z = -k e_z, \tag{27}$$

where k is some constant. Let's change variables according to (25-27) in equations (17-24) and rewrite them:

$$\frac{e_r}{r} + \dot{e}_r - \frac{e_\varphi}{r}\alpha - \chi e_z = 0, \tag{28}$$

$$-\frac{e_z}{r}\alpha + e_\varphi\chi - \frac{\mu\omega}{c} k e_r = 0, \tag{29}$$

$$-\dot{e}_z + e_r\chi - k\frac{\mu\omega}{c} e_\varphi = 0, \tag{30}$$

$$\frac{e_\varphi}{r} + \dot{e}_\varphi - \frac{e_r}{r}\alpha - k\frac{\mu\omega}{c} e_z = 0, \tag{31}$$

$$k\frac{e_r}{r} + k\dot{e}_r - k\frac{e_\varphi}{r}\alpha - k\chi e_z = 0, \tag{32}$$

$$-k\frac{e_z}{r}\alpha + k e_\varphi\chi - \frac{\varepsilon\omega}{c} e_r = 0, \tag{33}$$

$$k\dot{e}_z - ke_r\chi + \frac{\varepsilon\omega}{c}e_\varphi = 0, \quad (34)$$

$$-k\frac{e_\varphi}{r} - k\dot{e}_\varphi + k\frac{e_r}{r}\alpha + \frac{\varepsilon\omega}{c}e_z = 0. \quad (35)$$

It can be proved that this system can be reduced to a system of four equations (28-35) with unknowns $e_z,\ e_\varphi,\ e_r,\ k$.

3. About the flow of energy

The primary challenge is to find a solution in which the energy flow remains constant over time. Let us find the conditions under which the functions (2.9-2.14) satisfy this requirement.

It is known that the flux density of electromagnetic energy is the Poynting vector

$$S = \eta E \times H, \quad (1)$$

where

$$\eta = c/4\pi. \quad (2)$$

In cylindrical coordinates r, ϕ, z the electromagnetic energy flux density has three components S_r, S_ϕ, S_z directed along the radius, along the circumference, along the axis, respectively. They are determined by the formula

$$S = \begin{bmatrix} S_r \\ S_\varphi \\ S_z \end{bmatrix} = \eta(E \times H) = \eta \begin{bmatrix} E_\varphi H_z - E_z H_\varphi \\ E_z H_r - E_r H_z \\ E_r H_\varphi - E_\varphi H_r \end{bmatrix}. \quad (3)$$

We will consider the case when there are no longitudinal strengths, i.e. $H_z(r) = 0$, $E_z(r) = 0$. Therefore, $S_r = 0,\ S_\varphi = 0$, i.e. the energy flux propagates only along the oz axis and its density is

$$S = S_z = \eta\left(E_r H_\varphi - E_\varphi H_r\right) \quad (4)$$

or, taking into account (9-16),

$$S = S_z = \eta\left(e_r h_\varphi \mathrm{si}^2 - e_\varphi h_r \mathrm{co}^2\right). \quad (5)$$

If

$$e_r h_\varphi = -e_\varphi h_r, \quad (6)$$

then

$$S_z = \eta e_r h_\varphi. \quad (7)$$

From (7) we find the total energy flux through the cross section of the wave

$$\overline{\overline{S_z}} = \frac{\mathrm{c}}{4\pi}\iint_{r,\varphi}\left(e_r h_\varphi dr \cdot d\varphi\right) = \frac{\mathrm{c}}{2}\int_0^R\left(e_r h_\varphi dr\right). \quad (8)$$

This integral is independent of time. Therefore, when condition (6) is satisfied, the energy flux of the electromagnetic wave is constant in time.

4. Solving Maxwell's equations

The next task is to find the form of the functions $e_r, h_\varphi, e_\varphi, h_r$, satisfying the system of equations (1-8) and condition (3.6). Before looking for solutions, it should be noted that Maxwell's equations can have many solutions (like any system of partial differential equations). Some of these solutions violate obvious physical requirements, in particular, the fulfillment of the law of conservation of energy. For example, the well-known solution in the form of a wave function, as is known, violates this one (in this solution it is preserved only on average in time, which contradicts the very spirit of this law).

In [5], a solution was found in which the amplitudes of the magnetic and electrical strengths in cylindrical coordinates r, φ, z have the following form:

$$|\mathrm{E}| = Ar^\beta, \tag{1}$$

where A are some constants, β is a linear function of r.

In this solution, the law of conservation of energy is fulfilled. But there is another drawback - such solutions are applicable only when the parameter r is limited:

$$0 < r < \infty. \tag{2}$$

In particular, in the absence of longitudinal strengths, this solution has the following form:

$$h_z(r) = 0, \tag{3}$$

$$e_z(r) = 0, \tag{4}$$

$$e_r(r) = e_\varphi(r) = \frac{A}{2} r^{(\alpha-1)}, \tag{5}$$

$$h_\varphi(r) = -\sqrt{\frac{\varepsilon}{\mu}} e_r(r), \tag{6}$$

$$h_r(r) = \sqrt{\frac{\varepsilon}{\mu}} e_r(r), \tag{7}$$

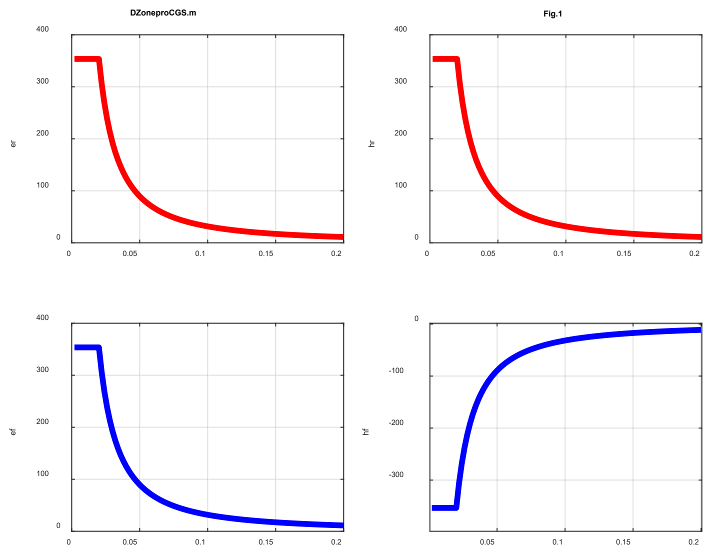
$$\chi = \omega\sqrt{\mu\varepsilon}/c, \tag{8}$$

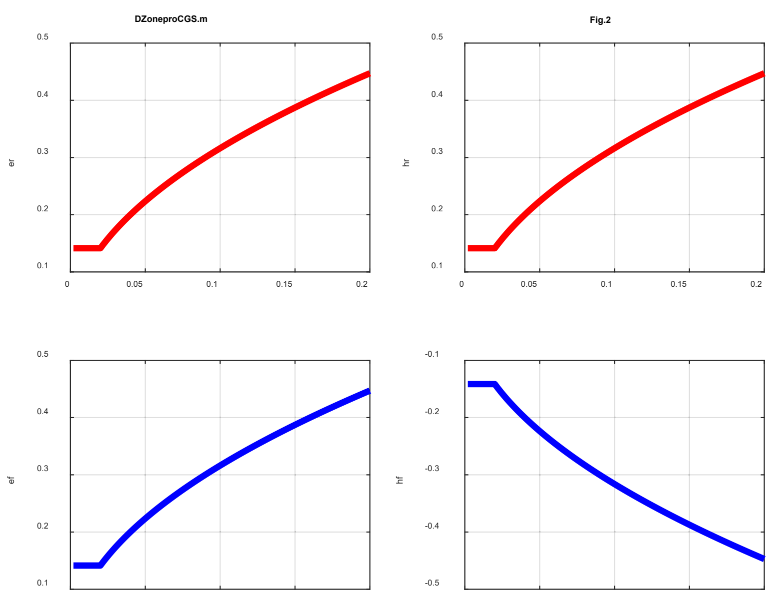
where A is some constant. In this solution, condition (3.6) is satisfied. Indeed, (5-8) implies (3.6). However, it is clear that in this solution the strengths

1) take an infinite value at $r = 0$, if the exponent r is negative;
2) take an infinite value as $r \to \infty$, if the exponent of r is positive.

Example 1.

In fig. 1 shows the graphs of the functions $e_r, e_z, h_\varphi, h_r, h_z$ at $A = 2,\ R = 0.2,\ \omega = 10^5,\ \frac{\varepsilon}{\mu} = 1$ in the CGS system. In fig. 1 is taken $\propto = -0.5$, and in Fig. 2 it is taken $\propto = 1.5$.





5. Second solution of Maxwell's equations

At present, the applicability of Maxwell's equations to all phenomena of electrodynamics and electrical devices is undeniable. Consequently, there must be such a solution of Maxwell's equations for an electromagnetic wave in a vacuum, where there are no infinite strengths. Further, we will show that such a solution can be obtained by a simple transformation of the solution considered above.

To do this, let's return to equations (2.1.28-2.1.37). Consider equation (2.1.28):

$$\frac{e_r(r)}{r} + e_r'(r) - \frac{e_\varphi(r)}{r}\alpha - \chi \cdot e_z(r) = 0, \tag{1}$$

If the parameter α depends on r, i.e. $\alpha = \alpha(r)$, then this equation takes the form:

$$\frac{e_r(r)}{r} + e_r'(r) + e_r(r)\alpha(r)\alpha'(r) - \frac{e_\varphi(r)}{r}\alpha - \chi \cdot e_z(r) = 0,$$

For $e_z(r) = 0$ and $e_\varphi(r) = e_\varphi(r)$ it takes the form:

$$\frac{e_r}{r} + e_r' + e_r\alpha\alpha' - \frac{e_r}{r}\alpha = 0, \tag{2}$$

or

$$\left(\frac{1}{r}(1-\alpha) + \alpha\alpha'\right)e_r + e_r' = 0, \tag{3}$$

Let's denote:

$$y(x) = e_r(r) \tag{4}$$

and from (3, 4) we get:

$$\frac{dy}{dx} = \left(\frac{1}{x}(\alpha - 1) - \alpha\alpha'\right)y. \tag{5}$$

The solution to this equation is known and has the form:

$$y = Ae^F,$$

$$F = \int\left(\frac{1}{r}(\alpha-1) - \alpha\alpha'\right)dr = (\alpha-1)\log(r) - \frac{\alpha^2}{2},$$

$$e^F = \exp\left((\alpha-1)\log(r) - \frac{\alpha^2}{2}\right) = x^{(\alpha-1)}\exp\left(-\frac{\alpha^2}{2}\right)$$

$$= \left(\exp\left(-\frac{\alpha^2}{2}\right)x^{(\alpha-1)}\right)$$

Returning to the previous notation, we find

$$e_r(r) = A\left(\exp\left(-\frac{\alpha(r)^2}{2}\right)r^{(\alpha(r)-1)}\right). \tag{6}$$

We need to find a decreasing function in which the condition

$$\alpha(r=0) = 1 \tag{7}$$

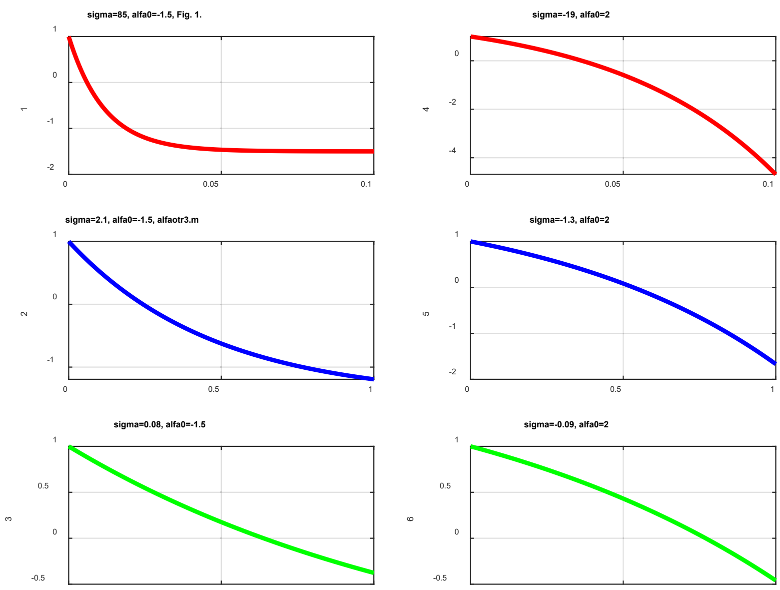
so that for $r = 0$ we get $r^{(\alpha(r)-1)} = 0$. We will use the following function

$$\alpha(r) = 1 + (\alpha_o - 1)\big(1 - \exp(-\sigma r)\big). \tag{8}$$

In this function

$$\begin{Bmatrix} \sigma > 0, \text{if } \alpha_o < 0 \\ \sigma < 0, \text{if } \alpha_o > 0 \end{Bmatrix} \tag{9}$$

Fig. 1 shows functions (8) for various values of α_o, σ, R (the value of R is the maximum value on the abscissa).



All equations (2.1.28-2.1.35) can be transformed in the same way. In addition, here we will not consider longitudinal strengths. Then equations (2.1.28-2.1.31) will take the form:

$$\frac{e_r}{r} + \dot{e}_r - \frac{e_\varphi}{r}\alpha - \chi e_z = 0, \tag{10}$$

$$-\frac{e_z}{r}\alpha + e_\varphi \chi - \frac{\mu\omega}{c} k e_r = 0, \tag{11}$$

$$-\dot{e}_z + e_r \chi - k\frac{\mu\omega}{c} e_\varphi = 0, \tag{12}$$

$$\frac{e_\varphi}{r} + \dot{e}_\varphi - \frac{e_r}{r}\alpha - k\frac{\mu\omega}{c} e_z = 0, \tag{13}$$

The solution of these equations will differ from formulas (4.3-4.8) only in the form of equation (4.5), which in this case will take the form (6).

From (3.7, 6, 4.6) we find the density of the electromagnetic energy flux at a given radius r

$$S(r) = \frac{c}{4\pi}\sqrt{\frac{\varepsilon}{\mu}} e_r^2(r). \tag{14}$$

and then, according to (3.8), the energy flux in the cylinder with radis R:

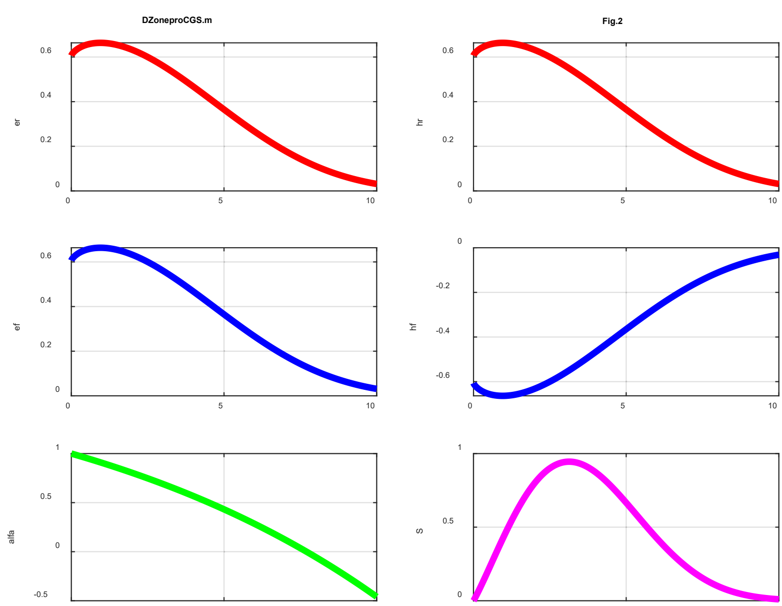
$$\overline{\overline{S_z}} = \frac{c}{4\pi}\iint_{r,\varphi}(S(r)dr \cdot d\varphi) = \frac{c}{2}\sqrt{\frac{\varepsilon}{\mu}}\int_0^R (re_r^2 dr). \tag{15}$$

or

$$\overline{\overline{S_z}} = \frac{c}{4\pi}\iint_{r,\varphi}(S(r)dr \cdot d\varphi) = \frac{c}{2}\sqrt{\frac{\varepsilon}{\mu}}\int_0^R (re_r^2 dr). \tag{16}$$

where

$$S_o(r) = (re_r^2). \tag{17}$$



In fig. 2 shows the functions $\alpha(r), e_r(r), S_o(r)$ - see (8, 6, 17) for $R = 10, \sigma = 0.09, \alpha_o = 2, A = 1$. It is seen that the functions $e_r(r), S_o(r)$ take zero values for $r > R$. This means that an electromagnetic wave exists in a cylinder with a certain radius. It makes sense to call such a wave a cylindrical wave.

Some reader will exclaim: "Ha! The wave function is known, in which there are no additional parameters. And here a solution is proposed *in which you need to select some parameters. Who is looking for and installing them? "*

My answer is this. The wave function arises as a result of processes unknown to us so far, and this result is described as a solution to Maxwell's equations. The reason for this state of affairs is still unknown to us. But our belief that the wave function exists is justified by the fact that it is a solution to Maxwell's equations and nothing more. Consequently, it can be argued that any solution of Maxwell's equations is realized physically under condition (3.6) - whatever this solution may be.

It turns out that the wave function cannot exist physically, but there are various other functions, less elegant, but existing physically.

Thus, there is a solution to Maxwell's equations that describe a cylindrical wave.

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Solving Maxwell's Equations for AC Wire

Annotation

It is indicated that an electromagnetic wave propagates in an AC wire. The well-known solution of Maxwell's equations in the form of a wave equation is not acceptable, if only because in such a solution the law of conservation of energy is fulfilled only on average.

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2. Solving Maxwell's Equations
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1. Introduction

At present, the applicability of Maxwell's equations to all phenomena of electrodynamics and electrical devices without exception is indisputable. However, it is not always possible to describe these phenomena and devices in the form of a solution to the complete system of Maxwell's equations, and not a certain subset of this system. The same applies to the AC wire. Below, an electromagnetic wave in an alternating current wire is described as a solution to the full system of Maxwell's equations. It is important to note that the well-known solution of Maxwell's equations in the form of a wave equation is not acceptable, if only because in such a solution the energy conservation law is fulfilled only on average.

Maxwell's equations for vacuum cannot be used directly for AC wire, since the wire has conduction currents and dielectric constant. In the case under consideration, Maxwell's equations have the form:

$$\mathrm{rot}(E) + \frac{\mu}{c}\frac{\partial H}{\partial t} = 0, \quad (1)$$

$$\mathrm{rot}(H) - I = 0, \quad (2)$$

$$\mathrm{div}(E) = 0, \quad (3)$$

$$\mathrm{div}(H) = 0, \quad (4)$$

$$\mathrm{div}(I) = 0, \quad (5)$$

where E is electric strengths, H is magnetic strengths, I is conduction currents, μ - absolute magnetic permeability.

2. Solving Maxwell's Equations

In the system of cylindrical coordinates, these equations have the form:

$$\frac{E_r}{r}+\frac{\partial E_r}{\partial r}+\frac{1}{r}\cdot\frac{\partial E_\phi}{\partial \phi}+\frac{\partial E_z}{\partial z}=0, \quad (1)$$

$$\frac{1}{r}\cdot\frac{\partial E_z}{\partial \phi}-\frac{\partial E_\phi}{\partial z}=\frac{\mu\omega}{c}\frac{dH_r}{dt}, \quad (2)$$

$$\frac{\partial E_r}{\partial z}-\frac{\partial E_z}{\partial r}=\frac{\mu\omega}{c}\frac{dH_\phi}{dt}, \quad (3)$$

$$\frac{E_\phi}{r}+\frac{\partial E_\phi}{\partial r}-\frac{1}{r}\cdot\frac{\partial E_r}{\partial \phi}=\frac{\mu\omega}{c}\frac{dH_z}{dt}, \quad (4)$$

$$\frac{H_r}{r}+\frac{\partial H_r}{\partial r}+\frac{1}{r}\cdot\frac{\partial H_\phi}{\partial \phi}+\frac{\partial H_z}{\partial z}=0, \quad (5)$$

$$\frac{1}{r}\cdot\frac{\partial H_z}{\partial \phi}-\frac{\partial H_\phi}{\partial z}=I_r, \quad (6)$$

$$\frac{\partial H_r}{\partial z}-\frac{\partial H_z}{\partial r}=I_\varphi, \quad (7)$$

$$\frac{H_\phi}{r}+\frac{\partial H_\phi}{\partial r}-\frac{1}{r}\cdot\frac{\partial H_r}{\partial \phi}=I_z, \quad (8)$$

$$\frac{I_r}{r}+\frac{\partial I_r}{\partial r}+\frac{1}{r}\cdot\frac{\partial I_\phi}{\partial \phi}+\frac{\partial I_z}{\partial z}=0, \quad (9)$$

We will search for unknown functions in the following form:

$$H_r.=h_r(r)\mathrm{co}, \quad (10)$$

$$H_\phi.=h_\phi(r)\mathrm{si}, \quad (11)$$

$$H_z.=h_z(r)\mathrm{si}, \quad (12)$$

$$E_r.=e_r(r)\mathrm{si}, \quad (13)$$

$$E_\phi.=e_\phi(r)\mathrm{co}, \quad (14)$$

$$E_z.=e_z(r)\mathrm{co}, \quad (15)$$

$$I_r.=i_r(r)\mathrm{sic}, \quad (16)$$

$$I_\phi.=i_\phi(r)\mathrm{coc}, \quad (17)$$

$$I_z.=i_z(r)\mathrm{sic}, \quad (18)$$

where

$$\mathrm{co}=\cos(\alpha\varphi+\chi z)\cos(\omega t), \quad (19)$$

$$\mathrm{si}=\sin(\alpha\varphi+\chi z)\sin(\omega t), \quad (20)$$

$$\mathrm{coc}=\cos(\alpha\varphi+\chi z)\sin(\omega t), \quad (21)$$

$$\mathrm{sic}=\sin(\alpha\varphi+\chi z)\cos(\omega t), \quad (22)$$

By direct substitution, one can make sure that functions (10-18) transform the system of equations (1-9) with four arguments r, ϕ, z, t into a system of equations with one argument and unknown functions $h(r), e(r), i(r)$. This system of equations is as follows:

$$\frac{e_r(r)}{r} + e_r'(r) - \frac{e_\phi(r)}{r}\alpha - \chi \cdot e_z(r) = 0, \tag{21}$$

$$-\frac{1}{r} \cdot e_z(r)\alpha + e_\phi(r)\chi - \frac{\mu\omega}{c} h_r = 0, \tag{22}$$

$$e_r(r)\chi - e_z'(r) + \frac{\mu\omega}{c} h_\phi = 0, \tag{23}$$

$$\frac{e_\phi(r)}{r} + e_\phi'(r) - \frac{e_r(r)}{r} \cdot \alpha + \frac{\mu\omega}{c} h_z = 0, \tag{24}$$

$$\frac{\boldsymbol{h}_r(r)}{r} + \boldsymbol{h}_r'(r) + \frac{\boldsymbol{h}_\phi(r)}{r}\alpha + \chi \cdot \boldsymbol{h}_z(r) = 0, \tag{25}$$

$$\frac{1}{r} h_z(r) \propto -h_\varphi(r) - i_r(r) = 0, \tag{26}$$

$$-h_r(r)\chi - \dot{h}_z(r) - i_\varphi(r) = 0, \tag{27}$$

$$\frac{h_\varphi(r)}{r} + \dot{h}_\varphi(r) + \frac{h_r(r)}{r} \propto -i_z(r) = 0. \tag{28}$$

$$\frac{i_r(r)}{r} + i_r'(r) + \frac{i_\phi(r)}{r}\alpha + \chi \cdot i_z(r) = 0. \tag{29}$$

Next, we introduce into consideration the coefficient k, which connects the functions h and e:

$$h_r = ke_r, \tag{30}$$

$$h_\varphi = -ke_\varphi. \tag{31}$$

$$h_z = -ke_z. \tag{32}$$

We perform the change of variables according to (30-32) in equations (21-29) and rewrite them

$$\frac{e_r}{r} + \dot{e}_r - \frac{e_\varphi}{r}\alpha - \chi e_z = 0, \tag{33}$$

$$-\frac{e_z}{r}\alpha + e_\varphi\chi - \frac{\mu\omega}{c} ke_r = 0, \tag{34}$$

$$-\dot{e}_z + e_r\chi - k\frac{\mu\omega}{c} e_\varphi = 0, \tag{35}$$

$$\frac{e_\varphi}{r} + \dot{e}_\varphi - \frac{e_r}{r}\alpha + k\frac{\mu\omega}{c} e_z = 0, \tag{36}$$

$$k\frac{e_r}{r} + k\dot{e}_r + k\frac{e_\varphi}{r}\alpha - k\chi e_z = 0, \tag{37}$$

$$-k\frac{e_z}{r}\alpha + ke_\varphi\chi - i_r = 0, \tag{38}$$

$$k\dot{e}_z - ke_r\chi - i_\varphi = 0, \tag{39}$$

$$-k\frac{e_\varphi}{r} - k\dot{e}_\varphi + k\frac{e_r}{r}\alpha - i_z = 0, \tag{40}$$

$$\frac{i_r}{r} + i_r' + \frac{i_\phi}{r}\alpha + \chi \cdot i_z = 0. \tag{41}$$

Note that equations (33) and (40) coincide for

$$i_z = -k\chi e_z \tag{42}$$

Note that equations (34) and (38) coincide for

$$i_r = \frac{\mu\omega}{c} ke_r. \tag{43}$$

Note that equations (35) and (39) coincide for

$$i_\varphi = k\frac{\mu\omega}{c}e_\varphi. \tag{44}$$

Note that equations (36) and (40) coincide for

$$i_z = -k\frac{\mu\omega}{c}e_z. \tag{45}$$

Из (42, 45) находим:

$$\chi = \frac{\mu\omega}{c} \tag{46}$$

Considering (33, 41, 44, 45), we note that equations (33, 41) coincide. Finally, equations (33) and (37) coincide.

Thus, equations (37-41) can be excluded from the system of equations and replaced by conditions (42-46). The remaining 4 equations (33-36) are a system of differential equations with three unknowns e_r, e_φ, e_z. Let's rewrite (33-36) taking into account (46) and get:

$$\frac{e_r}{r} + \dot{e}_r - \frac{e_\varphi}{r}\alpha - \chi e_z = 0, \tag{47}$$

$$-\frac{e_z}{r}\alpha + e_\varphi\chi - \chi k e_r = 0, \tag{48}$$

$$-\dot{e}_z + e_r\chi - k\chi e_\varphi = 0, \tag{49}$$

$$\frac{e_\varphi}{r} + \dot{e}_\varphi - \frac{e_r}{r}\alpha + k\chi e_z = 0. \tag{50}$$

Adding (48, 49), we get:

$$-\dot{e}_z - \frac{e_z}{r}\alpha + \chi(1-k)(e_\varphi + e_r) = 0, \tag{51}$$

or

$$(e_\varphi + e_r) = \frac{1}{\chi(1-k)}\left(\dot{e}_z + \frac{\alpha}{r}e_z\right), \tag{52}$$

Adding (47, 50), we get:

$$\frac{1}{r}(e_\varphi + e_r) + \frac{d}{dr}(e_\varphi + e_r) - \frac{\alpha}{r}(e_\varphi + e_r) - (1-k)\chi e_z = 0$$

or

$$\frac{d}{dr}(e_\varphi + e_r) + \frac{1-\alpha}{r}(e_\varphi + e_r) - (1-k)\chi e_z = 0 \tag{53}$$

Combining (52, 53), we get:

$$\frac{1}{\chi(1-k)}\frac{d}{dr}\left(\dot{e}_z + \frac{\alpha}{r}e_z\right) + \frac{1-\alpha}{r}\cdot\frac{1}{\chi(1-k)}\left(\dot{e}_z + \frac{\alpha}{r}e_z\right) - (1-k)\chi e_z = 0$$

or

$$\left(\ddot{e}_z + \frac{\alpha}{r}\dot{e}_z - \frac{\alpha}{r^2}e_z\right) + \frac{1-\alpha}{r}\left(\dot{e}_z + \frac{\alpha}{r}e_z\right) - (1-k)^2\chi^2 e_z = 0$$

or

$$\ddot{e}_z + \left(\frac{\alpha}{r} + \frac{1-\alpha}{r}\right)\dot{e}_z + \left(-\frac{\alpha}{r^2} + \frac{1-\alpha}{r}\cdot\frac{\alpha}{r} - (1-k)^2\chi^2\right)e_z = 0 \tag{54}$$

We got the Bessel equation. According to (46), we can take

$$\chi \approx 0 \tag{55}$$

Then equation (54) takes the form:

$$\ddot{e}_z + \frac{1}{r}\dot{e}_z + \frac{\alpha^2}{r^2}e_z = 0 \tag{56}$$

The solution to this equation has the form

$$e_z = Ar^\alpha, \tag{57}$$

where A is some constant. Indeed, substituting (57) into (56), we obtain

$$(\alpha-1)\alpha r^{\alpha-2} + \frac{\alpha}{r}r^{\alpha-1} - \frac{\alpha^2}{r^2}r^\alpha = 0$$

or

$$(\alpha-1)\alpha + \alpha - \alpha^2 = 0,$$

which is an identity.

It is important to note that for $\alpha < 0$ it follows from (57) that the strength increases with increasing radius, which can <u>explain the skin effect</u> without additional assumptions.

Now we find e_φ and e_r, assuming that

$$e_\varphi = AN\, r^{\alpha-1}, \tag{58}$$

$$e_r = AMr^{\alpha-1}, \tag{59}$$

where M and N are unknowns. Substituting (58, 59) in (48, 49), we find:
где M и N - неизвестные. Подставляя (58, 59,57в) в (48, 49), находим:

$$-\frac{\alpha}{r}Ar^{2-\alpha} + \chi AN\, r^{\alpha-1} - \chi kAMr^{\alpha-1} = 0,$$

$$-\alpha Ar^{\alpha-1} + \chi AMr^{1-\alpha} - k\chi AN\, r^{\alpha-1} = 0$$

or

$$-\alpha + \chi N - \chi kM = 0, \tag{60}$$

$$-\alpha + \chi M - k\chi N = 0. \tag{61}$$

It is seen that $N = M$. Hence,

$$-\alpha + \chi(1-k)N = 0,$$

or

$$N = M = \frac{\alpha}{\chi(1-k)}. \tag{62}$$

Thus,

$$e_r = e_\varphi = A\frac{\alpha}{\chi(1-k)}\, r^{1-\alpha}. \tag{64}$$

Obviously,

$$i = e/\rho, \tag{66}$$

where ρ is the resistivity. Moreover, from (42, 46) we find:

$$\rho = -\frac{1}{k\chi}. \tag{67}$$

Since the values of ϱ are known, we obtain:

$$k = -\frac{1}{\chi\rho}. \tag{68}$$

From (43-46, 68) we get:

$$i_z = e_z/\rho, \tag{69}$$
$$i_r = -e_z/\rho, \tag{70}$$
$$i_\varphi = -e_z/\rho. \tag{71}$$

So, the solution has the form of equations (10-22), where

- the functions $e(r)$ are defined by (64, 57),
- the functions $i(r)$ are defined by (69,70,71),
- the functions $h(r)$ are defined by (30, 31, 32, 68).

Let's find another voltage on a wire with a length L

$$U = \int_0^L E_z dz = e_z \int_0^L \mathrm{co} \cdot dz. \tag{72}$$

3. Energy flows

The flux density of electromagnetic energy - the Poynting vector is determined by the formula

$$S = \eta E \times H\ , \tag{1}$$

where

$$\eta = c/4\pi\ . \tag{2}$$

In cylindrical coordinates r, ϕ, z, the electromagnetic energy flux density has three components S_r, S_ϕ, S_z directed along the radius, along the circumference, along the axis, respectively [1]. They are determined by the formula

$$S = \begin{bmatrix} S_r \\ S_\varphi \\ S_z \end{bmatrix} = \eta(E \times H) = \eta \begin{bmatrix} E_\varphi H_z - E_z H_\varphi \\ E_z H_r - E_r H_z \\ E_r H_\varphi - E_\varphi H_r \end{bmatrix}. \tag{3}$$

or, taking into account the previous formulas,

$$S_r = \eta\left(e_\varphi h_z - e_z h_\varphi\right)\mathrm{co} \cdot \mathrm{si}, \tag{4}$$
$$S_\varphi = \eta(e_z h_r \mathrm{co}^2 - e_r h_z \mathrm{si}^2), \tag{5}$$
$$S_z = \eta\left(e_r h_\varphi \mathrm{si}^2 - e_\varphi h_r \mathrm{co}^2\right). \tag{6}$$

Substituting here (2.33-2.35, 2.68-2.70), we get:

$$S_r = \eta\left(-k e_\varphi e_z + k e_z e_\varphi\right)\mathrm{co} \cdot \mathrm{si}, \tag{7}$$
$$S_\varphi = \eta(k e_z e_r \mathrm{co}^2 + k e_r e_z \mathrm{si}^2) = \eta k e_r e_z, \tag{8}$$
$$S_z = \eta\left(-k e_r e_\varphi \mathrm{si}^2 - k e_\varphi e_r \mathrm{co}^2\right) = -\eta k e_r e_\varphi. \tag{9}$$

Substituting (2.64, 2.65) here, we find that there are two energy fluxes in the wire with a density

$$S_\varphi = \eta k A^2 \frac{1}{2\chi} r^{2\alpha-1}, \tag{10}$$

$$S_z = -\eta k A^2 \frac{2\alpha-1}{4\chi^2} r^{2\alpha-2}. \tag{11}$$

Given these known densities, the unknowns A and α can be found from (10, 11).

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Series: **PHYSICS**

Valery A. Etkin

Principle of processes discernibility

Annotation

The fundamental role of the principle of distinguishability of processes in the construction of fundamental disciplines is revealed. It establishes the correspondence of the number of degrees of freedom of a system to the number of processes occurring in it and prevents methodological errors in the mathematical apparatus of the systems studied. According to him, the study of nonequilibrium systems requires the introduction of additional parameters of heterogeneity. This leads to a generalization of the law of conservation of energy and allows you to abandon the idealization of processes, to avoid the occurrence of thermodynamic inequalities in the study of irreversible processes and to carry out the synthesis of fundamental disciplines.

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2. Distinguishability of processes as the basis for finding state coordinates
3. The heuristic value of the principle of distinguishability of processes
4. The principle of distinguishability as an antipode of the principle of relativity.
5. Conclusion
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1. Introduction.

Each fundamental discipline classifies the studied processes in accordance with its methodology and conceptual system. Mechanics, for example, distinguish between processes of rectilinear and curvilinear, uniform and accelerated motion. Classical thermodynamics distinguishes between isochoric and isobaric, isothermal and adiabatic, reversible and irreversible processes [1]. The theory of irreversible processes (TIP) [2] and physical kinetics classifies processes for reasons that cause them, distinguishing, in particular, concentration diffusion, thermal diffusion, and barodiffusion. The theory of heat transfer, on the contrary, distinguishes processes from the mechanism of energy transfer, dividing it into conductive, convective, and radiant [3]. Electrodynamics, where all processes are associated with a charge, distinguishes processes by their consequences, distinguishing between electrification and polarization, magnetization and radiation of electromagnetic waves, electrical conductivity and flux linkage [4].

However, when developing a unified theory of nonequilibrium processes of transfer and conversion of any form of energy, which is the energy dynamics [5], it is necessary not only to combine these methods. The fact is that in such systems the same state changes (for example, an increase in temperature) can be caused by both external heat transfer and the appearance of internal heat sources due to friction, chemical reactions, high-frequency heating, magnetization reversal, etc. Similarly, the volumetric deformation of a system can be caused not only by the completion of the compression work but also by chemical transformations within the system. In the same way, changes in the composition of the system can be achieved both by diffusion of suitable substances across the boundaries of the system and by chemical reactions in it. Therefore, in any theory of nonequilibrium systems, processes should be classified regardless of what caused these or other changes in the state — by external energy exchange or by internal (including relaxation) processes. This article is devoted to finding a way to distinguish between processes for this case.

2. Distinguishability of processes as the basis for finding state coordinates

In energy dynamics, which adheres to the deductive method of research and a systematic approach to its object, the principle of distinguishability of processes is formulated in the most general way: "there are independent processes that differ only in the causes that cause them and the conditions of their course, but also in special, phenomenologically distinct and irreducible to other changes the state of the system that they cause [5].

Based on this principle, which is axiomatic in nature, it is easy to prove "by contradiction" the theorem on the number of degrees of freedom, according to which "the number of independent arguments of the energy of the system U as a function of its state is equal to the number of independent processes taking place in it". The proof is based on the fact that any deviation from this principle in one direction or another leads to the loss of independence of either some of the energy arguments or some of the processes taking place in the system. This establishes the necessary and sufficient conditions for an adequate description of the properties of the system under study, which avoids both "underdetermination" and "overdetermination" of the system1).

Violation of this principle is the main source of methodological errors in most modern theories. As an example of "underdetermination", we can refer to the hypothesis of local equilibrium [6], which assumes the presence of equilibrium in the elements of the continuum (despite the occurrence of the same processes in them as outside them), the possibility of describing their state with the same set of variables as in equilibrium (despite the appearance of potential gradients) and the validity for them of all equations of equilibrium thermodynamics (despite their inevitable transition to inequalities in the presence of irreversibility). As an opposite example, we can point to attempts to introduce "hidden variables", "additional (including" collapsed "measurements"), to assign rotational degrees of freedom to material points, etc.

The principle of distinguishability draws a clear line between the concept of the state coordinate and the process coordinate, i.e., a physical quantity, the change of which is a necessary and sufficient sign of the course of this process. This means that the coordinate can only be a parameter that does not change while other processes occur in the same system. It was this requirement that gave rise to the well-known problem of finding the coordinates of equilibrium heat transfer, which R. Clausius called entropy for a completely different property [1]. Such a coordinate could only become a parameter that would not change in the absence of heat transfer (in adiabatic processes). Hence the requirement of the reversibility of the process, i.e., the absence of sources of the heat of friction, chemical, and other transformations. The same applies to the coordinates of any other process. Violation of this requirement immediately led to the emergence of "thermodynamic inequalities." This is the reason why most fundamental theories limit themselves to the study of the so-called "conservative systems", where such sources are absent.

The goal set by the energy dynamics of the synthesis of theories of transfer and conversion of any form of energy required the rejection of the classification of processes for the reasons, methods and consequences of energy exchange and the transition to finding the coordinates of the state regardless of whether its changes are caused by external energy exchange (as in equilibrium systems) or internal irreversible (relaxation) processes. This is where the principle of distinguishability of processes becomes necessary. Let us show this by the example of the so-called "heat process", by which K. Putilov understood the change in the internal thermal energy of the system dU_q, whatever it was caused by heat supply $đQ$ from the outside or heat dissipation $đQ^д$ in the system itself [7]:

$$dU_т = đQ + đQ^д. \qquad (1)$$

The partial differential sign $đ$, proposed by S. Newman in 1875, emphasizes that in this case it is not a change in any quantity Q or W, but their elementary number.

R. Clausius called this value "the total heat of the body", defining it as the sum of the heat received from the outside and the work of "disgregation" (dissipative nature) [8]. In this case, the quotient of dividing the total differential of one state parameter U_q by another parameter (absolute temperature T) is obviously the total differential, so the existence of entropy S as a state parameter and the coordinate of the heat process already S does not require complex justification:

$$dS = dU_т/T = đQ/T + đQ^д/T = d_eS + d_iS, \qquad (2)$$

where d_eS, d_iS are the changes in entropy caused by external heat transfer and internal dissipation heat sources, respectively [6].

Such a record is characteristic, generally speaking, not only for entropy but also for other state parameters. In particular, a change in the number of moles of k-th substances N_k in a multicomponent system can be caused not only by their diffusion across the boundaries of the system but by chemical reactions within the system. The total (free and bound) charge can also be changed to only as a result of electrical conductivity, but also the inhomogeneous polarization of the system. In all such cases, the extensive parameters of nonequilibrium systems Θi cease to be the coordinates of the corresponding energy exchange processes $\Theta_i(t)$, but remain, however, a quantitative measure of the carrier of the ith form of energy U_i. With this approach, entropy takes on the meaning of a thermal pulse, that is, the amount of internal motion of microparticles of a substance that has lost its vector nature due to its randomness [5]. Such an interpretation of entropy justifies the concept of the flow of entropy in TIP, which cannot be said about entropy as a measure of probability.

Expression (2) indicates the need to distinguish the changes dΘi of the state coordinates Θi from the changes $d_e\Theta_i(t)$ of the energy exchange coordinates $\Theta_i(t)$ as functions of the process. This became especially obvious with the transition to the study of open systems in which another type of energy transfer appeared - mass transfer, which is due to the transfer of matter across the boundaries of the system and cannot be reduced to either heat or work [9]. Thus, when considering nonequilibrium systems, it became necessary to refuse to find the energy exchange coordinates Θ_i (t) and to move on to finding arguments Θ_i of energy as a function of the state of the system $U_i(\Theta_i)$.

3. The heuristic value of the principle of distinguishability of processes

The principle of distinguishability of processes allows us to prove that any processes arise only in inhomogeneous (internally nonequilibrium) systems. Indeed, expressing the speed of a process with the total time derivative of the corresponding independent extensive parameter Θ_i and representing it as an integral of the local ϱi and average density $\Theta_i = \int \varrho_i dV = \int \overline{\rho}_i \, dV$, we find:

$$\int [d(\varrho_i - \overline{\rho}_i)/dt] dV = 0. \qquad (3)$$

It follows that any processes $d(\varrho_i - \overline{\rho}_i)/dt \neq 0$ arise in the system only because of its heterogeneity $\varrho_i - \overline{\rho}_i \neq 0$, and at least some of them have opposite directions in its different parts ($d\varrho_i/dt > 0$ and и $d\varrho_i/dt < 0$). This means that when the continuum system is split into an infinite number of equilibrium elements of volume dV as objects of study, we "splash out the water with the child as well". Instead, in order to describe the state of nonequilibrium (spatially inhomogeneous) media as a whole, the introduction of additional variables is necessary. these are the "distribution moments" $\boldsymbol{Z}_i = \Theta_i \boldsymbol{R}_i$, characterizing the shift $\Delta \boldsymbol{R}_i$, of the radius vector $\boldsymbol{R}_i$, of the center of the extensive quantity Θ_i from its equilibrium position $\boldsymbol{R}_{io} = 0$. This kind of state change is caused by the work "against equilibrium" in the system or vector relaxation processes accompanied by temperature equalization, pressure, chemical and other potentials of the system.

Thus, in accordance with the principle of distinguishability, the state of a spatially heterogeneous system is characterized in the general case by doubled (in comparison with equilibrium systems) the number of variables Θ_i and $\boldsymbol{R}_i$, where i is the number of energy forms of the system. This means that the energy of such a system as a function of its state has the form $U = =\Sigma_i U_i(\Theta_i, \boldsymbol{R}_i)$, and the expression of its total differential takes on the character of identity:

$$dU \equiv \Sigma_i \Psi_i d\Theta_i + \Sigma_i \boldsymbol{F}_i \cdot d\boldsymbol{R}_i, \ (i = 1,2,\ldots, n) \qquad (4)$$

where $\Psi_i \equiv (\partial U_i/\partial \Theta_i)$ are the averaged values of the potential of the system (absolute temperature T, pressure p, chemical potential of the kth substance, its electric potential, etc.; $\boldsymbol{F}_i \equiv (\partial U_i/\partial \boldsymbol{R}_j)$ are the forces in their general physical sense.

Identity (4) as applied to isolated systems ($dU_{iz} = 0$) reflects the law of conservation of their energy. According to him, the energy of each independent degree of freedom of the system U_i can change both as a result of its transfer across the boundaries of the system (its first sum), and due to the performance of work

$$đW_i = \boldsymbol{F}_i \cdot d\boldsymbol{R}_i. \qquad (5)$$

as a quantitative measure of the transformation of other *j*-forms of energy into it. In this case, the forces $\boldsymbol{F}_i$ acquire a single meaning of the gradient of the corresponding form of energy, a single analytical expression, and a single dimension. Thus, identity (4) gives the most complete mathematical formulation of the law of conservation and transformation of energy, covering both equilibrium and nonequilibrium states, both the processes of energy transfer (1st sum) and the processes of its transformation (2nd sum). Moreover, it covers all possible forms of energy inherent in open and closed, closed and open, isolated and uninsulated systems. This allows us to give the energy *U* a simple and clear sense of the most general function of the state of the system characterizing its ability to act [5].

In equilibrium (homogeneous) systems, identity (4) becomes the generalized equation of the 1st and 2nd principles of the classical thermodynamics of open systems

$$dU \equiv \Sigma_i \Psi_i d\Theta_i, \qquad (6)$$

thereby confirming the failure of the local equilibrium hypothesis. It is also valid for any values of the quantities included in it, regardless of whether they take into account the contribution of dissipative processes or not. Therefore, it is applicable to any processes (both reversible and irreversible). This will solve the well-known "problem of thermodynamic inequalities", consisting of the transition of equation (6) to inequality in the case of irreversible processes. However, now the terms $\Psi_i d\Theta_i$ no longer characterize the heat transfer or the operation of the system, since the total differentials $d\Theta_i$ also take into account the internal sources of coordinates Θ_i. At the same time, there is no need to idealize processes expressed by the concepts of "reversible", "equilibrium", "quasistatic", etc.

4. The principle of distinguishability as an antipode of the principle of relativity.

As early as 1632, in the book "Dialogue on the two major systems of the world - the Ptolemaic and the Copernican", Galileo noted as a fact that if a stone is moved straight and evenly from a mast, then it falls as if on a stationary ship to the foot masts. In particular, in the hold of a ship sailing uniformly and rectilinearly, no experiments can detect its movement relative to the aquatic environment and land. This position, known as the "principle of relativity of Galileo", was laid by I. Newton in the foundation of his 1st law [10]. It followed from it that no mechanical experiments carried out inside a closed mechanical system can establish whether a given body is at rest or moves uniformly and rectilinearly.

A. Poincare in 1895 extended this principle to electromagnetic phenomena, calling it the postulate of relativity. According to him, not only mechanical but also electromagnetic experiments performed inside an arbitrary reference frame, it is impossible to establish a difference between the states of rest and uniform rectilinear motion. It followed that physical laws should be formulated in such a way that the rest and uniform rectilinear movement of the system are indistinguishable [11].

A. Einstein in 1905 extended the postulate of relativity to all natural phenomena and laid it the foundation of the special theory of relativity (STR). Soon, he formulated the principle of local indistinguishability of gravitational and inertial forces, calling it the principle of equivalence of inertial and gravitational masses and putting it in the foundation of the general theory of relativity (GR). Then it was joined by the principle of indistinguishability of accelerated and rotational motions, which essentially extended the indistinguishability of the dynamic effects of acceleration and gravity to non-inertial reference systems [12]. So the principle of indistinguishability, which essentially is the principle of relativity, was the basis of all theoretical physics. In electrodynamics, this was expressed in the principle of indistinguishability of electrons in a metal; in elementary particle physics - in principle the indistinguishability of identical particles; in QED - in the indistinguishability of matter and field; in a unified field theory - in the statement about the possibility of merging together (under certain conditions - to complete indistinguishability) of three of the four known types of interaction. And all this was done contrary to the principle of distinguishability by extrapolating the Galileo principle, which is valid only for translational motion. Meanwhile, in the Universe, rotational motion prevails, for which there is a preferred CO. As a result, the well-known idea of Leibniz about the absence of two completely identical things in nature (its analog to the principle of distinguishability) was supplanted by principles of the opposite nature, which ultimately gave rise to the indistinguishability of truth and error.

5. Conclusion

As we see, the classification of processes according to the principle of their distinguishability not only eliminates the need to idealize processes and systems in the foundations of the theory, but also prevents inequalities in the analytical expressions of heat transfer and work in non-conservative systems, paving the way for the synthesis of fundamental disciplines on a general conceptual and methodological basis. The heuristic value of this principle is confirmed by the entire centuries-old history of the successful development of natural science and the very fact of the "branching" of a single tree of science as we study a new group of processes and increase the number of degrees of freedom of the system under study.

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Series: **PHYSICS**

Valery A. Etkin

Alternative to the theory of inversible processes

Annotation

We propose a thermodynamic theory that does not exclude from consideration any (reversible or irreversible) part of the real processes of energy transfer and conversion. This is achieved by the fact that the main quantities used by the thermodynamics of irreversible processes (TIP) - forces and flows - are found in it not on the basis of the principle of increasing entropy, but from the law of conservation of energy. This way of constructing TIP prevents the occurrence of thermodynamic inequalities and allows one to substantiate all its provisions without invoking the postulates and considerations of a molecular-kinetic and statistical-mechanical nature. This opens up the possibility of further reducing the number of empirical coefficients and expanding the scope of TIP applicability to nonlinear systems and states that are far from equilibrium, as well as to energy conversion processes which are primarily of interest to power engineers, technologists, biophysicists and astrophysicists. At the same time, the unity of the laws of transformation of all forms of energy and the difference between their equations, reciprocity relations and efficiency criteria from the generally accepted ones are proved. On this basis, a theory of similarity of power plants is proposed and their universal load characteristics are constructed, which make it possible to take the next step towards bringing the results of the thermodynamic analysis of their efficiency closer to reality.

Contens

1. Introduction
2. Preventing the transformation of equations of thermodynamics into inequalities
3. Thermodynamic derivation of the Onsager reciprocal relations
4. The method of finding "superposition effects" without using Onsager relations.

5. Establishing the fundamental difference between the laws of relaxation and energy conversion
6. Development of a universal criterion for the efficiency of energy converters
7. Construction of a theory of similarity of power plants
8. Summary and Conclusion
References

1. Introduction

In the history of science there are frequent cases when a new theory brought in significant change in the natural science paradigm. The last part of the twentieth century was no exception; as this paradigm shift occurred in the fundamental theories of the thermodynamics of irreversible processes (TIP). Researchers from many countries contributed to its creation [1-11]. It enriched the theoretical thought of the twentieth century with the "principle of reciprocity" of heterogeneous phenomena, sometimes called the "fourth law of thermodynamics", and explained the many effects that arise at the junctions of fundamental disciplines due to the simultaneous occurrence of several non-static processes. However, later on, interest in this theory began to fade. To a large extent this is due, in our opinion, to the fact that the basic quantities underlying this theory, thermodynamic forces $\mathbf{X}_i$ and fluxes $\mathbf{J}_i$, are included on the basis of the principle of entropy increase, which exclude from consideration the reversible component of real processes. Yet it is precisely this component, connected to the execution of useful external work W^e, which is of interest primarily in fields related to energy, technology, biophysics and astrophysics. This drawback can be eliminated by switching to finding these forces and fluxes on a basis of a more general law of conservation of energy. We shall consider the advantages that nonequilibrium thermodynamics gains as a result.

2. Preventing the transformation of equations of thermodynamics into inequalities

It is known that the equations of the 1st and 2nd laws of classical thermodynamics of open systems are combined in the form of the Gibbs relation [12]:

$$dU = TdS - pdV + \Sigma_k \mu_k dN_k \qquad (1)$$

This relation connects the internal energy U of the object (or system) under study with its entropy S, volume V and the number N_k of moles of the k^{th} substances, as well as with the generalized potentials ψ_i conjugated with them (the chemical potentials of these substances is represented by μ_k, absolute temperature by T and pressure p by.), This then becomes the inequalities:

$$\delta Q \neq TdS;\ \delta W_p \neq pdV;\ \delta W_k \neq \mu_k dN_k \qquad (2)$$

This happens because in non-equilibrium systems the parameters S, V, N_k change not only as a result of external energy exchange, but also as a result of internal relaxation processes (the number of moles N_k *is* due to chemical reactions; the volume V corresponds to the expanded form in a vacuum while not performing work; the entropy S *is* due to friction and other irreversible processes.) As a result, the energy exchange of the system with the environment can no longer be found on the basis of changes in these parameters, and the mathematical apparatus of thermodynamics based on equation (1) turns out to be inapplicable. This disadvantage can be eliminated by going directly to the fluxes of these energy carriers across the boundaries of the system. For this we use the law of conservation of energy in the form proposed by N. Umov (1873) [13]:

$$dU/dt = -\oint \boldsymbol{j}_u \cdot d\mathbf{f}, \qquad (3)$$

where $\boldsymbol{j}_u$ ($W \cdot m^{-2}$) is the internal energy flux density through the vector element $d\mathbf{f}$ of the closed surface $\mathbf{f}$ of the system of constant volume V in the direction of the external normal $\mathbf{n}$ (Figure 1).

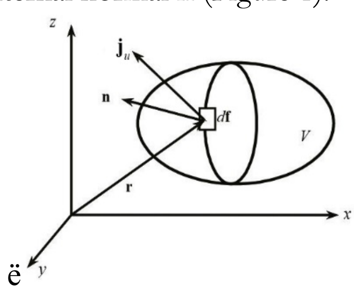

Figure 1. Energy flux through the boundary of the system Figure 1

Unlike the later equation of J. Poynting (1884), this form of the energy conservation law takes into account the kinetics of real processes, without making any assumptions about the mechanism of energy transfer in a solid media or about the internal structure of the system.

According to this equation about short-range effects, energy U does not simply disappear at some points of space and arise in others, but rather carries the i^{th} energy carrier Θ_i (with the number of moles k of the substance N_k , their corresponding charges Q_k, their entropies S_k, the impulses $\boldsymbol{P}_k$, etc.) through the fixed boundaries of the system. Let us now find the expanded form of this law, which is valid for any i^{th} material carrier of energy. For this, we will take into account that the energy flux $\boldsymbol{j}_u$ is the sum of the fluxes $\boldsymbol{j}_{ui}$ carried by each of them. These fluxes, in turn, are expressed by the product of the flux density of the i^{th} energy carrier $\boldsymbol{j}_i = \rho_i \boldsymbol{v}_i$ by its potential $\psi_i \equiv dU_i/d\Theta_i$, where $\rho_k = d\Theta_i/dV$ and $\boldsymbol{v}_i = d\boldsymbol{r}_i/dt$ are the density of the i^{th} energy carrier and the rate of its transfer across fixed boundaries systems, resp., i,e. $\boldsymbol{j}_{ui} = \psi_i \boldsymbol{j}_i$, so that

$$\boldsymbol{j}_u = \Sigma_i \boldsymbol{j}_{ui} = \Sigma_i \psi_i \boldsymbol{j}_i, \quad (4)$$

Using the Gauss-Ostrogradsky theorem, we transform the integral $\oint \boldsymbol{j}_u \cdot d\mathbf{f}$ into a volume integral $\int \nabla \cdot \boldsymbol{j}_u dV$. Then, after decomposing $\nabla \boldsymbol{j}_u = \nabla(\psi_i \boldsymbol{j}_i)$ into independent components $\Sigma_i\ \psi_i \nabla \cdot \boldsymbol{j}_i + \Sigma_i\ \boldsymbol{j}_i \cdot \nabla \psi_{ik}$, the energy conservation law (3) takes the form:

$$dU/dt + \Sigma_i \int \psi_i \nabla \cdot \boldsymbol{j}_i dV + \Sigma_i \int \boldsymbol{j}_i \cdot \nabla \psi_i dV = 0 \quad (5)$$

If we take the average value Ψ_i of the potential ψ_i and the average value $\boldsymbol{X}_i$ of the potential gradient $\nabla \psi_i$ both from under the integral sign, then equation (5) can be expressed in terms of the parameters of the system as a whole, as is customary in classical thermodynamics:

$$dU/dt + \Sigma_i \Psi_i J_i + \Sigma_i \boldsymbol{X}_i \cdot \boldsymbol{J}_i = 0. \quad (6)$$

Here $J_i = \int \nabla \cdot \boldsymbol{j}_i dV = \oint \boldsymbol{j}_i\ d\mathbf{f}$ is the scalar flux of the i^{th} energy carrier through the boundaries of the system; $\boldsymbol{J}_i = \int \rho_i \boldsymbol{v}_i dV = \Theta_i \overline{\boldsymbol{v}_i}$ is its vector flux (impulse).

Unlike the Gibbs relation, Equation (6) contains $2i$ terms (i=1,2, ... n) and describes not only the processes of introducing the k^{th} substance N_k into the system as well as the series Q_k, the entropy S_k , the momentum $\boldsymbol{P}_k$, etc. in the homogenous system being investigated, but also the processes of redistribution of the system volume of overcoming the forces of the $\boldsymbol{X}_i$ and the performance of work "against equilibrium" in it. Therefore, it is applicable to a wide class of open ($N_k = var$), non-closed ($\boldsymbol{X}_i = var$) and non-isolated systems ($U = var$), which are the object of study in other fundamental disciplines. At the same time, it allows the irreversibility of the above processes. Indeed, considering (6) together with the integral equation of the energy carrier balance Θ_i

$$d\Theta_i/dt + \int \nabla \cdot \boldsymbol{j}_i dV = \int \sigma_i dV. \quad (7)$$

In this case, the densities of local and substantial fluxes $\boldsymbol{j}_u$ coincide. We find that, besides the energy carrier Θ_i appearing in the Gibbs ratio, it takes into account the presence of these internal sources of density σ_i. It is easy to see that under the conditions of local equilibrium ($\boldsymbol{X}_i = 0$), Eq. (6) takes the form

$$dU/dt = \Sigma_i \Psi_i d\Theta_k/dt - \Sigma_i \Psi_i \int \sigma_i dV, \quad (8)$$

i.e., it transforms into a generalized Gibbs ratio for complex multivariable systems $dU = \Sigma_i \psi_i d\Theta_i$ only when the internal sources of entropy $d_uS/dt =$

$\int\sigma_s dV$ and other energy carriers $d_u\Theta_i/dt = \int\sigma_i dV$ (including products of chemical reactions d_uN_k/dt) disappear. This testifies to the inconsistency of the hypothesis of local equilibrium, according to which the state of an element of the inhomogeneous continuum of the system is characterized by the same set of variables as in equilibrium. This follows from the fact that this assumption also means the absence of "production of entropy" ($d_uS/dt > 0$). The latter makes it necessary to introduce the parameters of inhomogeneity $\boldsymbol{X}_i$ and the fluxes $\boldsymbol{J}_i$ associated with them into the equations of nonequilibrium thermodynamics.

It is remarkable that Equation (6) does not become an inequality despite the obvious inclusion of the dynamic (irreversible) processes under consideration. This solves a major "problem of thermodynamic inequalities" which until now has prevented any application of the mathematical apparatus of nonequilibrium thermodynamics to real processes (i.e., those with fluxes at finite speeds).

It is also important that our derivation of an expanded form of the law of conservation of energy (6) contains definite forces $\boldsymbol{X}_i$ and fluxes $\boldsymbol{J}_i$. This bestows it with a definite sense corresponding to an energy field strength Θ_{ik} and averaged pulse k^{th} energy source $\boldsymbol{P}_i = \Theta_i\boldsymbol{\upsilon}_i$. Furthermore, it does not require a compilation of complex and cumbersome equations for the balance of matter, charge, momentum, energy and entropy. This dramatically simplifies the ability for thermodynamics to solve certain problems.

3. Thermodynamic derivation of the Onsager reciprocal relations

One of the most important provisions of the theory of irreversible processes is the “reciprocity relation" $L_{ij} = L_{ji}$ between the off-diagonal coefficients L_{ij} and L_{ji} in the "phenomenological" laws postulated by L. Onsager:

$$\boldsymbol{J}_i = \Sigma_j L_{ij}\boldsymbol{X}_j \qquad (9)$$

These ratios establish the relationship between dissimilar fluxes $\boldsymbol{J}_i$ and forces $\boldsymbol{X}_j$ and reduce the number of proportionality coefficients between them to be experimentally determined from n^2 to $n(n+1)/2$. To prove these relations, the future Nobel laureate L. Onsager had to use the theory of fluctuations, the principle of microscopic reversibility and an additional postulate about the linear nature of the laws of decay of fluctuations [1]. All three of these assumptions are somewhat outside of classical thermodynamics; therefore, he rightly called his theory "quasi-thermodynamics".

Meanwhile, it can be shown that these relations gain support from the law of the conservation of energy (6). From that law, based on the independence of the mixed derivative from the order of differentiation with respect to the variables $\boldsymbol{X}_i$ and $\boldsymbol{X}_j$ (i, j=1,2,...n), it follows:

$$\partial^2 U/\partial X_i \partial X_j = \partial^2 U/\partial X_j \partial X_i \qquad (10)$$

This directly implies the relationship between unlike fluxes and forces, which we term *differential reciprocal relations* [13]:

$$(\partial J_i/\partial X_j) = (\partial J_j/\partial X_j). \qquad (11)$$

These relations are applicable to both linear and nonlinear transport laws and allow any dependence of the coefficients L_{ij} on the parameters of the equilibrium state ψ_i and Θ_i. Application to the linear laws (9) directly leads to the symmetry of the matrix of phenomenological coefficients $L_{ij} = L_{ji}$:

$$(\partial \boldsymbol{J}_i/\partial \boldsymbol{X}_j) = L_{ij} = (\partial \boldsymbol{J}_j/\partial \boldsymbol{X}_j) = L_{ji} \qquad (12)$$

Their derivation shows that these relationships are a consequence of more general reasons than the reversibility in time of microprocesses. This explains why these relationships have often turned out to be valid far in domains far beyond the above conditions.

4. The method of finding "superposition effects" without using Onsager relations.

In isolated systems, the sum of internal forces $\Sigma_i \boldsymbol{F}_i$ (i = 1, 2… n) is always zero. This means that, in accordance with Newton's 3rd law, any one of them can be expressed as the sum of n = 1 different forces of the j^{th} kind: $\boldsymbol{F}_i = - \Sigma_{n-1} \boldsymbol{F}_j$. The relationship of these forces to thermodynamic forces $\boldsymbol{X}_i$ is easy to construct. From the expression for power $dW/dt = \boldsymbol{X}_i \cdot \boldsymbol{J}_i = \boldsymbol{F}_i \cdot \overline{\boldsymbol{v}}_i$ it follows that $\boldsymbol{X}_i = \boldsymbol{F}_i / \Theta_i$, i.e., it represents the precise meaning of force in its more general physical interpretation. Taking this into account, laws (17) can be represented in a form closer to (9):

$$\boldsymbol{J}_i = L_i \Sigma_j \Theta_j \boldsymbol{X}_j, \qquad (13)$$

Such a form of the laws of transfer and relaxation does not require the empirical coefficients L_i to be constant; this expands the scope of these equations' applicability to nonlinear systems and states far from equilibrium. In addition, it allows to propose a new method for finding the "superposition effects" of irreversible process which are due to "partial" (incomplete) equilibria of the i^{th} kind ($\boldsymbol{J}_i = 0$). The specificity of this method is easier to understand with the example of the diffusion of the k^{th} substance in a continuous heterogeneous composition (with the concentration of components c_j, temperature T and pressure p). According to laws (13), this process has the form:

$$\boldsymbol{J}_k = -D_k \nabla \mu_k, \quad (14)$$

where D_k is the diffusion coefficient of the k^{th} substance; μ_k *is* its chemical potential.

If we represent $\nabla\mu_k$ through its derivatives with respect to the concentrations c_j of its independent components, their temperature and pressure, then equation (14) can take the form:

$$\boldsymbol{J}_k = -D_k (\Sigma_j \mu_{kj}^* \nabla c_j + s_k^* \nabla T + \upsilon_k^* \nabla p). \quad (15)$$

where $\mu_{kj}^* \equiv (\partial\mu_k/\partial c_j)$, $s_k^* \equiv (\partial\mu_k/\partial T)$, $\upsilon_k^* \equiv (\partial\mu_k/\partial p)$.

Three components of the resulting force $\boldsymbol{F}_k$ on the right side of this expression are responsible for the usual (concentration) diffusion $\boldsymbol{F}_{kc} = \Sigma_j \mu_{kj}^* \nabla c_j$, thermal diffusion $\boldsymbol{F}_{kT} = s_k^* \nabla T$ and barodiffusion $\boldsymbol{F}_{kp} = \upsilon_k^* \nabla p$. This allows one to separate the thermodynamic factors μ_{kj}, s_k^*, υ_k^* and the kinetic factors D_k of multicomponent diffusion and establish a number of empirically established relationships between them [15]. Given the existing experimental means, it was mathematically unsound to obtain such results via the Onsager diffusion equation $\boldsymbol{J}_k = - \Sigma_i D_{ki} \nabla \mu_i$ [1].

As another example, consider an inhomogeneous system divided into two parts by a porous partition. If a temperature difference ($\Delta T \neq 0$) is created in it, then a gas or liquid flux $\boldsymbol{J}_k = D_k (s_k^* \nabla T - \upsilon_k^* \nabla p)$ occurs through the partition, leading, under conditions of incomplete equilibrium ($\boldsymbol{J}_k = 0$), to the occurrence of a pressure difference on both sides of the partition (Feddersen effect, 1873) :

$$(\Delta p/\Delta T)_{\text{st}} = - q_k^*/T\upsilon_k^*, \quad (16)$$

where $q_k^* = Ts_k^*$ represents the heat transfer of the k^{th} substance.

This phenomenon is now called thermo-osmosis. The opposite phenomenon has also been observed: the appearance of a temperature difference on both sides of the partition when air or other gas is forced through it. Both of these effects are of the same nature as the Knudsen effect (1910) - the appearance of a pressure difference in vessels connected by a capillary or a narrow slit and filled with gas of different temperatures. They are also of the same effect as the Allen and Jones "fountain effect" (1938), consisting of liquid helium II flowing out, at the slightest heating, from a vessel closed with a porous stopper. The opposite phenomenon - the occurrence of a temperature difference when a pressure difference is created on both sides of the partition - is called the *mechanocaloric effect* (Daunt-Mendelssohn).

In the case of systems that initially have the same pressure on both sides of the porous partition ($\Delta p = 0$) and initially the same concentration of the k^{th} substance ($\Delta c_k = 0$), when a temperature difference ΔT is created, a concentration difference occurs on both sides of it (the *Soret effect*, 1881):

$$(\Delta c_k / \Delta T)_{st} = - q_k^*/T\mu_{kk} . \quad (17)$$

The opposite phenomenon, the appearance of temperature gradients during diffusion mixing of components, was discovered by Dufour in 1872 and bears his name. In isothermal systems (ΔT=0) for creating pressure differential across the membrane Δp occurs via reverse osmosis, i.e., the separation of a binary solution with separation from the k^{th} component (usually a solvent). This phenomenon is widely used in water treatment plants. This occurs when the concentration difference k^{th} component is given by the expression:

$$(\Delta c_k/\Delta p)_{st} = - \upsilon_k/\mu_{kk}. \quad (18)$$

These results are consistent with those obtained in the framework of TIP [6,8]. However, for this it was not necessary to assume the linearity of phenomenological laws, postulate the constancy of the phenomenological coefficients L_i or D_k and resort to Onsager's reciprocity relations. At the same time, it becomes clear that these effects arise due to the onset of states of partial (incomplete) equilibrium; any multivariable system passes through such states on its way to full equilibrium. In this case, the "effects of superposition" are the result of superposition not of fluxes $\boldsymbol{J}_i$, but rather of forces $\boldsymbol{F}_j$ in full accordance with the principles of mechanics. The advantages of this method consist not only in the further number of phenomenological coefficients from $n(n+1)/2$ in TIP to n [14], but also in the possibility of finding superposition effects in nonlinear systems far from equilibrium. In this case, the TIP itself becomes free from any postulates expressing the coefficients L_i as a function of the parameters of the system.

5. Establishing the fundamental difference between the laws of relaxation and energy conversion

Consider an isolated system ($dU/dt = 0$; $J_i = 0$) in which energy is converted from one form to another. For such a system, from (6) immediately follows:

$$\Sigma_k \boldsymbol{X}_k \cdot \boldsymbol{J}_k = 0. \quad (19)$$

For the process of converting some i^{th} form of energy into j^{th}, this expression can be given the form:

$$\boldsymbol{J}_i/\boldsymbol{X}_j = - \boldsymbol{J}_j/\boldsymbol{X}_i. \quad (20)$$

According to this expression, the direction of the internal flux $\boldsymbol{J}_i$ of the i^{th} energy carrier, induced by the "exterior" force $\boldsymbol{X}_j$, is opposed to the direction of the "exterior" flux $\boldsymbol{J}_j$, induced by the driving force $\boldsymbol{X}_i$. If we denote the ratio $\boldsymbol{J}_i / \boldsymbol{X}_j$ by L_{ij}, and the ratio $\boldsymbol{J}_j / \boldsymbol{X}_i$ by L_{ji}, then we come to the antisymmetric Onsager-Casimir reciprocity relations [6, 8]:

$$L_{jj} = - L_{ji}. \tag{21}$$

This provision maintains the opposing direction of diverse forces; fluxes in the processes of energy conversion and possesses a general physical status. In particular, Faraday's law of induction follows from it, if by $\boldsymbol{J}_i$ we mean the flux of magnetic coupling (expressed by the number of lines of force), and by $\boldsymbol{X}_j$, the resulting voltage.

However, these conditions of antisymmetric matrices with "phenomenological" coefficients indicates also that for the processes of interconversion of ordered forms of energy, in the law (9) of Onsager, the coefficients L_{ij} and L_{ji} must be modified by the opposite signs:

$$\boldsymbol{J}_i = L_{ij} \boldsymbol{X}_i - L_{ji} \boldsymbol{X}_j. \tag{22}$$

$$\boldsymbol{J}_j = L_{ji} \boldsymbol{X}_i - L_{jj} \boldsymbol{X}_j. \tag{23}$$

In particular, as is well known from the practice of working with a welding transformer, an increase in the voltage in the secondary circuit $\boldsymbol{X}_j$ (approaching the "no-load" mode) causes a decrease in the current in the primary circuit $\boldsymbol{J}_j$, and the "short circuit" mode ($\boldsymbol{X}_j = 0$) on the contrary, increases it. Thus, Equations (22, 23) are more consistent with the phenomenological status (based on experience) than is Equation (9).

It is no less important that the condition of interconnection of forces and fluxes (19) is a consequence of the law of conservation of energy (6). Under conditions of system relaxation, these conditions of counter-directional flux are absent, so that the fluxes $\boldsymbol{J}_i$ and $\boldsymbol{J}_j$ become independent. In this case, the reciprocity relations $L_{ij} = L_{ji}$ are fulfilled trivially (they vanish), and the equations of transfer and relaxation take the form of equations of heat conduction, electrical conductivity, diffusion, etc., in which the flux $\boldsymbol{J}_i$ becomes a unique (eponymous) function of the thermodynamic force $\boldsymbol{X}_i$. This independence was also assumed in the theory of L. Onsager, since he defined the scalar fluxes J_i as time derivatives of the independent parameters of the system. Therefore, strictly speaking, he did not have sufficient grounds for postulating rules (9), in which each of the fluxes depends on all forces acting in the system.

6. Development of a universal criterion for the efficiency of energy converters

It is generally accepted that the energy conversion efficiency of any reversible non-thermal machine is equal to unity, while for a heat engine it is limited by the thermal efficiency of an ideal Carnot machine [15]:

$$\eta_t = 1 - T_2/T_1 < 1, \tag{24}$$

where T_1, T_2 are constant temperatures of supply and removal of heat in the heat engine cycle, equal to the absolute temperatures of the heat source and sink.

This "discrimination" of heat engines is based on the firm belief that "heat and work are, in principle, unequal" [15]. In fact, a closer look reveals that this reflects a misunderstanding of the concepts of absolute and relative efficiency. Thermal efficiency η_t, like its analog η_i for ordered forms of energy, characterize the ratio of the work W_i performed by the converter to the energy U_i supplied from the source of the i^{th} form of energy. Such efficiencies are usually called *absolute*.

According to the theorem of Carnot efficiency, an ideal cycle of the heat engine does not depend on the properties of its working body, nor on the design features of the machine or the mode of operation. Therefore, such "efficiency" more likely characterizes not its coefficient of performance, but rather the possibilities offered by nature thanks to its inherent spatial inhomogeneity (difference of temperatures of the hot and cold heat sources). Strictly speaking, this figure should not have been called "machine efficiency" because this figure is characterized more by the "degree of instability" of the heat source.

The concept of efficiency of electric and other motors has a different meaning. Such efficiencies characterize the ratio of the work W_i actually performed by the engine to the theoretically possible work W_i^t. They take into account the losses in the machine itself and are ideally equal to one. Such efficiencies are called *relative internal* η_{oi}. In thermodynamics such efficiency η_{oi} is an evaluation of the performance of the processes of compression or expansion of a body upon which work is done. Naturally, the application of the same term "efficiency" to these two fundamentally different concepts causes non-specialists to misunderstand the inefficiency of heat engines.

In this respect, it is very useful to represent the efficiency through energy fluxes. Nonequilibrium thermodynamics allows us to express the efficiency ratio in terms of the output power N_j and the input transforming device N_i [16]:

$$\eta_N = N_j/N_i = \boldsymbol{X}_j \cdot \boldsymbol{J}_j / \boldsymbol{X}_i \cdot \boldsymbol{J}_i \leq 1. \tag{25}$$

This efficiency, which we term "power-based energy conversion efficiency", or henceforth "power efficiency" for short, is equally applicable to thermal and nonthermal, cyclic and acyclic, straight and reversed machines, including the "direct energy conversion" machines. It takes into account both the kinetics of the energy conversion process and all types of losses associated with both the delivery of energy to the energy converter and the energy conversion process itself. It also depends on the operating mode of the installation, twice turning to zero: in "idle" ($J_j = 0$) and in "short circuit" modes ($X_j = 0$). This also distinguishes it from the "exergy" efficiency, which is expressed by the ratio of free energies at the outlet and inlet of the installation. In a word, this efficiency most fully reflects the thermodynamic performance of the installation and the degree to which it realizes the possibilities that the source of ordered energy provides. Moreover, such an efficiency is the only possible indicator of the performance of an installation in those cases when the concept of absolute efficiency becomes inapplicable due to the impossibility of separating energy sources and receivers in a continuous medium. Examples include force fields, chemically reactive environments, polarized or magnetized bodies, or dissociated or ionized gases. All this makes it an irreplaceable tool for analyzing the efficiency of not only energy, but also technological installations, as well as energy converters created by nature itself. This is especially important due to the fact that many non-experts confuse efficiency with the heat transfer coefficient or the coefficient of performance, which may be distinguished by their units. Therefore, the use of power efficiency (24) not only reveals the unity of the laws of transformation of any forms of energy, but also allows us to propose a theory of the similarity of power plants of various types.

7. Construction of a theory of similarity of power plants

An appropriate generalization of TIP to the processes of useful energy conversion in various machines allows us to propose a theory of the similarity of power plants [16]. This would complement the classical theory of heat engines by analyzing the relationship of thermodynamic efficiency (energy conversion efficiency) with productivity (based on power $\boldsymbol{N}$) and the operating mode of power and technological plants. As in the theory of similarity of heat transfer processes, the mathematical model of such systems includes, along with equations (22, 23), the conditions for the uniqueness of the object of study. The latter contain *boundary conditions* determined in the case under consideration by the magnitude of the driving forces at the border with the energy source or object of work $\boldsymbol{X}_i$, $\boldsymbol{X}_j$, or by the magnitude of the fluxes $\boldsymbol{J}_i$, $\boldsymbol{J}_j$ at these boundaries, and by the initial conditions. These latter are set by the magnitude of these forces $\boldsymbol{X}_{jo}$ or fluxes $\boldsymbol{J}_i$ in the initial mode, for example, at the "idle" of the installation (at $\boldsymbol{J}_j = 0$) , or in the "short circuit" mode $\boldsymbol{J}_{jk}$ (at $\boldsymbol{X}_j = 0$) , as well as the coefficients L_{ij} (i, j =1,2) characterizing the transport properties of the system. These conditions make it possible to give the transport equations (22, 23) a dimensionless form

$$\boldsymbol{X}_j/\boldsymbol{X}_{jo} + \boldsymbol{J}_j/\boldsymbol{J}_{jk} = 1. \quad (26)$$

and on its basis, propose a number of similarity criteria for power plants. One of them, which we called the load criterion, is composed of the boundary conditions set by the value of the forces $\boldsymbol{X}_j$, $\boldsymbol{X}_{jo}$ or fluxes $\boldsymbol{J}_j$, $\boldsymbol{J}_{jk}$:

$$\mathcal{B} = \boldsymbol{J}_j/\boldsymbol{J}_{jk} = 1 - \boldsymbol{X}_j/\boldsymbol{X}_{jo}. \quad (27)$$

This criterion depends solely on the load of the installation and varies from zero in no-load mode ($\boldsymbol{J}_j = 0$) to one in the "short circuit" mode ($\boldsymbol{X}_j = 0$).

Another criterion consists of the resistance coefficients R_{ij}, the reciprocal of the conductivity coefficients L_{ij}:

$$\Phi = R_{ij}R_{ji}/R_{ii}R_{jj} \quad (28)$$

This formula is similar in meaning to the ratio of reactive and active resistances, known in radio engineering as the "quality factor", or "Q-factor" for short, of the circuit, and therefore is called the "criterion of the Q-factor" of the installation. Its value fluctuates from zero to infinity ($0<\Phi<\infty$), increasing as the "active" resistances (from the side of scattering forces) R_{ii} and R_{jj} decrease and the "reactive" resistances R_{ji} (from the side of "heterogeneous" forces) increase. Like thermal resistances in the theory of heat transfer, they depend on the transport properties of the system, i.e., ultimately, on the design performance of the installation.

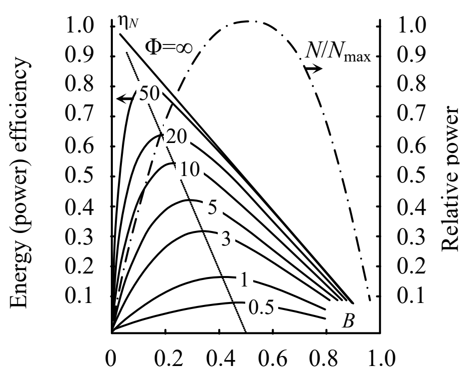

Fig.2. Universal load characteristics of energy converters

Using these criteria in the expression for the power efficiency (24), it can be given the form of a *criterial equation for the energy conversion process:*

$$\eta_N = (1 - \mathcal{B})/(1 + 1/\mathcal{B}\Phi). \quad (29)$$

Consequently, the *efficiency of any energy converter under similar conditions* (*B, Φ* as above) *is the same*. It is expedient to call this provision the *principle of similarity of power plants*) [16].

This principle allows one to build a universal load characteristic of linear energy - converting systems (Figure 2) [16]. Solid lines in the diagram show the dependence of the power efficiency η_N of the installation on the load criterion B at different values of the quality factor Φ, and the dash-dotted line shows the dependence on the load of its output power N_j.

As can be seen in Fig. 2, in the absence of energy losses ($\Phi = \infty$) and the steady state of the process of its conversion ($B \to 0$), the efficiency of the installation reaches, as expected, unity. However, in all other cases the value of the power-based efficiency becomes zero twice, once in "idle" setting ($B = 0, J_j = 0$) and once in the "short-circuit" setting ($B = 1, X_j = 0$). This result is obtained by taking into account the energy consumption for the installation's own needs, as well as losses from irreversible energy exchange (including heat exchange) between the energy source and the working fluid of the installation, friction in pipelines and all kinds of energy "leaks"[3] occurring at idle running of the installation.

The main feature of this characteristic is the presence of a pronounced maximum efficiency for a given load of the installation. Such modes, usually labeled *nominal,* move farther and farther from the maximum power mode, corresponding to the relative load $B = 0.5$, as the efficiency increases. As a result, the power-based efficiency of a real Carnot cycle (from quasi-statistical characteristics of the processes) at $O < \infty$ is not a maximum, but rather zero. Thus, taking into account the power and performance of the power plant brings the results of the thermodynamic analysis of its efficiency closer to reality.

Universal load characteristics are very useful not only for monitoring compliance with the most economical operating modes of basic, peak and transport power plants, but also when choosing the most promising of them with respect to future operating modes. In this way, nonequilibrium thermodynamics of energy conversion processes acquire important practical applications.

8. Summary and Conclusion

1. The main disadvantage in using the incomplete theory of thermodynamics of irreversible processes (TIP) as a general physical theory is its original limitations on processes of energy dissipation; this can be traced to its dependence on the principle of increasing entropy.

2. The approach to non-equilibrium thermodynamics from a more general position of an energy conservation law indicates a failure of the hypothesis of local equilibrium. Thus, it highlights the necessity of introducing additional variables of a nonequilibrium state, whereupon potential gradients and generalized process speeds would arise.

3. Determination of the basic quantities in which TIP is defined -- thermodynamic forces and energy fluxes -- on a more general basis of a law governing the transfer of energy in path environments allows us to create a locally non-equilibrium thermodynamics. This version of thermodynamics does not exclude from consideration any (reversible or irreversible) component of real processes.

4. We propose an approach, which for brevity we term “energodynamics”, to prevent the occurrence of inequalities in the transition to non-static processes. This allows to take into account the irreversibility of real processes of energy conversion not only in thermodynamics, but also in other fundamental disciplines.

5. Energodynamics allows us to give a strictly thermodynamic theory, free from the postulates and considerations of molecular-kinetic and statistical-mechanical theories, and one which validates all the provisions of a TIP, thus expanding it domain to nonlinear processes and states far from equilibrium.

6. The isolation of independent processes occurring in the system under study refutes Onsager 's postulate about the dependence of each of the fluxes on all forces acting in the system. It thus makes it possible to find, for each flux, a unique corresponding force whose disappearance results in the cessation of the process.

7. The proposed energodynamic method for finding the superposition effects of heterogeneous processes allows further reduction in the number of empirical coefficients by $n(n+1)/2$ in TIP to n and explains these superimposed effects not by fluxes, but rather by forces in full accordance with the principles of mechanics.

8. A suitable generalization of TIP to the processes of purposeful transformation of various forms of energy in natural and technical systems reveals their fundamental unity and difference from relaxation processes both in relation to their equations and their reciprocity relations.

9. The transition to the study of the kinetics of energy conversion processes allows us to propose a universal criterion for the efficiency of power and technological installations, taking into account, respectively,

their power and performance, and combining the advantages of absolute, relative, exergy, etc. efficiency.

10. The unity of the laws of transformation of thermal and non-thermal forms of energy discovered within the framework of energodynamics made it possible to propose a theory of the similarity of power and technological installations and to construct their universal load characteristics that facilitate the choice of nominal, peak, etc. modes of their operation.

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Exploring the Mother-Father-Child Triad: a Fresh Insight on the Roots of Latent Violence

To the precious memory of my mother

Annotation

This work examines the early childhood and pre-natal environment through a collection of multiple biographical and autobiographical resources which, in addition to containing personal memories, reconstruct transgenerational stories of the well-known historical personalities. Numerous works have already emphasized the mother-child dyad; this work emphasizes the importance of the mother-father-child basic triad. By exploring several archetypal cases, this study should also contribute to the understanding of the roots of self-destructive behaviors and the origin of violent feelings and thoughts.

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Introduction

Seen in a broader context, violence has much deeper roots. This paper will illustrate the fact that early experiences, as portrayed by autobiographical statements by well-known brilliant writers in their reminiscences, journals, diaries or memoirs, provide the most valuable and authentic information about the relationship in the basic mother-father-child triad, and therefore are of great importance for prenatal and perinatal psychology studies.

While most psychological studies, such as psychological bestsellers by Alice Miller [1] or Susan Forward [2] are concerned mostly with the parent-child dyads, this research explores all the complexity of the triad as a system, when the nature of mother-father ties precedes, predetermines and molds the future mother-child, father-child and child-parents bonding. We shall see how the conflicts that arose between the future father and mother, will be reflected in the conflicts between the offspring and each of the parents, and finally between the child and social groups or institutions (such as the school, the state or the church).

Linking the primary family ties with temporology (i.e. the time and birthtime studies) provides a fresh interpretation of the formation of our personalities in general, including the roots of latent or accumulated violent feelings. We shall see how temporological approach and time-codons symbolism [3, 4] indicate which kind of relationships was dominant around us before our birth and how our needs were met when we were infants. Many attendants of my temporological lectures report that such an understanding of the family as a complex system helps them to move beyond laying blame on their parents. Furthermore, by identifying their own responsibilities and *Whole-Self* resources they can lessen their repressed feelings of frustrations, outrage or violent self-destructiveness.

A personal anecdote. One of my early memories deals with a child's fear to be torn between the mother and father. My grandmother was known for her hospitality. On holidays and birthdays, many relatives and friends were gathering in her house. Although it should have been an exciting event, I hated such meetings. The reason for this was an embarrassing habit of some of Grandma's guests to ask me a common for those days question: "Whom do you love more: your mother or your father?" It was an awful moment for a four-or-five-year-old child who used to stick to the truth. I could not hurt the feelings of my parents. I wished to disappear, to dissolute, but I had to whisper an "appropriate" answer: "Equally, I love them the same way, equally." Of course, it was a lie, because each bond is unique. The truth was that I loved my parents dearly but differently. In my eyes they were two distinct people, and I could not and did not want to compare my love for different constituents of the same family complex unit. At that time, I was too young to express my thoughts eloquently, so I tried to conceal my feelings and to say something so straightforward and simplified that it turned out to be a lie.

Later in my adult life, I was deeply moved while I was writing a chapter for *Celestial Twins* about the tragic, dramatic and suicidal story of two talented people – Hart Crane and Ernest Hemingway [5]. I was pondering:

"Both were extremely sensitive people who in their youth dreamed of absolute beauty and love, striving to present in their works a vital and tangible emotion. Unfortunately, that lovely dream did not survive their later years, when they grew self-absorbed and embittered. Behind their success lurked a feeling of emptiness and self-alienation. In the end, their self-destructiveness became so great that both committed suicides. How did they become such frustrated adults?" [5, p. 137].

From their writings it became clear:

"Both claimed that the roots of their troubles were hidden in their childhood. Hemingway claimed that the best early training for a writer is 'an unhappy childhood,' while Crane prayed to get 'an improved infancy.' From early childhood they felt estranged from their fathers; in their adulthood both waged a prolonged vendetta against their mothers; in the end, both blamed their parents for all their misfortunes" [5, p. 138].

Both celestial twins have experienced their parents as the two opposites who were tearing them apart during their entire lives. Consequently, both felt themselves "like being put up on a cross and divided."

Reading Crane's and Hemingway's bitter letters made me cry. "If it made me sick just to think over the provocative questions of my Grandma's guests, how could they survive such a perpetual torture?" – I pondered repeatedly. I could not stop asking myself: how can we prevent such tragic events in the future?

Gradually I was gaining a deeper understanding of the symbolic messages written in the skies in the time of our birth. Traditionally, the coordinates of the Sun represent the father-image and the coordinates of the Moon represent the mother's image as both are seen through the eyes of the newborn [6, 7]. The combination of the two (including the aspect between them) indicates the basic nature of the newborn's future view of human interrelationships. Usually, it is believed that when a child is born with a challenging aspect between the Sun and the Moon (such as 90° or 180°), some degree of hostility, grief or disharmony is indicated between the mother and father [6, p. 108]. Such discords may also imply that the relationship is not what the parents expected it to be. Whatever the cause, the child picks up the parental tensions, frustrations or mourning, and it seems to the child that his parents have a conflict. As a result, the person with the challenging aspects between Sun and Moon is vacillating between following the different parental patterns. Such people have more self-doubt regarding relationships than other people. It is widely believed today that we cannot ignore either part of our personality, and therefore when we tend to suppress one of them for a long time, it will eventually burst forth in violent words or actions.

Looking temporologically, we can see, for example, that in Crane's family such challenging Sun-Moon aspects appeared not only during his birthdate, but also during that of his mother. So, are we talking about hereditary inborn patterns?

In Hemingway's family we find such aspects not only in Ernest's birth data, but also in that of his older sister Marcelline and their younger brother, Leicester, who also eventually committed suicide. So, was Crane predestined to hate his mother and to destroy his own life? Or were Hemingway and his brother predestined to follow their father's self-destructive pattern, taking their own lives?

The *Whole-Self Prebirth Psychology* approach does not agree with such a deterministic conclusion. On the contrary, it argues that when we accept the validity of all the patterns, exemplified by seemingly irreconciled parents and their ancestors, we can learn a unique way to feel in peace with ourselves by expressing, correcting and adjusting all the inherited traditions. Yet to succeed in such a complex task, to avoid the negative tendency of blaming our parents, adults with the challenging Sun-Moon aspects are requested to transform their accumulated frustration and rage. They should accept that for them it is useless and even wrong to blame the parents. Betty Lundsted suggested that spiritual needs are especially important for such persons. "When we start to become conscious, we are in fact beginning the trip that Jung describes – the search for the spiritual or conscious self" [6, p. 107].

For more than two decades I have been collecting materials that could clarify and illustrate the rather vague term "spiritual needs." It led me also to ponder on the questions of the personal responsibilities of each member in the triad father-mother-child.

Unfortunately, it is impossible to describe here the dozens of relevant life stories that I came across during this long researching period. Each family is different, and each child learns a unique lesson in his/her specific family triad. Each Sun-Moon challenging aspect in the skies is repeated in different celestial configurations affecting slightly different reactions. In addition, I believe that to examine the roots of personal feelings, we need the most truthful first-hand information about personal experiences.

Usually, each therapist can survey his patient's life just for a short flash of time while both – a healer and a client – are confined to a controlled and artificial environment. To eliminate these restrictions, in *Celestial Twins* I argued that like in the case of modern medicine, which began with the study of anatomy, it would be most effective to start learning modern psychology and temporology on the dissecting table of the anatomy of destiny [5]. I supposed then and I still believe now that the autobiographical records, journals and memoirs of deceased well-known people are the best window we will ever have into our mind and soul. It is problematic to evaluate the level of emotions and aggressiveness of living people *in situ* because people may either deliberately conceal their impulses or change their reactions both in the presence of other people and in other periods of their life. Therefore, in the present study I have also chosen to deal with the archetypal biographical narratives of well-known historical personalities, whose life stories had been "completed" and whose autobiographical materials were published and examined by multiple researchers. In that kind of study, the subjective experiences are collected from authentic resources, while the objective indicators are associated with the historical birth data in each case.

The common feature of all the following cases is that the parents of the described historical personalities had different temperaments and opposite values. As a result, from their birth (or even from their conception) these people were constantly facing the contradictive and irreconcilable expectations from their parents. While all of them were extraordinarily mentally gifted, they were primarily the children of their historical epochs, the flesh and blood humans with their talents, aspirations, pains and faults. Unable to reconcile the conflicting exaggerated demands of their parents, these people lived with the constant feeling of guilt and frustration which eventually led them to experience outbursts of violent hatred and self-destructiveness. These are the symptoms of an accumulated despair, which does not infrequently result in suicide, and which, in so-called "ordinary families" were more frequent than can be imagined.

In addition to the radical differences between the parents, temporological aspects in all the following cases displayed amazing similarities. Although these cases are describing deceased people from the past, their experiences and feelings are still relevant for many people in their self-growth journey.

I shall begin with the brief reminder of the Hemingway-Crane survey, and then I shall explore in a chronological order nine additional archetypal cases, going back as early as the days of Blaise Pascal (b. 1623) and getting closer to our days with the extraordinary life of Jacqueline Kennedy (b. 1929). I tried to include in this list remarkable people from different countries, speaking different languages. Belonging by birth to all the four traditional elements (Fire, Earth, Air, Water), they had also different emotional inclinations [4, 8]. (According to the philosophy of the four elements, Fire is the prime element of volition and desire; Earth is the prime pragmatic element, associated with matter; Air is the prime mental element, associated with human thoughts; Water is the most sensitive element, associated with human feelings. The current findings suggest that people with different innate emotional nature prefer different emotions. As a result, there are many conflicts between people born in different elements [4, 8]).

In my earlier publications I have described the drastic changes which were introduced by the rare Phoenix-born generation (born between 1885-1900) in all the fields of our lives, including prenatal psychology [9]. We shall see the similar changes in the following stories.

Finally, it happened so that this chapter is more about men than women. The objective reason lies in the difficulties of confirming birthdates of the well-known women and finding their published autobiographical records. There is less access to their inner life and feelings. To compensate this lack and to bring this study even closer to our days I made an exception, and, in the end, I included a contemporary story of one amazing female medical doctor. Of course, to save her privacy, I had to hide her identity, but I believe that her case will help many people to lessen their anxiety and to attain greater peace of mind. In addition, in each case we meet all the fabulous mothers of our heroes; we can listen to them, reconstruct their feelings and learn about their suppressed frustrations and rage.

Additional note: unless otherwise indicated translations from Russian are my own.

Cases 1&2. Hart Crane and Ernest Hemingway – Lives with Tragic Consequences

One of the most significant writers (Ernest Miller Hemingway) and one of the most significant poets (Harold Hart Crane) of the so-called Lost Generation were born on the day of the full moon of July 21, 1899. They were born as celestial twins, and both belonged to respected and prosperous American families. On the one hand, in accordance with the most common Sun-Moon opposition's features, both celestial twins were born into families with parents who frequently opposed each other, and both experienced their fathers and mothers as two different poles of existence. On the other hand, the scenarios of Hemingway's and Crane's early lives resembled the stories of many other emotionally gifted children who felt themselves humiliated by rigidly ridiculing and insensitive parents as it was described by Alice Miller in her psychological classic *The Drama of the Gifte*d *Child* [1]. Unfortunately, the future lives of these celestial twins demonstrated almost all the mechanisms of defense suggested by Miller – such as dreams of grandiosity, depressions, alcoholism, escape from attachments and self-destructiveness. The similarities in Hemingway's and Crane's prenatal experiences, in heart-breaking dramas of their emotionally charged lives, in their suicidal personalities and in their letters are so striking that I have decided to explore these cases as a unity [5, pp. 137-158].

Hemingway's and Crane's mothers were daughters of war veterans. Both were born in Oak Park and named Grace: Grace Edna Hart and Grace Hall. Both Graces were attractive girls who received voice training and dreamed of becoming famous singers. Their lives were changed radically when they met their future husbands, Clarence Edmonds Hemingway and Clarence Arthur Crane. One-year senior than their future wives, both Clarences were charming young men, who enjoyed sports, hunting and fishing, but who had no special interest in music. Although their families thought that the match was a splendid one, both Graces were reluctant to raise a family instead of pursuing a promising musical career. Eventually, the two marriages took place in Chicago, but both Graces felt that they had sacrificed their dreams, and that frustration rankled within them for most of their lives.

For both celestial twins, it is possible to trace the roots of their future conflicts to the prenatal period. The Hemingways and the Cranes eagerly pretended to look like happy families. Yet the reality was different.

Ernest Hemingway recalled that he always felt the underground currents in the family. Two such highly strung personalities as Grace and Clarence Hemingway, hedonistic and spartan, often got on each other nerves so that they welcomed temporarily separations. Hemingway's older sister, Marcelline, (b. 15.1.1898) who was also born with the challenging Sun-Moon aspect, witnessed in her autobiography:

"Opposites are said to attract, and surely no two young people could have been more opposite than my father and mother" [10, p. 49].

In Crane's family, extremely romantic but terrified of sexuality, Grace Crane imagined marriage as a continuing courtship, where the wife's role was to sing to her husband and to accompany him to parties. On the contrary, Clarence was jealously possessive; he expected Grace to be the sympathetic friend during the day and the passionate lover at night. From their wedding day, "their marriage was a source of mutual agony. Never entirely out of love, each found essential characteristics of the other well-nigh unbearable" [11, p. 7]. Later Grace would speak about men in general: "They make me sick, they make me tired" [11, p. 494].

On July 21, 1899 two sons were born: in Oak Park – Hemingway, in Garrettsville – Crane. Neither deliberately cruel nor malicious, their parents were extremely rigid people who saw everything as black and white. Tragically, the two Graces held different values from those of two Clarences'.

Clarence Crane was remembered as "a person with a pure and single devotion to one set of values, which made him blind to all conceptions of life but his own" [12, p. 163]. A pillar of the local Congregational church, Clarence Hemingway showed a piety that was sometimes indistinguishable from intolerance, and his opposition to smoking, drinking and dancing was notorious.

Hemingway's younger brother, Leicester (b. 1.4.1915, with the Sun-Moon opposition), described Grace Hemingway: "Mother would get so involved looking at her side of a problem she could forget there was another side" [13, p. 62]. A self-righteous Christian Scientist, Crane's mother was described in his letters as an insensitive woman: "The weight of this terrible Christian Science satisfaction I feel growing heavier and heavier on my neck" [14, p. 33].

Each parent tried to mold his sons after himself, but the clash of their ideals made frequent quarrels unavoidable. As a result, the lives of both children became in Crane's words a constant struggle to "reconcile the irreconcilable." Years later, when working in business became as necessary to Crane as composing poetry, he complained that he felt himself "like being put up on a cross and divided" [12, p. 138]. In his childhood Hemingway complained that the domestic quarrels between his parents led them to plan separate vacations, and that he usually took sides with one or the other in order to preserve what he called "an armed neutrality." In his adulthood Hemingway maintained that he was forced to be ambitious in two directions; hunting in Africa was every bit as necessary to him as looking at Goyas and El Grecos in the Prado [15, p. 85].

Crane and Hemingway remembered their adolescent problems during 1915 and 1916. Hemingway recollected that he had tried to run away from home, while Crane remembered trying to commit suicide. Both claimed that the roots of their troubles were hidden in their childhood. Hemingway claimed that the best early training for a writer is "an unhappy childhood" [16, p. 232], while Crane was praying to get "an improved infancy" [17, p. 86]. From early childhood both were blaming their parents in all their misfortunes.

Harold and Ernest were very sensitive children who were desperately trying to get the love of their parents. Yet all was in vain, and nothing could please them. Both fathers were harsh disciplinarians who had never enough time to spend with their sons. Clarence Crane, who would eventually become a prosperous candy manufacturer in Cleveland, was extremely busy with his business. His dream was that when the only son would grow up, he would become his partner. A medical doctor, Clarence Hemingway wrote to the 11-year-old Ernest about his dream: "... it will be only a few years before you and Papa will be visiting clinics together" [18, p. 21]. Yet meanwhile, he was so nervously busy that any sign of idleness among his brood roused him to sharp words and sudden scolding.

Both Graces tried to cultivate in their sons the love for arts and music, but both found it difficult to be warm mothers. Constantly focused on their own needs and frustrations, both mothers were insensitive to the pain they inflicted to their sons. Whenever there were any emotional problems in their families, the Graces rushed to their darkened rooms declaring they had a strong headache. Leicester remembered: "Having her wishes crossed always produced a crisis, and there were hundreds of them while we children were growing up" [13, p. 42]. Describing Grace Crane's nervous breakdown in 1917, Crane's biographer wrote: "Incessant brooding aggravated her condition, so that much of the time she was confined to her bed. There, as in years before, Harold again took up his post, sitting beside her in the darkened room for hours..." [11, p. 83]. It is widely accepted that both Graces often used guilt and manipulations to control their children. In his later years Hemingway usually called his mother "that bitch" [19, p. 17]. Seeing in his mother the sole cause of his crippled life, Crane in his last years spread incredible stories concerning her character and morals.

One of the most touching recollections of his painful boyhood, Crane's poem *Passage* discloses his solution to the unbearable emotional trauma: to escape by forgetting. Stop remembering and life would be better. "My memory I left in a ravine," wrote Crane. Similarly, Hemingway's life has been called a *Life Without Consequences*, because he had chosen not to remember [18]. In one of his best stories, *Big Two-Hearted River*, Hemingway through his autobiographical hero Nick Adams revealed his method of escaping from his troubling memories: to stop thinking, to stop remembering.

Harold and Ernest were very sensitive children who tried hard to get the love of their parents. Unfortunately, both Graces not only loved beauty, but also hated everything which they thought to be ugly or dirty. Both were convinced that their duty was to teach their children how to conduct themselves to fulfill their mothers' plans, and both could turn immensely stern with the children when they neglected to perform some chore. Leicester witnessed: "There were rules, which could not be broken, and expectations, which absolutely had to be met. The individual and his special needs and circumstances were secondary" [13, p. 62]. Yet how could a child meet the expectations of his/her parents when they were unrealistic and sometimes even inhumane? Later Ernest would complain: "I remember Mother saying once that she would rather see me in my grave than something – I forgot what – smoking cigarettes perhaps" [20, p. 259]. In cases of major infractions of the rules Dr. Hemingway punished his children with a razor strap, while Grace employed on such occasions a hairbrush. As if being beaten was not humiliating enough, the children had to kneel asking God for forgiveness. Later Ernest would remember that after such punishments, he was thinking about patricide: "He had sometimes sat in the open door of the shed with his shotgun, drawing a bead on his father's head" [21, p. 31].

But can we blame Hemingway's father, who suffered from a depressive disorder? Tragically, his condition worsened as he aged, leaving him increasingly more withdrawn, subject to outbursts of irrational rage that confused his children. At the age of 57, he shot himself to death. Three of his children would also eventually commit suicide.

From his early days Hart Crane also suffered from his mother's scolding. At the age of 16 he blamed his mother: "For the last eight years my youth has been a rather bloody battleground for yours and father's sex life and troubles" [14, p. 18]. Even after his parents' eventual divorce in 1917, Crane found himself caught in their tug-of-war for his affections. Grace's pressure on him was so strong that after one of her breakdowns he wrote: "The hardest thing for me to bear is the blame that Mother puts on me as being in a major way responsible for her present condition... This trouble will never, never end, I'm afraid, or if it does, it will be in insanity" [11, p. 99].

A word in defense of Grace Crane. Of course, from the point of view of her child, she could be blamed for all his problems. But, as far as it is known, she also was born with a challenging Sun-Moon aspect. Her abusive behavior was stemming from her own self-destructive personality inherited from her parents. Who can blame her, when most of her life she spent alternately suffering from psychosomatic illnesses and undergoing Christian Science therapy?

In 1925-1926, Boni & Liveright published Hemingway's *In Our Time* and Crane's *White Buildings*. Both books were highly praised by critics; Crane and Hemingway simultaneously became famous, but for both celestial twins this achievement was a poisoned success when they understood that even their fame could not please their parents. Crane's parents as usual were overwhelmed by their troubles. Hemingway's parents responded by refusing to read the "naughty" things he wrote.

After 1926, Crane increasingly turned to the blind alleys of alcoholic and sexual debauchery, willfully seeking escape in the most brutal degradations. In his drunken rages he shouted that he was "caught like a rat in a trap" [22, p. 229]. He felt that he had been too cruelly exposed to the treacheries of human relations ever again to trust them completely. On April 27, 1932 Crane leapt to his death from the deck of the liner on which he was sailing from Mexico to New York. He was lost in the Caribbean, near the coasts of Cuba.

Astonishingly, Hemingway as if anticipated Crane's death, when in 1926 he was contemplating his own suicide: "When I feel low, I like to think about death and the various ways of dying. And I think about probably the best way unless you could arrange to die some way while asleep, would be to go off a liner at night ... There would be only a moment of taking the jump and it is very easy for me to take almost any sort of jump" [20, p. 19].

In 1932, Crane realized Hemingway's black dream. Hemingway had survived. Yet his surging and ebbing of suicidal dreams would continue, forcing him to take "any sort of jumps" and to turn toward drunken debauchery. To mention just one example of his violent behavior, in London in 1944 he mounted a photograph of his future wife Mary's husband on a toilet seat in Ritz Hotel's men's room and machine-gunned it.

Even the Nobel Prize could not bring Hemingway peace of mind. In 1959 he showed signs of a mental breakdown. On July 2, 1961 he shot himself dead.

Unfortunately, Hemingway and Crane were not pursuing any spiritual quest. Their instinctive defense was to blame their parents and their societies. Nevertheless, born during the Phoenix Hour of 1885-1900, Hemingway and Crane independently developed several emotional theories, which should be known to all parents interested in a loving care.

One of them was: never impose your personality on another person's emotions.

Case 3. Blaise Pascal – Life in the Shadow of Death

Blaise Pascal (1623-1662) was one of the greatest physicists and mathematicians of all time who had also contributed to the fields of literature, philosophy and theology. Though fragmentarily, the details of Pascal's early life were highlighted by his older sister Gilberte Perier and her daughter Marguerite as fully as it could be expected for their distant epoch [23, 24]. Pascal's *Thoughts*, written in a personal style as his own "spiritual autobiography," were regarded by Emile Cailliet as the "journals" of his life [25].

In his introduction to Pascals's *Thoughts,* the Nobel Laureate Thomas Stearns Eliot (1888-1965) wrote:

"Pascal is one of those writers who will be and who must be studied afresh by men in every generation. It is not he who changes, but we who change. It is not our knowledge of him that increases, but our world that alters and our attitudes towards it. The history of human opinions of Pascal and of men of his stature is a part of the history of humanity. That indicates his permanent importance" [26, p. vii].

The following text will show how Pascal's life-story can contribute to new approaches to child-raising.

Pascal's father, Étienne (1588-1651), was an educated man and a wealthy lawyer. He belonged to the French aristocracy and served as king's counselor. On the one hand, he is remembered as an honest man and a person of great knowledge who was befriended by men of eminence in science and arts. On the other side, he was a stern person and a harsh disciplinarian who wanted to mold his children's will, expecting them to obey his wishes. In addition, he was fond of the ascetical ideas of Stoics and disapproved any demonstration of physical affection.

Little is known about his wife, Antoinette Begon (1596-1626), whom he married in 1616. Gilberte described her as a very fragile, pious and charitable young woman who was in many senses quite an opposite of her husband.

The couple's first daughter Antonia was born in 1617. She lived just a few days and died even before her baptizing. This tragedy is rarely mentioned by Pascal's biographers. It appears that because of high infant mortality, references to such events seemed to be too ordinary, too commonplace to be included in the family chronicles. The French historian Philippe Ariès (1914-1984) wrote about those days: "It was thought that the little thing which had disappeared so soon in life was not worthy of remembrance: there were far too many children whose survival was problematical" [27].

Yet the reality of pain, fear and grief is far from being unworthy of mentioning. The sad fact is that Blaise and his two sisters, Gilberte (1620-1685) and Jacqueline (1625-1661) were born into the atmosphere impregnated with the distress, fears of illness and death. It seems that Pascals' lot was to deal regularly with illness and death [28].

One of the most symbolic and striking family's legends, recorded by Marguerite, described how Pascal was snatched from the jaws of death when he was a baby. When Blaise was just one year old, he suffered from a mysterious malady. At the beginning, it looked like an ordinary intestinal disorder, but later it was accompanied by two extraordinary and frightening symptoms:

"Pascal could not look at water without having violent transports; he could not bear the sight of his father and mother close to each other. He allowed his parents to caress him separately, but if they both approached him, 'he cried and behaved with excessive violence. All that lasted a year, while the evil grew; he fell into such an extreme state that he was believed to be near death'" [29, p. 50].

Nothing could help the baby, and he was wasting away. His attacks were more violent and more exhaustive, and his parents became desperate. Then one day they heard a rumor that Blaise was bewitched by a local witch who wanted to take her revenge on Étienne, because he refused to help her when she had asked him. To make a long story short, Étienne forced the woman to break the spell, and that midnight:

"…'the child appeared dead; he had no pulse, no voice, no sensation; he grew cold, and had all the signs of death'. Close to one o'clock in the morning he began to yawn; they started warming him and gave him some wine with sugar in it. The wet-nurse gave him suck. As he revived, Blaise saw his mother and father close together and began screaming. Although not cured, Blaise was at least alive.' About six or seven days later he began to be able to tolerate the sight of water… and in three weeks the child was entirely cured" [29, p. 51].

The fairytale symbols of this story are striking. Pascal's inner conflict, indicated by the positions of the Sun in the rational Airy Sign of Gemini and the Moon in the emotional Watery Sign of Pisces, was projected into the outer world as his inability to consume or to see the water and as his violent protest against the union between his Father (his rational thoughts, the Mind) and his Mother (his religious feelings, the Heart).

This time Pascal was cured, but the next tragedy was already close, and it struck him at the early age of three, when his mother died in

1626. What was the impact of this tragedy? We do not know. Silence. John R. Cole wrote: "Our embarrassment is most acute with respect to his mother's death and its possible significance. Antoinette Begon's early death is a historical fact but so, too, is the silence of the sources on any immediate or deferred psychological effects on her young children" [30, p. 261].

Étienne has never remarried. He became a dedicated father who decided that he alone would be his children's educator. The father adored his daughters and son, but he was undemonstrative with his affections. He demanded much from them, and in the absence of the warming maternal influence, there was no one to offset Étienne's rigorous schedule he planned for his son. Like in the preceding case, the intellectual side (Ratio, Mind) of such home education was brilliant, but the emotional side (Love, Heart) was deeply suppressed and frozen. The family environment was filled with tensions between the Mind and the Heart, between the rigorous thinking and the inner serenity of belief.

Gilberte remembered that learning rarely ceased in the Pascal home, even during mealtimes. Pascal's health began to fail under the strain, and from the age of 18 he did not have any single day without suffering from pains and various psychosomatic ailments [23]. Indirectly, Eliot blamed Pascal's father for his excessive demands from Blaise: "For his application to studies in childhood and adolescence impaired his health and is held responsible for his death at thirty-nine" [26, p. viii]. Maybe this reasoning sounds logical, but from the prenatal point of view, Pascal's health was impaired much earlier, perhaps before his birth, when his mother was in pain of loss after Antonia's death.

Whatever the reason might be, Pascal's behavior became extremely self-destructive. Gilberte recorded several striking examples of him consciously hurting himself. She mentioned his preference for sickness ("sickness is the natural state of Christians") and his choice to love no one. Although he loved to help people and to talk with friends, he wore a studded iron belt beneath his shirt to keep him from enjoying conversations with them. He went so far as to lash himself with an iron belt when some thought of pleasure or vanity came to him. Pascal's asceticism became so extreme that he hated food and resorted to self-destructive mortification of his body. His rejection of the body became almost unbelievable. In his *Thoughts* he claimed: "I can easily conceive a man without hands, feet, head, for it is only experience which teaches us that the head is more necessary than the feet. But I cannot conceive a man without thought; he would be a stone or a brute."

As the years passed by, Pascal's inner conflict between his love to God and his love to rational scientific inquiry became more profound and painful. He saw the entire world as torn apart and divided:

"Those who are accustomed to judge by the heart do not understand the process of reasoning, for they wish to understand at a glance, and are not accustomed to seek for principles. And others on the contrary, who are accustomed to reason by principles, do not at all understand the things of the heart, seeking principles and not being able to see at a glance."

At some point his view of the love of God became so all-consuming that he was prone to criticize normal affection or to condemn his own pursuit of scientific and mathematical research. Pascal's biographer Donald Adamson portraited him as having a dual personality: "Precocious, stubbornly persevering, a perfectionist, pugnacious to the point of bullying ruthlessness yet seeking to be meek and humble" [31]. Pascal's inner split was felt also by Voltaire, who respected Pascal's eloquence, but described him as "the sublime misanthropist."

As we have already seen in the previous case, much hostility may be accumulated with the Sun-Moon challenging aspect. In Hemingway's oeuvre this hostility manifested itself in violent war-time reports and novels. In Pascal's case, it was said that in *The Provincials* he attacked his theological opponents with ferocity and personal hatred. It was further suggested that "*The Provincials* may have been Pascal's opportunity to rid himself of suppressed emotions his lifestyle caused" [28, p. 93]. I should like to add here, that Pascal's lifestyle, his austerity and his problems with affection can all be traces to his prenatal and perinatal periods.

Among the disturbing manifestations of the challenging Sun-Moon aspects (90°), Hickey described possible separations from the parents in the early childhood; tensions between the will and the emotions, between the past and the future; poor health and tendency "to feel that everyone around him is wrong" [7, p. 206]. It seems that Pascal's life illustrated most of these tendencies.

It is doubtful that in his own life Pascal has found the middle way to appease the opposite sides of his personality. Yet his life can become an example and lesson for the future generations. Analyzing Pascal's dual and divided personality, T. S. Eliot insightfully wrote: "Pascal is a man of the world among ascetics, and an ascetic among men of the world; he had the knowledge of worldliness and the passion of asceticism, and in him the two are fused into an individual whole" [26, p. xv]. And he added:

"It is the just combination of the scientist, the *honnête homme*, and the religious nature with a passionate craving for God, that makes Pascal unique" [26, p. xviii].

Pascal's life journey might be seen either as an inner tug-of-war or as a search of a way toward a higher plane of consciousness where the mathematics of love is not the same as the arithmetic of the material world. By dividing his love and withholding it from his body and his mind, Pascal actually was killing himself. In his times it was too bold to think that the more love you give the world and its inhabitants, the more love gets the whole Universe and its Creator. Wishing to bring joy and happiness to the world, Pascal however was spreading more sorrow and pain. Trying to love God, he was his own worst enemy. But maybe, this behavior was a manifestation of the repressed grief for the loss of his oldest sister and his mother? We can only speculate about the causes of Antoinette's early death, and it is a striking fact that there is no information how Pascal reacted to her death, either as the little boy or later as an adult.

Whatever the results of his own life, Pascal should be gratefully remembered for his courage to reveal and share his thoughts. That's was perhaps the reason why T. S. Eliot could "think of no Christian writer, not Newton even, more to be commended than Pascal to those who doubt, but who have the mind to conceive, and the sensibility to feel, the disorder, the futility, the meaninglessness, the mystery of life and suffering, and who can only find peace through a satisfaction of the whole being" [26, p. xix].

Pascal did not write autobiography, but he left us a striking self-portrait: "Man is neither angel nor brute, and the misfortune is that whoever would play the angel plays the brute."

Case 4. Goethe – the "Werther Fever" and Confessional Writing as Self-therapy

Johann Wolfgang von Goethe (1749-1832) has gained recognition as one of the most famous German poets of all times. He is also internationally known for his brilliance in art theory, natural science, literature, philosophy and memoirs.

Accounts from the modern biographical dictionaries typically convey near-perfect pastoral childhood-stories of well-known people while stressing more educational activities of children than any diversions they might have had. Goethe's autobiography, *Dichtung und Wahrheit* (*Poetry and the Truth*) gives us a more comprehensive and personal point of view of the child [32]. This autobiography was so unique and important that it inspired Sigmund Freud to analyze Goethe's early memories and to publish his conclusions in a short essay [33]. Freud believed that the earliest memory we have is also our most important memory that shapes our life. Reading *Dichtung und Wahrheit*, he suggested that Goethe's conflicts with his mother that affected his capacity for love in adulthood went far back into his childhood, to the early age of four. Freud's ideas seemed to be revolutionary in his days, but during the new Phoenix Hour our consciousness was rapidly expanding [9], and now we can trace Goethe's problems further into his prenatal and perinatal periods.

Until the 20th century children often received little respect from adults and could not pursue their own aspirations [9, 27]. Like Pascal, Goethe was not an exception. Goethe's father, Johann Caspar Goethe (1710-1782) came from a wealthy family. He was an Imperial Councilor and an educated man. Although good-willed, he appears in Goethe's memoirs as pedantic, impatient, remote and opinionated person, who overburdened his children with studies and despotically controlled all the important decisions concerning their lives. Later Goethe would complain: "Too many parents make life hard for their children by trying, too zealously, to make it easy for them."

Goethe's mother, Catharina Elisabeth Goethe (1731-1808) was twenty years younger than her husband whom she married at the tender age of 17. Their marriage was not a love match and the great age gap between the spouses was accompanied by significant differences in their temperaments. She was a contrast to him in almost everything: while Catharina had a cheerful personality, her husband was known for his "stern sense of order." During the first years of their marriage Johann Caspar kept his young wife busily engaged in multiple intellectual pursuits. Later he would demonstrate the same attitude to their children. In contrast, Catharina would secretly take part in her son's occasional rebellion against the paternal dictate and see in him her only true companion.

Like in Pascal's case, less is known about Goethe's relationships with his mother than with his father. Those days most women were not allowed or encouraged to publish their archives, and it is difficult to reconstruct Catharina's true feelings, because in 1792 Goethe burned almost all her letters. It is widely believed that Catharina had a great influence over her son during his early days, but less is known about his attitude towards her. Whatever the reasons for this, Goethe could not forgive his parents. In 1808 he did not attend his father's funeral. In his Weimar years Goethe avoided his mother. She never visited him in Weimer, and in more than 33 years, he met her only four times. He did not attend her funeral either [34, p. 234].

Being an insightful astrologer, Goethe described his own birth on a full moon day as an extremely dramatic event:

"On the 28th of August 1749, at mid-day, as the clock struck twelve, I came into the world, at Frankfort-on-the-Maine. My horoscope was propitious: the sun stood in the sign of the Virgin, and had culminated for the day; Jupiter and Venus looked on him with a friendly eye, and Mercury not adversely; while Saturn and Mars kept themselves indifferent; the Moon alone, just full, exerted the power of her reflection all the more, as she had then reached her planetary hour. She opposed herself, therefore, to my birth, which could not be accomplished until this hour was passed.

These good aspects, which the astrologers managed subsequently to reckon very auspicious for me, may have been the causes of my preservation; for, through the unskillfulness of the midwife, I came into the world as dead, and only after various efforts was I enabled to see the light. This event, which had put our household into sore straits, turned to the advantage of my fellow-citizens, inasmuch as my grandfather, … took occasion from it… to introduce or revive the tuition of midwives, which may have done some good to those who were born after me" [32].

In his poetical way Goethe described the differences between his practical father (the Sun in the Earth sign of Virgo) and his vivacious mother (the Moon in the Water sign of Pisces):

From father my inheritance
Is stature and conduct steady.
From mother I have my love of romance
And a tongue that's ever ready.

Goethe's life began with a near-death experience and throughout all his childhood he was haunted by illnesses and deaths. More than once his condition was perilous. He had measles, chickenpox and many other common infectious childhood diseases. He remembered his brother, about three years younger than himself, who was likewise gravely ill but was too tender to survive. In his memoirs Goethe perfunctorily mentioned a very pretty and agreeable girl, who also soon passed away. In fact, the family had either six or seven children (Goethe's biographers are not sure about their exact number). Goethe was the firstborn son. He and his one-year-younger sister Cornelia were the only surviving children.

The available information about the other children is scarce. Most of Goethe's biographers choose, like in Pascal's case, to keep silent about those poor kids. As far as I could find, their names were: Hermann Jacob, born in November, 1752, died in January, 1759; Catharina Elisabeth, born in September, 1754, died in December, 1755; Johanna Maria, born in March, 1757, died in August, 1759; and Georg Adolf, born in June, 1760, died in February, 1761. Just try to imagine the nightmare of this family when for more than 12 years, the young mother was either pregnant or was burying her infants one after another! Much was obscure in the family where losses were not openly discussed or grieved. What was the psychological impact on the surviving siblings? We now learn more about the parental loss and attachment theories, but what do we know about the early loss of younger siblings? We do know that Goethe's sister, Cornelia (1750-1777), was depicted as a hypochondriac, overburdened with the studies and robbed from the joys of childhood. Goethe himself admitted in his autobiography that since his childhood and during all his life he suffered from "a feeling of solitude, and a sense of vague longing resulting from it." In addition, the consequences of Goethe's maladies were doubly grievous for the boy because his pedantic and didactic father practiced "pedagogic oppressions" and imposed double lessons upon his surviving convalescent kids.

One of the earliest Goethe's memories was his delight from throwing family crockery out of the window of his house. He was clapping his hands for joy when all the collection of mugs, plates, etc. was dashed over the pavement and destroyed. Why did the child enjoy crashing fragile things? Perhaps the life itself and the family relationships were too fragile for him to endure?

Goethe experienced the gloomy atmosphere of his house as if it was intended "to awaken dread and terror in childish minds." His father's strict educatory rules compelled children to sleep at night alone in their rooms, and when they could not overcome their fears and asked for help, their father was frightening them and demanding that they get back to their sleeping places.

Speaking about the family relationships presented in Goethe's autobiography, E. L. Stelzig stressed the conflicts between the parents: "What is clear is that the fault line that runs through the Goethe household puts the father on one side and the mother, son, and sister on the other" [35, p. 180]. This contradiction in the family increased with years. Goethe remembered: "My father followed out his views unshaken and uninterrupted. The mother and children could not give up their feelings, their claims, their wishes."

The children were frightened and upset to be a part of the conflict between their parents. Such relationships were not healthy either between his parents, or between the parents and the children. They had even induced suicidal ideas described by Goethe at the age of 24 in one of his most celebrated and powerful autobiographical novels *The Sorrows of Young Werther*. Written "with the blood of his heart" (in Goethe's own words), this book started the phenomenon known as the "Werther Fever": the wave of copycat suicides by young men throughout Europe. There is no doubt that Goethe's intentions were innocent and good, but the results were violently morbid.

Suicide is an event of self-violence, hatred and the extreme self-destructiveness. According to Goethe, we have here to do with those whose lives are embittered by exaggerated demands upon themselves: "Since I myself was in this predicament, and best knew the pain I suffered in it, and the exertion it cost me to free myself, I will not conceal the reflections which I made, with much deliberation, on the various kinds of death which one might choose."

Werther became an intense version of Goethe's lifelong practice of confessional writing as self-therapy. Unlike Werther, Goethe had survived. Yet keeping in mind his parental troubled relationships, it is not surprising that he dreaded any idea of being bonded by marriage. There were multiple sad love stories, departures and painful rejections in Goethe's life. Here I would like to mention his only marriage with the young flower-girl, named Christiane Vulpius (1765-1816), whom he met in 1788. For 18 years she remained his mistress, although she was officially his housekeeper. Only in 1806 the 57-year-old Goethe legitimized their relationship by marrying her. It is very important to stress that he – a celebrate polymath – and his uneducated wife, 16 years younger than him were very dissimilar people.

Furthermore, Goethe's marriage was not from love. The Goethe's early family pattern was tragically repeated when four of his children died in their infancy. The only surviving Goethe's son was Julius August Walter von Goethe (1789-1830). He was blamed by Goethe's biographers for inheriting "his mother's vice of drinking." Yet it is worth keeping in mind that he had inherited also his father's challenging Sun-Moon aspect (Sun in Capricorn making 90° with the Moon in Aries). It is also time to remind that mothers do suffer from the loss of their babies, and it is very cruel to blame poor Christiane for her moodiness and weakness. Yes, she and Goethe were very different in their temperaments and intellects, and yes, their only surviving child had extremely tensed relations with his father. Julius August died before his father, when he was just 40 years old.

While Pascal was torn between being an angel or a brute, Goethe's Mephistopheles saw himself as a "Part of the darkness which gave birth to light." Already in 1797 Goethe in his *Hermann and Dorothea* wrote: "We can't form our children on our own concepts; we must take them and love them as God gives them to us." Maybe for Goethe this was just a momentous insight, but it is our task and privilege to make those dreams an everyday reality.

Case 5. Schopenhauer – in Search of "Better Consciousness"

Arthur Schopenhauer (1788-1860) was one of the most read Western philosophers who had a profound posthumous impact on literature, music and science. In his writings he presented his original views about love, marriage, sex and the value of life. Most of his life he remained "a lonely, unfriendly, and practically unrecognized figure" [36, p. 8]. Sometimes he is regarded as a pessimist and sometimes he is defined as a misanthrope – a person who once had a childish belief that all people are basically good, but later was deeply disappointed by the entire humanity. During his entire life he felt homeless, and this sense of homelessness became the leitmotif of his philosophy. He went as far as to declare that our world is a sad and ill-made place; "that the world itself was not his home" [37, p. 1]. For him: "Life is deeply steeped in suffering and cannot escape from it; our entrance into it takes place amid tears, at bottom its course is always tragic, and its end is even more so" [38].

A more intimate glance into his prenatal history and his earliest experiences enables us to understand better the origins of his pessimism, misanthropy and the violent outbursts that were periodically accompanying them.

Arthur's mother, Johanna (née Troisiener) Schopenhauer (1766-1838) was born in Danzig. She came from a middle-class honorable but rather poor family: her father was a merchant and city councilor. Johanna grew up as a precocious child who possessed great talent for foreign languages. Later she was described as a pleasure-loving, gifted, witty, but rather insensitive girl whose dream was to become a painter. Unfortunately, her authoritative parents forbade her to even think about becoming an artist – a profession that in those days did not suit girls. During the 1820s-1830s she became a popular German writer and salonnière who established a friendship with Goethe.

At the tender age of 18, Johanna married Heinrich Floris Schopenhauer (1747-1805) who was twenty years her senior. In her memoirs, Johanna openly admitted that she "no more pretended ardent love to him than he demanded it" [39, p. 13]. Heinrich Floris became a Father figure for his young wife, and Johanna explained that it was a marriage of convenience: she was attracted not to him but rather to his social rank and the possibilities that his wealth could open to her.

Arthur's father, Heinrich Floris, was a wealthy prosperous shipowner and merchant. Short and stout (somebody would add "ugly"), he lacked physical attractiveness and did not love his wife. Both spouses were united by their love to travels, but otherwise they had very different temperaments and interests. He was a man of iron will, remembered also for his intelligence and ruthless candor combined with volcanic wrath and frightening depths of gloom. In addition, there was in him a fear of mental illnesses that showed up in other members of the family. For young vivacious Johanne to be married to him meant to be dominated solely by Heinrich Floris.

Later Schopenhauer would claim that to his father he owed his "will; that is, his temperament and character; to his mother, the quality of his intelligence" [40]. Paradoxically, in his notorious essay *On Women*, Schopenhauer would also declare that women "are childish, foolish," "intellectually short-sighted," and "their reasoning powers are weaker."

The first act in the drama of Johanna's marriage, which was to have profound effect on future Schopenhauer's philosophy and life, began as early as in 1787. Prior to Arthur's birth, when Johanna was still unaware of her pregnancy, the Schopenhauers took their summer journey to England. At the beginning Johanna was delighted to see the world. But soon she found out that there was a secret reason for their trip: her husband was considering a move to England. Heinrich Floris used to make all the decisions alone, by himself, without consulting anybody, including his wife. That time he had decided in advance that they would have a son, that his name would be Arthur, that he would become a merchant like his Dad, that he would be born on English soil and that as a future international merchant he would enjoy a British citizenship.

The first serious conflict between the spouses occurred in England when Johanna became aware of her pregnancy and felt homesick. In her memoirs she told about her anxious longing for the calming presence and beneficial care of her mother. She begged her husband to return to Danzig and stay there near her mom's place until confinement. In this clash of wishes she had no chance to win. Her destiny was to obey her husband's dictate. After her "hard struggles" with herself she obeyed but continued to hold resentment: "…no one helped me, I had to overcome my grief alone. The man dragged me, in order to cope with his anxiety, half-way across Europe" [39, p. 11].

Eventually, it was Heinrich Floris's wish to return to Danzig before Arthur's birth. During London's winter foggy time he suffered from irrational fears – a kind of mental disorder – and he decided to leave the island. The echo of this event will appear in Schopenhauer's secret diary: "I have inherited from my father that fear, which I myself is cursing" [39, p. 12].

The child was born on the full moon of February 22, 1788. 39-years younger than Goethe, Arthur had the same challenging aspect as him, but exactly in the opposite signs. While Goethe was born in Virgo with the Moon in Pisces, Schopenhauer was born in Pisces with the Moon in Virgo. There were many parallels in the parental relationships in Goethe's and Schopenhauer's families. In their adulthood both firstborn sons would be left with many similar scars. Nevertheless, born in an emotional Water sign, Schopenhauer, perhaps, felt himself wounded deeper than more Earthy and practical Goethe.

After Arthur's birth, Johanna spent the following five lonely years in their country villa. Heinrich Floris did not like to meet people, but exactly the opposite was true for his sociable and charming 20-year old intelligent wife. She did not like her new lifestyle that bound her to a growing son. Soon she found that motherhood itself was a highly unsatisfying occupation for her: she felt greatly bored and restricted to stay far from the eventful life in the cultural centers. The sensitive boy demanded love, but in his mother's heart there were only growing frustration and resentment.

The boy's father took no part in his early upbringing. He was visiting them only once a week, and like in the case of Hemingway and Crane, his life was devoted to his business matters. Moreover, he believed that the father's educational role should begin later, when the child will grow up. But later it was already too late: in Artur's adolescence, the differences between him and his overcritical father's expectations became unbearable: "No matter what Arthur promised about living up to his father's expectations, nor what good reports he received from his son, Heinrich Floris found a way to find fault" [37, p. 85].

As a result, from Arthur's s early days until his death he felt himself as an abandoned baby, robbed of parental warmth and affection. In his essay *On Women* he would make from his subjective experience a universal generalization:

"As in animals, so in man, the original maternal love is purely instinctive and therefore ceases with the physical helplessness of the children. In its place, there should then appear one based on habit and reasoning; but often it fails to appear, especially when the mother has not loved the father. The father's love for his children is of a different kind and is more enduring. It rests on his again recognizing in them his own innermost self and is thus of metaphysical origin."

Like in Hemingway and Crane's cases, young Arthur was desperately craving for missing love and affection. When he was six years old, his parents returning from a walk found him in perfect despair, imagining that they had abandoned him [41, p. 264].

When Arthur became just 9 years-old his father sent him away to study in France. He was left there for two years with the family of a business partner. (An important detail: that time Arthur's only sibling, Adel, was born. Was it surprising that Arthur would never feel close to his only sister?)

Since his adolescence Arthur worried over his imagined and unimagined diseases. After his father's death, he worried that his mother (and later his sister as well) would try to deprive him of part of his inheritance. In his adulthood Schopenhauer was afraid of intimacy; in his old age he suffered from *harpaxophobia*, i.e. his morbid fear of robbers, thieves or being robbed.

Like Goethe, Schopenhauer early began to loath the professional life his father designated for him. Arthur's own dream was a university education and a scholarly life, but like Hemingway or Crane, he felt depressed being divided between his duty to choose the father's occupation and his natural inclination to follow his mother's artistic or intellectual lifestyle.

His father's untimely death, in 1805, most likely as a result of suicide, was a crucial point in Arthur's life. With the consent of his mother, he withdrew from business and embraced the career of the scholar. Yet the feeling of the duality did not leave him. Unfairly as it were, years later he would even blame his father's death on his mother. He viewed Johanna as a bad wife to his father and an unloving "bad" mother to himself.

After Henrich's death, mother and son did not get along. Johanna did not want to suffer from Arthur's irritating and overbearing personality and refused to live under the same roof with him. During his short visits, mother and son clashed frequently and violently; his behavior depressed her, it "ruined her serenity" [37, p. 132]. In letters written to Schopenhauer, Johanna made it clear how distressed she was at her son's pessimism, his arrogance, and his imperious ways. After 1814 (for more than two decades!) mother and son never met again (which reminds us of Goethe's avoidance of his mother). Schopenhauer continued to speak ill of Johanna even after her death, making little of her mother skills and depicting her as a thoroughly self-centered woman.

Another German philosopher, Johann Gottlieb Fichte (1762-1814), wrote that "The sort of philosophy a man has, depends on the sort of man one is." Symbolically, Schopenhauer's attitude towards Fichte reflected his usual pattern of conflicts and perplexity in relationships: from admiration and attraction to disappointment and repulsion. At first, he admired Fichte's works and wanted to attend his lectures at Berlin University. Nevertheless, his "*a priori* veneration for Fichte, which drew him to Berlin, 'soon turned to scorn and derision'" [37, p. 159].

Philosophical studies could not help Schopenhauer overcome his accumulated rage. To grasp his feelings, it is most important to see the events via Schopenhauer's own eyes. In his journals he recorded that while listening to Fichte's lectures he was gripped by anger: he felt that Fichte "said things which made me wish to place a pistol to his chest and say to him: You must now die without mercy, but for your poor soul's sake tell me whether with all that *gallimaufry* you had anything precise in mind or whether you were merely making fools of us?" [39, p. 141].

It was neither the first, nor the last Schopenhauer's violent outburst. During his school years there were numerous fights; he drank alcohol and smoked cigars. He also possessed a pair of fine pistols, and it was reported that he got carried away with some experiments with gunpowder, which led to some minor burns [37, p. 30]. During her son's university years Johanna warned him that he will ruin his life, unless he transforms his behavior:

"… because of your rage at wanting to know everything better than others; of wanting to improve and master what you cannot command. With this you embitter the people around you, since no one wants to be improved or enlightened in such a forceful way, least of all by such an insightful individual as you still are; no one can tolerate being reproved by you, who also still show so many weaknesses yourself, least of all in your adverse manner, which in your oracular tones, proclaims this is so and so, without ever supposing an objection. If you were less like you, you would only be ridiculous, but thus as you are, you are highly annoying" [37, p. 130].

"Almost all of our sorrows spring out of our relations with other people" – wrote Schopenhauer. In 1821 a violent event, known usually as a seamstress lawsuit complicated Schopenhauer's life and did not allow him to teach at Berlin University. This lawsuit was made by a 47-year-old Caroline Luise Marguet, who occupied another room in the Berlin rooming house where he lived. Her habit of talking loudly on trivial matters outside his door irritated Schopenhauer who hated noises. One day he could no longer abide her chatter and requested her to go away. When she refused him and talked back, the confrontation escalated and he pushed her down the stairs. Later Marguet accused Schopenhauer of beating and kicking her. In her civil suit against him she claimed that she could not move her right arm due to the assault, a situation that made it impossible for her to continue her trade. She also claimed that Schopenhauer pushed her against a commode, which caused injury to her genitals [37, p. 410]. She won, and Schopenhauer was ordered to pay her a monthly maintenance for the rest of her life. The woman lived for twenty more years. When she died in 1852, Schopenhauer had to present to the court a copy of her death certificate, on which he had written in Latin: *Obit anus, abit onus* (the old woman dies, the debt departs).

Obviously, Schopenhauer did not love his deceased neighbor-seamstress. Yet he did not love either his mother or women in general. He wrote that "men are by nature indifferent to one another, but women are enemies" [42]. Following this belief, he had male acquaintances, but he had no friends. As to the women, obsessed with a malignant vision of them, Schopenhauer was trying to demonstrate their inferiority. In his attempt to stress contrasts between rational male and irrational female temperaments one could find rather subjective autobiographical details than general philosophical views. In his essay *The Metaphysics of Sexual Love* Schopenhauer revealed his deepest fears of intimacy and relationships with women in general:

"Every day it brews and hatches the worst and most perplexing quarrels and disputes, destroys the most valuable relationships, and breaks the strongest bonds. It demands the sacrifice sometimes of life or health, sometimes of wealth, and happiness. Indeed, it robs of all conscience those who were previously honorable and upright, and makes traitors of those who have previously been loyal and faithful" [37, p. 22].

Nevertheless, as always, Schopenhauer was divided between his contradictive needs, moods and wishes. Despite his negative views of sexuality, during most of his life he occasionally had sexual affairs. It appears that he was never in love, and all his partners were of lower social status, such as maids or prostitutes [37]. In a letter to his friend Anthime, Schopenhauer revealed that he had two out-of-wedlock daughters (born in 1819 and 1836), both of whom died in infancy.

R. Tsanoff summed up Schopenhauer's problematic personality:

"There are unlovely, amusing, pathetic, revolting traits in Schopenhauer's character. He was sensual; he was in many ways shameless. Something of a coward he was, and afflicted from his childhood with fright that bordered on mania" [41, p. 265].

The Nobel Laureate, Erwin Schrodinger (1887-1961), who was influenced by Schopenhauer's philosophy, wrote:

"It is quite irrelevant whether Schopenhauer himself lived in accordance with this higher ethic. His notorious diary-entry, '*obiit anus, abiit onus*' tells against his having done so …. I would prefer personal contact with Sancho Panza rather than with Schopenhauer; he was the more decent of the two. But Schopenhauer's books are still beautiful – except when some superstitious madness suddenly breaks out in them" [43].

Although Schopenhauer failed to refine his character or to heal his prenatal traumas, he at least tried to search for "better consciousness." In our next case we shall meet a person who was greatly influenced by

Schopenhauer's writings and whose life and theories open new opportunities for self-growth.

Case 6. Carl Gustav Jung – a Spiritual Way of a Healer

Carl Gustav Jung, one of the most famous psychologists and philosophers of the 20th century, was born in Switzerland, in the small village of Kesswil on the evening of July 26, 1875, when the Sun in Leo and the Moon in Taurus were in a challenging aspect of 90°.

While writing his remarkable autobiography, *Memoirs*, *Dreams, Reflections,* he experienced and revived "long-submerged images of childhood" [44, p. 15]. Eventually, the author revealed the story of a solitary, unhappy and even violent youth [45]. Jung's numerous biographers described his parents' marriage as an unhappy affair marked by prolonged separations and periodic mental illness: "Clearly Jung's childhood was a critical period of intense conflict that persisted in some ways throughout his life" [44, p. 15].

In his autobiography Carl Jung mentioned proudly that according to family legends, his paternal grandfather was Goethe's illegal son. Although there was no evidence to support or disprove such myth, Goethe's life, poetry and philosophy had influenced Jung deeply.

Jung's father, Johann Paul Achilles (1842-1896), was a gifted, but frustrated, man. His early dream to become a philologist came to a sudden end because of a financial crisis in his family. He was forced to live in very modest circumstances as a village pastor. Jung would later write about his father: "the days of his glory had ended with his final examination. Thereafter he forgot his linguistic talent. … and discovered that his marriage was not all he imagined to be" [45, p. 91].

Jung remembered that because of doing "a great deal of good – far too much" his father became a tired, irritable man who fell frequently into angry moods and burst into towering rage at home [46, pp. 16-17]. As his father's depressive moods grew worse, Jung felt that theology alienated his father from him. Johann Paul Achilles died in 1896, not yet 54 years old.

The grim fact is that Jung was born into the tensed atmosphere of frustration and grief. It is frequently going unmentioned that he was **the fourth child** of the family but the first to survive, followed nine years later by a sister.

Jung's mother, Emilie Preiswerk (1848-1923), had many reasons to feel herself frustrated and depressed. She married at the young age of 17 and as a result, she gave up her literary gift. Her father was a pastor, but both her parents demonstrated unusual psychic abilities such as talking with spirits or having second sight. Having inborn mediumistic abilities, Emilie reacted to the arrival of stillborn children in 1870, 1872, and 1873 by withdrawing from the reality and speaking to her ghosts. We may touch the depth of her pain by reading McLynn's description of the 27-old year Emilie whose youthful charms faded fast, to the point where she was considered "ugly as well as domineering" [47].

Later Jung concluded that his ability to perceive something, which he supposed he could not know at all, was inherited from his maternal ancestors. He remembered: "My mother was a good mother for me. She had hearty animal warmth, cooked wonderfully, and was most companionable and pleasant" [45, p. 48]. Yet her warmth was only one of the faces of his mother. Her other and frightening face was that of a visionary woman whose psychic powers expressed themselves powerfully but unpredictably. Jung remembered that when this second "archaic" nature of his mother was emerging: "...she would then speak as if talking to herself, but what she said was aimed at me and usually struck to the core of my being, so that I was stunned into silence" [45, p. 49].

From his early days Jung perceived hidden tensions and hostility between his parents. As an adult he would believe: "Life is a battleground. It always has been, and always will be" [48]. It is symbolic that the metaphor of a battle is one of the most frequently referred to by many people with the Sun-Moon challenging aspects.

In his early years Jung suffered from long periods of diseases and had several brushes with death. He tried to share his rich visionary experiences with his father but feared that he would be misunderstood. As the times passed by, Jung became his mother's confidant and she shared with him all the troubles that she could not share with her husband. Jung wrote:

"Dim intimations of trouble in my parents' marriage hovered about me. My illness in 1878 must have been connected with a temporary separation of my parents. My mother spent several months in a hospital in Basel, and presumably her illness had something to do with the difficulty in the marriage. … I was deeply troubled by my mother's being away. From then on, I always felt mistrustful when the word 'love' was spoken. The feeling I associated with 'woman' was for a long time that of innate unreliability. 'Father,' on the other hand, meant reliability and – powerlessness. That is the handicap I started off with" [45, p. 8].

During Jung's school years the teachers regarded him as a stupid and superficial pupil. Jung remembered: "A kind of silent despair developed which completely ruined school for me" [49, p. 48]. Since childhood Jung was aware that he, like his mother, had a second personality. The first personality, which Jung called No. 1, was the ordinary son of his parents.

The second personality, No. 2, was an old, wise man, who looked down from above with reflective calm, analyzing all the contradictory elements of each situation. Jung soon learned how to pass into this state of calmness and "of sheer poetry of the spirit" as exemplified by his No. 2 [49, p. 195].

After his father's death Jung's personality went through a temporary metamorphosis, and it was as if a new, extraverted personality emerged within him. This new self could get drunk and enjoyed asserting itself with an abrasive force. Jung was also able to sit in the student pub through the night, steadily drinking beer and forgetting his mother and sister waiting at home. Acknowledging the destructive side of himself, Jung explained such erratic behavior by the existence of what he called his "demon": "There was a demon in me... It overpowered me and if I was at times ruthless it was because I was in the grip of the demon" [49, p. 20]. When Jung offended some people, it was because the demon insisted that he should not tolerate their inability to understand him.

Jung's middle-life crisis was the most violent and self-destructive one. After his break with Freud, Jung suffered to the point of near madness as if he had reached a dead end. One day in December 1913, unable to understand one of his dreams, he remembered that a loaded revolver was in the drawer of his night table. He felt that if he failed this time, he would have to kill himself. Jung's deep self-investigation brought a fear of madness and caused violent resistance to any further exploration. When Jung was already on the edge of breakdown, he had a vision of Elijah, the prophet, who came to him in the image of Philemon. Walking up and down in the garden, giving the impression of a madman listening to his inner voices, Jung held extensive conversations with Philemon, who became for him almost as real as a living person. Eventually Philemon became his spiritual teacher who taught him the truth of existence.

Later Jung saw the ego "as a fragile archipelago of islands floating in the dark sea of the collective unconscious." According to him, these islands are made up "of the nuclear ego plus partial egos" [50, p. 96]. Allegedly connected with Jung's own peculiar multiple personalities, this definition is very impressive in connection with the childhood visions of the Russian writer Andrei Bely, who will be described later, in Case 9.

In his *Psychological Reflections*, Jung argued:

"In the adult there is a hidden child – an eternal child, something is always becoming, is never completed, and that calls for unceasing care, attention, and fostering. This is the part of personality that wishes to develop and complete itself. But the human being of our time is as far from completion as heaven is from the earth."

Jung's hidden child was deeply wounded by parental grief and by the tragic split between his parents. Nevertheless, Jung was able to find a unique way to unite his father's linguistic heritage with his mother's mystical visions. One of Jung's daughters, Gret Jung-Baumann, became a renowned Swiss astrologer. She believed that Jung was impelled to become an explorer of the hidden depths of the soul by his birth sign, Leo, and by the planetary positions at the moment of his birth.

In *Celestial Twins* I analyzed Jung's relationships with his beloved ones [5]. Here I would like just to mention that his confrontation with the inner demons helped him transform his attitude to life. He and his wife Emma Jung (née Rauschenbach, 1882-1955) had five children: Agatha Regina (1904-1998), Anna Margaretha (Gret, 1906-1995), Franz Karl (1908-1996), Marianne (1910-1965), Helene (1914-2014). All of his children already belonged to the new Phoenix Year. At least two of his daughters would follow their father and become presidents of the International Psychoanalytical Association.

Jung was born at the end of the previous Phoenix Year, before a new generation of the prenatal psychologists was born. His creative effort to seek wholeness and integration was not futile. Today humankind has already greatly diminished the rates of infant mortality, and there is also the growing hope that by the proper education we shall be able to lessen the level of tensions and frustrations in families.

A peculiar coincidence: two Nobel Laureates in physics, Erwin Schrodinger (1887-1961) and Louis de Broglie (1892-1987), who made groundbreaking contributions to quantum theory were born with the same aspect as Jung: when Sun in Leo and Moon in Taurus where in a challenging aspect of 90°. While Jung intended to reconcile the irreconcilable features of our psyche, de Broglie and Schrodinger were developing their theories of wave-particle duality. Born during the new Phoenix Hour (between 1885-1900), they were able to change the old paradigms and to open new possibilities for the following generations of holistic scientists. However, their detailed stories are beyond the scope of this paper.

Case 7. Oscar Milosz – The Wounded "Knight of Love"

Oscar Vladislas de Lubicz Milosz (1877-1939), a francophone poet, writer and thinker became a legendary, mythical figure already during his lifetime. His nephew, the Nobel Laureate Czeslav Milosz, wrote about him: "We can imagine him …as a member of one of the 'mystical lodges'" [52, p. 22]. Milosz is remembered as a truth-seeker who looked for initiation and eventually got it [5].

It is symbolical that a French Symbolist poet and critic Paul Fort has named him as "The French Goethe" [51, p. 412]. He did not know that Milosz, like Goethe, was born on a full moon day (May 28, 1877) and had a challenging aspect between the Sun and the Moon, accompanied by significant differences between his parents' temperaments and mentalities.

On his father's side, Milosz's ancestors were probably from an ancient Serbian royal family of Lusatia who left their estates near Frankfurt on the Oder while fleeing German pressure. The poet's great grandfather obtained the vast estates of Czereïa, then a part of Grand Duchy of Lithuania (now Belarus). The poet's grandfather was an officer in the Polish-Lithuanian army who married an Italian opera singer, a descendant of an ancient, impoverished Genoan family.

Milosz's father, Wladislav Milosz was a wealthy man of unrestrained character. According to a family legend, once, riding in his carriage in Warsaw, he was taken by the beauty of a young Jewish girl. Surprisingly, without a word being exchanged between them, she agreed to become his mistress. Daughter of a Warsaw Hebrew teacher, Miriam Rosalia Rosenthal was 20 years younger than Wladislav who later became her husband. The new couple left for Czereïa, where their only child Oscar was born. All his life Oscar tried to remain faithful to both his aristocratic and his Jewish parentage.

His parents belonged to different worlds remaining distant from him and from each other. Oscar grew up as a solitary and unhappy child. Oscar's father was violent and ill; his mother's uncomprehending solicitude oppressed him so much that the boy was never able to give free rein to his affection to her. In his poems Milosz described the uttermost sadness of a child's heart, remembering the parental place as a frozen, dumb and dark house, in which his "soul was dying from neglect" [52, p. 121].

As a 12-year-old boy, Oscar was sent to study in Paris, at the Lycée Janson de Sailly, first as a boarding student, then as a day student living in the household of his pedagogue. The necessity of separation, the need to break the depressive ties with the mother, who did not know the way of her son, and the feelings of loneliness lurk behind Milosz's poem *Nihumim (*which is the Hebrew word for *Consolations*).

The depth of Milosz's early trauma made him bear the stigma of loneliness and of an unappeased craving for love. Although in 1900 he was already recognized by the French literary critics as a genius, Milosz felt horribly sad and empty. Despite his success, he became a violent and deeply frustrated young man. His loneliness and thoughts about the absurdity of existence led him try to take his own life. On January 1, 1901 he shot himself in the region of the heart with a revolver. Milosz remembered that to his surprise he missed the heart and instead injured the lung. The lung became dangerously swollen, but to the great astonishment of the doctors he soon recovered.

This suicidal attempt led Milosz to a painful long process of soul-searching. Gradually he concluded that there is no solution for human problems either in hatred or in killing. In 1905 he proclaimed himself the "Knight of Love," pondering his role in the renewal of Christian metaphysics. In his search for healing and initiation Milosz studied theosophy, travelled intensively through Europe and North Africa and joined a few esoteric circles. Eventually he was initiated on December 14, 1914, when he experienced the visionary night of illumination, which he described just in a few words: "I have seen the spiritual sun" [52, pp. 447-449].

Nevertheless, known as a basically kind, loving and friendly person, during all his life the poet suffered from the deficiency of true intimacy in his relationships. During the WWI, Milosz was mobilized by the Russian Division of the French Army, where his job was to brief war correspondents. When the Russian writer Ilya Ehrenburg, as a war correspondent met him at the *Maison de la Presse*, he was shattered by the frightening disharmony between Milosz's aloof eyes and the horrible violence of his words:

"He would gaze at me with his pale, faded eyes and say, very calmly and quietly, that soon someone would invent a machine which would write poetry, and then some little boy of a genius, still in short trousers, would hang himself with his father's tie when he realized that he could never move anyone with words" [53, p. 188].

Milosz loved people, as he said in one of his poems, "with an old love exhausted by loneliness, pity and anger" [52, p. 28]. People felt this tragic split in his soul, because true love can be accompanied neither by pity nor by anger. He remained a bachelor and he had no children. In 1909 he fell in love with young Emmy Heine-Geldern, the great-niece of Heine. He believed that she was his celestial spouse, yet his happiness lasted just one year – the next year she married someone else. The poet wrote:

I am too great for the daughters of men;
They cannot understand my love.
My love is so great that no creature
Would dare approach it… [52, p. 93]

The most distinguishing feature of Milosz's later years was his emotional non-involvement in the life of the outer world, and after 1926 he grew increasingly solitary. The knowledge he gained from esoteric studies brought him to believe that his Earthly existence was anything but a transitory stay. Feeling that the obscurity of his work was commanded to him, Milosz declared that his message was not meant for everybody, but for the salvation of only a few. In his most spiritual works, such as *Ars Magna* (1921) or *The Exegetic Notes* (1926) he gave humanity a doctrine, which, he believed, would be understood only after his death.

When Milosz died, his name meant little to the wide public. The turning point in the public's attitude toward Milosz's poetry took place 20 years after his death. In 1966, an association *Les Amis de Milosz* was founded in Paris; its members gather every year on the anniversary of the poet's death and publish a journal, which reproduces biographical documents and records new publications on his writings.

Reading Milosz's story of a spiritual quest of a solitary child, reminded me one of King David's passionate prayers in his Psalms (27: 10,11):

When my father and my mother forsake me, then the LORD will take me up.
Teach me thy way, O LORD, and lead me in a plain path.

Although the next case is very similar to Milosz's story, and in *Celestial Twins* both life-stories were treated in parallel, here I decided to stress the different nuances between them and to tell them separately.

Case 8. Maximilian (Max) Voloshin – a Tragic Split

Like Milosz, the prominent Russian poet Maximilian Voloshin (1877-1932) was born on May 28, 1877, i.e. he was Milosz's celestial twin [5]. Like Milosz and Goethe, Voloshin was born on the day of a full moon. By significant coincidence, one of Voloshin's biographers and friends, the Russian poetess Marina Tsvetaeva, believed that he was "the real Goethian" [54, p. 253].

From his early childhood Voloshin was exposed to dual cultural and religious forces. On his father's side he was a descendent of a Cossack family from Zaporozhe in the Ukraine. Voloshin's father, Alexander Kirienko-Voloshin, was born in 1838, the same year as Milosz's father. Like Milosz, he was a wealthy man who led the typical life of a Russian nobleman. In 1868 he married the very young and beautiful Elena Glaser. She was a descendant of German Protestants who fled Germany and settled in Russia in the 18th century. In his *Autobiography* Voloshin mentioned that in addition to German there were also Italian and Greek ancestors on his mother's side. Like that of Milosz, this was an unusual match. The husband was almost 20 years his wife's senior and the couple had profoundly different temperaments and mentalities. Their first daughter – Voloshin's older sister – died in her infancy before his birth.

The atmosphere in Voloshin's house was gloomy and disharmonious. After Max's birth the relationship between his parents deteriorated gradually until Elena took her 2-year-old son and left her husband for good. Two years later Max's father prematurely died.

Elena loved Max dearly, yet she was a very masculine woman with deep traumas, which she never discussed openly with anybody. There were strong bonds between Voloshin and his mother, yet there was no kindness in her love and no friendship in their relationship. Her coldness caused deep pain in Voloshin's life. For the rest of his days he would ponder the question of the nature of the maternal bond, looking for new ways of education. In his poem *Motherhood* (1917), 40-year-old Voloshin lamented: "Darkness… Mother… Death… What an assonant unity…"; "From all the knots and tying of life – the knot / of the sonhood and the motherhood – it / is most closely and tightly strained…."

According to Voloshin, the task of the mother is to "love for the sake of love," to give her child each day a new birth for the sake of his freedom to become a separated individual. Such love should be totally unselfish: "And there is no reward or repayment for your love, / Because in love itself there is reward and repayment!" But this understanding would come to Voloshin in his forties.

In his childhood and youth, Voloshin suffered from loneliness, unhappiness and depression. As a result of the absence of proper parenting and as the unconscious need to duplicate the pattern established by the parents, he began to bear the stigma of an unappeased craving for love. He suffered from the deficiency of true intimacy in his relationships. Voloshin confessed: "I have a tragic split. When I am attracted to a woman, when I feel a spiritual closeness to her, – I cannot touch her. It seems to me like blasphemy" [55, p. 370].

Voloshin pondered: "Homeless long way is given me by fate…/ I am wanderer and poet, dreamer and passerby" [55, p. 12]. And he continued, "In your world I'm just a passerby, / Close to everyone, stranger to all" [56, p. 23].

The Russian writer – Ilya Ehrenburg, Voloshin's friend, described the terrible loneliness hidden in Max's eyes: "Max's eyes were friendly but somehow aloof. Many people considered him indifferent or cold: he looked at life with interest but from the outside. No doubt there were events and people that moved him, but he never spoke of them; he counted everyone among his friends, but it seems, he never had a friend" [53, p. 125].

In 1906 Voloshin married young Margarita Sabashnikova, a descendant of a well-known Russian family of publishers, who shared his interests in anthroposophy and art. Yet this marriage failed within less than a year. Voloshin's second marriage took place twenty years later, when in 1927 he married 40-year-old Maria Zabolotskaya, a practical woman who took upon herself all his materialistic problems. Voloshin's biographers would describe him "a man of uncertain or underdeveloped sexuality, both of whose marriages were of the marriage blanc variety" [57, p. 35]. Calm, loving, endlessly-detached, he would never have children.

Voloshin's youth was filled with turbulent and even violent events. In Moscow he was involved in student disorders and clashes with the authorities. His university studies became checkered with periods of suspension, during which he was either deported to Crimea or traveled in Europe. Eventually his university education ended with his arrest in 1900. On his release from prison, Voloshin withdrew to Tashkent. There he worked as an administrator on the extension of the Russian railway system, traveling in the heat of the desert through Middle Asia. Later Voloshin would remember this half a year spent in the desert with a caravan as the crucial moment of his spiritual life.

During his wandering years Voloshin had been attracted to the occult and the mystic. He studied Buddhism with a Tibetan lama, he became a friend and pupil of the Austrian mystic Rudolf Steiner. In Dornach, near Basel, Voloshin participated in the building of the first anthroposophical temple. This Goetheanum was designed by Steiner to become a school of spiritual science.

During the WWI Voloshin claimed that violence cannot bring peace and he dared to say that his love embraced the German wounded as well as Russian. Yet his road to such love, which embraces all the living, was not a straightforward one. For example, in 1909 Voloshin had a pistol duel with another famous Russian poet, Nikolay Gumilyov. Voloshin challenged him in order to protect the "good name" of a young poetess. Happily, both the duelists missed, and for Voloshin this accident became the last recorded time that he sought a violent solution to a problem.

In 1917, Voloshin's friends were surprised by his choice to stay in Russia. He could emigrate, and they expected him to leave for Paris. As time passed Voloshin became increasingly isolated in the inhumane state, where most of his friends became its victims. Nevertheless, Voloshin denied the possibility of overthrowing the Bolsheviks by force of weaponry; instead he proposed accepting the teachings of the Russian Orthodox St. Seraphim, whose spiritual doctrine centered on a program of contemplative prayer directed toward mystical experience. Following St. Seraphim, the poet argued for practice of spiritual cleansing by taking on, through compassion and forgiveness, all the various vices and sufferings of all beings, and by giving to them, through love, healing and peace of mind.

Voloshin's ideal world of love was a world of knowledge and not a world of hurtful feelings. But other peoples did not agree with him. The themes of Voloshin's works became unacceptable to the Soviet censors, and from 1926 he was unable to publish anything. His later poetry circulated only in handwritten notebooks. Often on the brink of starvation, Voloshin was saved only by the parcels from friends and by a small literary pension. On August 11, 1932 Voloshin died at his home.

The turning point in the posthumous history of Voloshin's works came about the same time as Milosz's, when Khrushchev's so-called period of "the thaw" had begun in the USSR. Voloshin's name was gradually coming back to the Russian consciousness, first as painter, then as a lyrical poet-symbolist, and eventually as a mystic, historian and prophet.

Our next case will take us already beyond the usual recollections into the enigmatic world where, according to Andrei Bely, the souls dwell before their incarnation on the Earth.

Case 9. Andrei Bely – Expanding Consciousness

Boris Bugayev (1880-1934), a distinguished Russian poet, writer and memoirist known under the pen name of Andrei Bely, was a symbolist. Symbolically, he has chosen as an epigraph of his most important autobiographic novel *Kotik Letaev* the following passage from Tolstoy's *War and Peace*:

" – You know, I think," – Natasha said in a whisper… – "that when you remember, remember, remember everything, you remember, back so far that you remember what it was like before you were on this earth…" [58, p. 3].

Bely believed that a new-born baby is far from being a white page. Even though they do not have the language to share their impressions, the newborns are part of a universal sea of consciousness and their memory extends back before birth. The babies can feel themselves mute, abandoned, frustrated, misunderstood or neglected. Those unexpressed feelings usually become vague or forgotten as the child grows up, but they still exist in our minds.

Following this belief, Bely was sure that the roots of his own troubles were hidden not only in his early infancy, but even in his historical predecessors, in the timing of his birth and in the troubled relationships between his parents who had, essentially, opposing views on life. One of Bely's favorite epithets is "scissors." In the first volume of Bely's memoirs, *On the Border of Two Centuries*, he defined his life as revolving about "the problem of scissors." He was born in 1880, on the edge between the passing Phoenix Year, and the new Phoenix Hour of 1885. He describes his terrible feeling of seeing the coming future but inability to enter and join it: "In many ways, we, children of the edge, are incomprehensible: we are neither the "end" of the century, nor the "beginning" of a new one, we are – the battle of centuries in our soul; we are scissors between the centuries; we should be treated in the light of the problem of scissors, realizing: we could be understood neither in the criteria of the 'old', nor in the criteria of the 'new'" [59, p. 180].

Born on October 26, with a challenging aspect (90°) between the Sun in the Water sign of Scorpio and the Moon in the Fiery Sign of Leo, he sees his parents "tearing me apart; fear and suffering overwhelm me; scissors again" [59, p. 185]. At the early age of four, Bely invented a peculiar game of transforming the conflicts of scissors into symbols and music. This was his way to solve the "'scissors' problem 1) between his parents and myself, 2) between father and mother, 3) between different views of the authoritative figures" [59, p. 180].

It is symbolic that in his childhood and youth Bely was deeply influenced by Schopenhauer. He described him as a "knife" which helped him to diminish the scissors problem. Indeed, Bely, like Schopenhauer, depicted the profound differences between his parents: "It is difficult to find two people as different as parents… rationalist and something completely irrational; the power of thought and hurricanes of conflicting feelings" [59, p. 96].

Like in Schopenhauer's case, the seeds of future quarrels in Bely's family could be seen already before the marriage of his parents, when the 40-year-old professor of mathematics at the Moscow University, Nikolai Vasilievich Bugaev (1837-1903), met his nineteen-year-old bride Alexandra (1858-1922). They differed so much that one can hardly imagine them as having a point of intersection. He was a venerable and respected scientist; she felt herself as a little girl. He was clear-minded, she suffered from nerval upheavals. He was physically unattractive if not ugly, she was a beauty. Three times he proposed to her, and three times she refused him. Eventually, in January of 1880, "Mother married him for 'respect'; father married her for 'proportions'; but neither 'respected proportions', nor 'proportional respect' did not work out in any way" [59, p. 102].

For Alexandra, like for Johanna Schopenhauer, this was a marriage of convenience greatly influenced by social and economic considerations. Such arranged marriages were a common practice at the time, yet it did not make Bely's lot easier. He was an extremely sensitive boy. He grew up as an only and solitary child, and from his earliest days he saw himself as the only link between his different parents; this "tormented him." Most of Bely's memoirs and writings revolve around the conflict between the child's father and mother (modeled after his own parents) over the best way of bringing him up. Like in all the previous cases, during all his life Bely often would be criticized for the notorious complexity of his character. One of his friends, the Russian poet Vladislav Khodasevich (1886-1939) described this tense situation:

"The very imagination of Andrei Bely was once and for all struck and – I daresay – shaken by the constant threats of his home life. These threats exerted the most profound influence on his character and on his entire life" [60, p. 53].

Khodasevich has vividly recreated the atmosphere in the Bely's family:

"His mother was very attractive: her husband was ugly, sloppy, ever lost in abstractions, with the beautiful, flirtatious wife, given over to the earthiest of desires…From these circumstances derived such a lack of harmony, from one day to the next manifesting itself in turbulent quarrels for hardly any reason at all. Boris was affected by all of them" [60, p. 53].

Bely inherited both temperaments of his parents. During the rest of his life he tried to fuse the orderly, rational and mostly mental approach of his father with irrational impetuosity of his mother. He sought harmony, but the main problem was that the mother disgusted her husband's icy intellect and was determined to make her best to prevent their son from continuing his father's scientific pursuits.

The descriptions of family's conflicts and the conscious and unconscious life of the child became the central themes in Bely's oeuvre. The first volume, *On the Border of Two Centuries*, presents Bely's early life as an open trauma due to ceaseless conflicts between his mom and dad. As a mathematician, his father was devoted to sciences, and his emotional insensitivity was something that his mother could not withstand. In one of his poems Bely described the striking portrait of his father (under the fictional name Letaev) and his critical attitude towards his son:

My father, Dean Letaev, says
Throwing his arms up into air:
"You, my young fellow, –
    It makes me sick
Really, the rot you are talking!"
And a mathematician's aridity
Would peep out of his tiny eyes [61, p. 13].

Mother used to complain with tears in her eyes that the father: "is prematurely developing the baby, – that's my business: I know how to raise children…" [59, p. 155].

Bely's mental gifts were evident early in his childhood, yet they were severely suppressed by his mother. Each of the parents tried to mold their son after himself or herself. Bely tried to be ambitious in both directions, but his mother demanded that he should not learn to read and write early. She was furious when she found out that her son was learning the alphabet. She reproved her little child frequently by calling him an incorrigible little "brainy mathematician":

" – Mommy used to kiss me: suddenly she would start to weep; and – she would put me aside: – 'He's not like me: he's like – his father" [58, p. 130].

The moments when his mom was pushing him away were "the most frightening things" in his life [58, p. 155].

Like Crane, Bely was deeply upset by the fact that he could not bridge his parents' temperaments. Like Hemingway, he was even considering patricide. In the spring of 1921 in St. Petersburg, Andrei Bely told his sad story to a young poetess Irina Odoevtseva (1901-1990):

"My parents fought over me. I took side with my ugly father against my beautiful mom and with my beautiful mom against my ugly dad. Each of them pulled me in his or her direction. They ripped me in half. Yes. Yes. They tore my childhood consciousness, my child's heart. I've been divided from my childhood. I felt myself a sinner. It was a sin to love my mom. It was a sin to love my dad. What could I, a sinner, do? I was locked into a circle of the family drama. I loved and hated… I've been a potential killer since childhood. **Yes. Yes. I could kill my father.** The Oedipus complex perverted by love. Mom beat me for my love to dad. She cried, looking at me: 'A big-foreheaded, brainy. He is like him, absolutely like him, and not like me…'"

Sometimes it is very difficult and disturbing to read Bely's testimonies because they present quite a maddening picture, but there is a great deal in them that reflects not only his family, but an archetypal situation in many modern families as well.

Like in Pascal's case, the accumulated frustrations, created by a painful dichotomy between rational and spiritual inner needs, led to periodical violent reactions. His relationships with colleagues were suffering because the style of his attacks against other symbolists was often too brutal and aggressive.

Before meeting Rudolf Steiner in 1912 and prior to attending his anthroposophical lectures, Bely was involved in a series of stormy relationships, including two of the most dramatic and scandalous love triangles of his days. The first of them included Alexander Blok (a famous Russian poet), his wife Lyubov Mendeleeva-Blok and Bely. The second one was between Bely, Valery Bryusov (another famous Russian poet) and Nina Petrovskaya (a writer on her own right). This latter story, described by Bryusov in his novel *The Fiery Angel,* became later the plot of Prokofiev's opera of the same name. Both affairs became extremely violent: first Bryusov called Bely out to a duel; then in turns, Bely and Blok called each other out to a duel. In addition, Bely was obsessed with morbid thoughts. There were even days when he stopped eating and considered suicide. There were also especially dark days when he was so frustrated and outraged that he felt a burning desire to wipe out an entire city. A crisis came when Nina attempted to shoot Bely at one of his lectures. Luckily, most of these destructive and self-destructive attempts were futile threats, but tragically, Petrovskaya's life was ultimately destroyed: following bouts of alcoholism and narcotics addiction she finally committed suicide.

This stormy period was followed by Bely's passionate search of transformation and new meanings of life. Between 1912-1916 he lived in Dornach and, like Voloshin, participated in the building of the Goetheanum – the world center for the anthroposophical movement. For Bely, his meeting with Steiner became the beginning of his spiritual work and a turning point in his attitude to life. Claiming an exceptionally good ability to recall the earliest impressions, in his writings he revived spectacular prenatal and perinatal pictures of the world and of the expanding consciousness as if they are experienced by a baby. Embracing Goethe's ideas of *Zeitgeist* and following his own insights, Bely stopped blaming his parents and came to conclusion that the most important task of the poet is to recover the memory of the time before his soul left the realm of its eternal dwelling and the ego descended into its earthy body. In *Kotik Letaev* he exclaimed: "…the impressions of childhood years, that is, memory, is a reading of the rhythms of a sphere, a remembering of the harmony of the sphere; it is – the music of a sphere; of the realm where – I lived before birth!" [58, pp. 140-141].

Such conscious adult work brought Bely to discover multiple interconnections between different hereditary traits and patterns in each of us. In his view, both an individual and the entire society are associated with numerous "rooms" and "apartments" with their specific cyclicities. In his second volume of memoirs, *The Beginning of the Century*, Bely made an attempt to transform his parents' patterns by accepting his own responsibility for his adult personality. I should like to quote a rather long passage that is somewhat foggy and difficult (as most of Bely's texts are), but which contains a very important message written with his own pain and blood:

"All the words about the beautiful and the novel in each friend – are an apartment in a series of apartments, whose roomers live neither in a new nor in a beautiful way; dreaming of a common cause that connects friends closely, you also dream of the connection between apartments, that is, the unity of experiences; it would seem that a connection has been made. Not at all! Series, hundreds of apartments with unknown, sometimes terrible, roomers were introduced into community; and inertness is revealed that is not liquidated in everyone; 'fathers' are not just inside me: often they are not overpowered; they lurk inside of us; that's why the borders between near and far, between the old and new are sometimes invisible to us: they are broken in each instant; and our impulses to change life are crashed every minute; a warder is always present; he is inescapable; and he is – you yourself who have not identified yourself; you think that you are winning, that the circle of your new tasks is expanding and coming into being; you have broken the ties with your past; you are only about the future, with the future; and suddenly – you are back to square one; you – have completed the circle; your release from a 'prison' is just a dream of release" [62, p. 521].

Bely's strongest message to all of us: "**you are – not Papa's, not – Mama's**" [58, p. 94]. As a child, he felt himself belonging to the sky, to the Milky Way, to the cosmos…

Bely's life was turbulent. He witnessed the First World War and survived the Civil war in Russia. He was married twice but had no children. One of the aims of Bely's case-study lies in outlining one of the original ways in which Bely enriched the genre of memoir, i.e. his earliest first-hand impressions as an infant, an embryo and a purely expanding consciousness. To date, the autobiographic materials or the memoirs have not attracted the same attention as the clinical cases. Yet even though they might include factual inconsistencies or discrepancies, the diaries or memoirs seem to have no rivals in providing a glimpse into the innermost personal experiences. In that sense, one of the important functions of Bely's brilliant historic-literary memoirs is to supply a true portrait of his epoch and its attitude towards the parental role in the child-raising.

In the next case we shall meet Sergei Prokofiev, a person of the Phoenix-Hour generation, whose diaries open a new possibility to trace our roots of frustration or cruelty.

Case 10. Sergei Prokofiev – a Child of the Stormy Age

First, I'd like to note that the following text is mostly based on my latest book *Opera PRKFV* dedicated to the temporological case-study of Sergei Prokofiev [63].

Unlike all the previous cases, Sergei Prokofiev (1891-1952), one of the most prominent composers ever, a virtuoso pianist and conductor, belongs already to a new historical epoch. According to the Phoenix Clock model, he was born during the Phoenix Hour of 1885-1900 and therefore belonged to a very rare kind of generations whose historical mission was to become precursors of new paradigms [4, 9].

Earlier I wrote that this was also the generation of the first psychologists who became aware of the crucial importance of the early developmental periods. Among the precursors and founders of the Prenatal psychology we find the names of Jean Piaget (1896-1980), Anna Freud (1895-1982), Nandor Fodor (1895-1964) and Gustav Hans Graber (1893-1982). Strikingly, Prokofiev too felt very acutely a new stream of consciousness or Goethe's *Zeitgeist*. From his early childhood he believed in his special mission both as a composer and a diarist. He began to keep diaries since his childhood as if he apprehended his personal life to be special, meaningful and different from that of the previous generations [64].

From Prokofiev's 2,250-page diaries, published in 2002, we get a personal account of the everyday life in his environment. From his brilliantly written *Childhood* – the first part of *Autobiography* – we have first-hand information about his early years, as well as about the history of his family and relationships between his parents.

Prokofiev was born on the full moon of the April 23, 1891**. Like in all the previous cases**, during all his life Prokofiev was often criticized for the striking complexity and contrasts of his character. Sometimes he suffered from violent outbursts of irrational rage. His friend Nicholas Nabokov admitted that Prokofiev's rudeness sometimes "bordered on sadistic cruelty." For example, once in his conservatory days, Prokofiev stuck his fingernails into a hand of his fellow student, the violinist Lazare Saminsky. Although Prokofiev tried to temper his reactions, according to Harold Schonberg: "He was stubborn, ill-tempered, obstinate, and surly. He had pink skin that would turn red when he was in a rage (which was often). He disturbed everybody: always ready with a crushing repartee, with an irritating chuckle and a celebrated leer" [65].

On the other hand, Prokofiev considered himself to be so vulnerable and touchy that he was worried why "his love could be easily turned into acute hatred?" [66, v.1, p. 164]. In 1933, when Natalya Sats (a Russian stage director who worked closely with Prokofiev on the creation of *Peter and the Wolf*) told him that sometimes he can be meek as a lamb, he muttered in response that sometimes he can be "evil as a devil". And he added: "Yes, I am sharply continental, and it's hard not only for those around me" [63].

Here I'd like to stress that **unlike** the previous cases, Prokofiev was early **and acutely aware** of his contrasts. "In my own character there is the need for freedom and independence; there is also despotism in it," he admitted in the *Diaries* [66, v.1, p. 176].

Moreover, he tried to ask himself sincerely: where does his rudeness come from? His self-search brought him to understand that the roots of his cruelty could be traced to his earliest days of life. Step by step we shall follow Prokofiev's prenatal history and find out possible influences in his formational years.

It should not already be a surprise that Prokofiev's duality and his roots of frustrations were accompanied by the sharp differences between his parents who constituted two different poles of his existence. His mother, Maria Grigorevna Prokofieva (1855?-1924) was born in St. Petersburg. She had a fine musical taste and was a serious amateur pianist. She loved to attend concerts and enjoyed social life in the cultural centers of Russia. She became her son's first piano tutor and she dreamt of promoting his musical career.

Nine years her senior, the composer's father, Sergei Alexeyevich Prokofiev (1846-1910), was a serious and responsible, but rather introvert person. He graduated from the Moscow Agricultural Academy and became a skillful agronomist. For thirty years he managed the estate of Sontsov, now Ukraine. He loved his quiet village life and preferred to stay far away from the intense life of the capitals.

During the 13 years of their marriage before Sergei's birth, the Prokofievs lost two daughters. That loss has deeply affected his parents' emotional nature and froze his father's natural warmth. The elder child, Maria, died at the age of two. Her younger sister, Lyubov, lived only nine months. Maria was told that the death of both daughters was caused by teething and that this problem was due to her own "bad" heredity. When, after a nervous waiting a son was born to the Prokofievs, they were afraid to lose this baby too, and this fear permeated their relationships with the baby. To keep him alive, Maria was ready to accept the most eccentric advice. One of her neighbors told her that the problem was in the breast milk of Maria herself, and to reduce the threat of the disease, it would be better not to feed the baby with mother's milk, but to take a nurse for him. In his *Childhood* Prokofiev recalled: "A healthy village girl was hired who had an out of wed-lock child. She had enough milk for two, but she didn't love her baby and, wishing to get rid of him, she held him upside down. My teeth erupted safely, but didn't I absorb with her milk of a stranger also her cruelty of character? " [67, p. 25].

Whatever the reasons for this, Prokofiev's reaction was violent and immediate: at the age of six weeks he almost died of bloody diarrhea; his parents could lose their third child.

The next scene from the *Autobiography* was also very painful for the baby. Despite her "warm" love to her son, in December 1891 his mother felt terribly bored and frustrated in the village. To cheer up she left her 8-month baby with his father and grandmother, while she was planning to spend the winter (as usual) in St. Petersburg. How could this little baby feel her absence? Children feel time differently, and a clue to this can be found in Andrei Bely's memoirs. When he was four years old, he was greatly upset by a temporary separation from his mother: "Mother spent in St. Petersburg about two months; but it was like years passed" [59, p. 185].

If it was so painful for a toddler, how should it have been for a baby who was separated from his mother during the crucial stage of a mother-child symbiosis? Two months for him were more than a quarter of his entire lifetime! Did he feel himself abandoned, or guilty, or worthless? We cannot be sure, but there is a hint in Prokofiev's *Autobiography*: "I was a nasty baby, I beat my mother in physiognomy when I didn't like her pince-nez, and I awfully shouted 'macaque!', Which meant 'milk'" [67, p. 25].

Why should any baby feel oneself as "nasty" or violent? What feelings did his parents mirror to him? Why didn't his mother want to witness his first steps and first words? We cannot know, but we do know the consequences of this behavior. From the *Diaries* it is seen how the echo of this first separation from the mother periodically came back as the refrain throughout the entire Prokofiev's life. His ambivalent attitude towards his own sons, his harshness and tactlessness, as well as numerous quarrels and periodic breaks with the loved ones were like a continuation of the process that began in his early (unconscious) childhood, when his mother suddenly left him during the formational period of his personality.

According to Prokofiev's first wife, Lina, sentiments in Prokofiev's relationships as in his music were "anathema." Prokofiev's "lack of basic human feeling could be shocking, as was the strange comfort he found in transferring matters of the heart to the mind" [68, p. 34]. As an example of his insensitivity, Lina quoted Prokofiev's chilling entry from his 1910 diary, written soon after his father's untimely death: "Did I love him? I do not know … He served me, his only son, unstintingly, and it was thanks to his tireless work that I was provided for so long with all my material success" [68, p. 34].

At the early age of nine Prokofiev wrote his first opera. The "Giant" is an opera in three acts and six scenes to a libretto by the young composer. In the beginning of that story a terrible Giant tries to kidnap the little girl Ustinya, who is rescued by Sergeyev (the composer himself) and his friend Yegorov with the assistance of a good King. However, the opera ends with the defeat of the King by the Giant and the King's suicide. This plot indicates that at the age of nine, Prokofiev's imagination was already inspired by the violent and far from being childish narratives. In a way, his first libretto became prophetic. As an adult, Prokofiev would confront his helplessness, when his friends, relatives and his first wife Lina would be victimized by a terrible Giant – The Russian Revolution and its notorious leader, Stalin.

Let us proceed to another meaningful scene from Prokofiev's *Childhood*. Till the age of 12 Prokofiev was homeschooled. In 1903 his parents had to accept a difficult decision, where should he continue his education. The parents had opposite opinions, which led to frequent quarrels between them. One night, Prokofiev woke up from a depressing scene when he overheard his father shouting to his mother: "In that case, nothing remains for me but to shoot myself" [67, p. 105]. The boy took these words seriously and began to cry. The parents tried to calm him down. In the end, his father began to cry too, and then he left the room.

As a child, Prokofiev felt himself guilty for the quarrels between his parents. His mother wanted to educate him in the capital, because she herself wanted and needed to move there. His father opposed this wish, because he had to stay in the estate, and he could not move with the family. On the other hand, he could not live without his wife and son. It was a deadlock. The mother won, but the father soon became gravely ill.

Is it so surprising that Prokofiev had a difficulty to express his feelings without fear of hurting either his mother or his father? Is it a surprise that he chose not to express his feelings at all? Yet the price for such tranquility is usually high. The accumulated feelings of frustration and rage caused Prokofiev to suffer from acute headaches and later from high blood pressure.

He desperately tried to be good with everybody, but sometimes it did not work. One of the sad facts was that his firstborn son, Svyatoslav, has inherited from him a challenging aspect (90°) between the Sun and the Moon. Unfortunately, it is obvious from Prokofiev's *Diaries* that he did not want to marry his first wife Lina and he did not intend to have a child at that period of his life. His first attitude to the baby was ambivalent. The baby's crying irritated him, and he even insisted to give the child away to a nursing family. There were numerous quarrels between him and Lina about raising their son. Finally, the situation improved when Prokofiev became a practitioner of Christian Science [66].

During all his conscious life Prokofiev tried to improve his "nasty" temperament. During his conservatory years in St. Petersburg he looked for the answers in Schopenhauer's philosophy. During his years spent outside Russia he, like Grace Crane, was attracted to Christian Science teachings, which helped him diminish his inner tensions. Indeed, his second son, Oleg, was born during a quieter period of Prokofiev's life, and he did not inherit this demanding aspect. For a while, Prokofiev's spiritual work on improving his nature was efficient, but it could not solve all his health problems for a long time.

After returning to the USSR, Prokofiev could not continue his self-growth journey. His relationships with Lina were deteriorating. His intense life-style was gradually becoming more self-destructive. In 1938 he met his future second wife Mira Mendelson. 24-years younger than Prokofiev, fragile and delicate Mira also had a challenging Sun-Moon aspect (90°). She felt in love with Prokofiev and threatened him to commit suicide if he would not leave his wife.

Somebody might say that Prokofiev should not have paid attention to such childish threats. Yet it was not true in his case. During his students' years, his best friend, Max Schmidthof, committed suicide. Prokofiev felt at least partly guilty, because he did not take seriously Max's words about suicide and did not prevent it. Prokofiev could not allow himself to witness the second such tragedy.

This short sketch does not intend to retell the entire narrative of Prokofiev's contradictory life. In my book and articles, I tried to be as objective as I could by adding to his amazing story a fresh look of the *Whole-Self Prebirth Psychology* and temporological approaches [4, 63, 64]. Recently I read in the *Observer*, an interview with Lina Prokofiev's biographer, Simon Morrison. He supposed that Prokofiev's letters to Lina revealed "a real indictment of his personality." And he continued:

"I have a moral question. Prokofiev's music is some of the most emotional of the 20th century, but he was a person of very little feeling. As a biographer, you have responsibilities. As a listener, I don't think I can listen to the music the same way again. It is a harrowing story."

At least in one thing I can fully agree with Morrison. Prokofiev's life story as well as the stories of all the other cases in this study were harrowing stories. And it is also true that our knowledge of Schopenhauer's, Pascal's, Hemingway's or Bely's biographies will alter our perception of their works. Yet should we blame them? And is there any way out of those patterns?

I hope that the answer is positive. To mention just two facts. First, in the new Phoenix Year the rate of child mortality is dramatically lessened. In parallel, there are less morbid feelings of grief and fear in young families. Second, there is no more "code of honor" and there are no more pistol duels in our generation. Men and women are more open to listen to each other and to respect each other.

From the practical point of view, let us listen carefully to Prokofiev. At the age of seven, young Sergei composed his first march for four hands. He was fascinated by the cooperation of all the hands: "Each of them plays a different thing at the same time and yet together it does not sound bad at all."

In this story, like in all the previous cases, there were no "good" or "bad" guys. There were many fears and too many conflicting needs. But at the same time all those people who have chosen a creative way of self-improvement left us their oeuvre and together their voices do not sound bad at all.

Case 11. Jacqueline Kennedy Onassis – "the Kennedy Curse" and Jackie's Legacy

As the widowed First Lady, Jacqueline Kennedy (1929-1994) became a popular object of media myth making. After John F. Kennedy's death, she became a single mother who is also remembered as a person who tried to protect her children from the notorious *Kennedy Curse* – a series of deaths, accidents, and other calamities involving members of the American Kennedy family.

Her extraordinary life was explored and commented on by numerous reporters and biographers. Unavoidably, some of their writings were full of inaccuracies or subjective opinions, but nevertheless that does not change the most well-known objective facts. On the one hand, many people envied Jacqueline for her beauty, intelligence, wealth, fame, power and life full of excitement and glamour. Liz Smith wrote that Jackie was "the Kennedy Blessing" and for more than five decades she captured people's imaginations "as no other woman has or probably ever will again in our time" [69]. On the other hand, Jacqueline is seen by many people as a tragic historical female figure. Married to a complex man, her life was kept in the public eye. For many decades she was haunted by multiple losses, violent deaths, personal destruction and the unbearable price she was requested to pay for her achievements. As a result, she is often depicted as a strong undefeated person whose survival was attributed to the less known, mysterious side of Jacqueline, which was described by Liz Smith as "an impenetrable air of reticence and spiritual-psychic secrets" [69].

Like in all the other cases, born on July 28, 1929 with a challenging Sun-Moon aspect (90°), Jacqueline (known also as Jackie) was described as a person with extremely complex character, being the most attractive, exasperating, intelligent and frustrating historical icon.

Sadly, Jackie declared: "I want to live my life, not record it." It is a pity that she did not leave her memories written in her own words. It is especially frustrating that the earliest part of her life, as well as the last part of it, has generally been minimized by her biographers. Fortunately, some authors tried to reconstruct Jackie's life using her own words from letters and public interviews [70, 71]. Although such records are less informative than the recollections of Bely or Prokofiev, they at least give us a clue to her troubled childhood and youth and enable us to find out common lines with all the previous cases.

The sad fact was that Jackie's early life became shattered by her parents' acrimonious divorce. Her mother, Janet Norton Lee (1907-1989) was the daughter of a lawyer of Irish descent. In 1928 she married John Vernou Bouvier III (1891-1957). He was the eldest son of Major John Vernou Bouvier Jr. (1866-1948), a successful attorney whose family gathered from France, Scotland and England. Both families were Catholic, both were proud of achieving the immigrant's highest dreams and becoming wealthy, respectful and influential members of their communities.

Janet's marriage seemed to be a successful pairing and this merry event was attended by more than five hundred guests. The groom was a stockbroker, a young son of a millionaire, a handsome charmer whom young women found irresistible. The bride was an accomplished horsewoman.

The couple had two daughters, Jackie and Lee (1933-2019). Their father was not happy to have a second daughter. He wanted a son, and he had a clear preference for the elder daughter. Their close relationship often excluded Lee. Both daughters, in their turn, preferred their permissive father to their demanding mother.

The bright facts about Jackie's early years were that she grew up having a generally privileged lifestyle. The dark side of Jackie's childhood related to the family's dim secrets. Her father was nicknamed by friends and foes as "Black Jack," mainly because of his vice-filled lifestyle and gambling addiction. D. Porter writes in his biography that he was "a hedonist, a rogue, a gambler, a scoundrel, a rascal, a libertine, and a heartbreaker. He led a dissolute life which featured promiscuous sex and reckless spending" [72]. Right from Jackie's birth, the life in the house turned into continuous battles between the parents. They separated in 1936. Eventually John's gambling and philandering led to the couple's divorce in 1940, with the press publishing intimate details of the split [73]. The scandal was enormous. Jacqueline was deeply affected by the divorce and subsequently had a "tendency to withdraw frequently into a private world of her own." After the divorce, her mother, Janet, continued to treat her ex-husband as her enemy. "For years, Jackie and Lee would hear nothing but vitriolic diatribes against Jack by Janet (and, in turn, against Janet by Jack)" [73].

As a young, beautiful, well-educated woman with a razor-sharp sense of humor, Jacqueline was attracted to a brilliant and handsome John Kennedy, who by "coincidence" was also born with a challenging Sun-Moon aspect (90°). They married in 1954. Jacqueline 's mother was so vindictive that she forbade the bride's father to attend the wedding and threatened to cause a scene if he arrived at the church. Jackie loved her dad, and she never forgave her mother for what she did to him that day [73]. Sadly, the day of her wedding was marred by her parents' continuing resentment and battles. Nevertheless, Jacqueline's ability to hide her feelings was amazing. One of her closest friends remembered that her seemingly serene face in fact was "a look of absolute fury."

It is unnecessary to remind here that under the surface Jackie and John Kennedy had a tumultuous marriage, and that, like her father, her husband JFK had an array of mistresses. How did it affect their family life? Whatever the reasons might be, one tragedy followed the other. In the book *A Thousand Days* by the historian Arthur Schlesinger we read that Jacqueline Kennedy and JFK had five children in ten years, of whom only two survived the first year. In 1955 Jackie was pregnant and waiting for a girl, whom she wanted to name Arabella. Tragically, it was a stillborn child. A year later Jacqueline was pregnant again, yet the child was stillborn again. The great joy of birth of their daughter, Caroline (b.1957) and that of their son John F. Kennedy Jr (1960-1999), was followed by another tragedy. In 1963, their second son Patrick died just two days after his birth, and three months before his father's assassination. Sadly, John F. Kennedy Jr. was also born with his parents challenging aspect between the Sun and the Moon. His life was also full of losses and violence. His father was killed three days before John's third birthday. His mother was deeply depressed and lived in a perpetual fear for the lives of her children. His uncle Robert was killed when little John was eight years old. His mother died of cancer in 1994. At the age of 38 he fulfilled his mother's worst fears and died in a plane crash.

Back to Jacqueline's life. When JFK was killed in 1963, she was grief-stricken. It was claimed that her mother and younger sister, Lee Radziwill, feared she would harm herself. She could not sleep, she had nightmares and often threatened suicide. Taraborrelli wrote that Jackie was given a lot of medication and she spent quite "a few years really not in her mind" [74].

During the coming years Jacqueline relied heavily on her brother-in-law Robert F. Kennedy. When he decided to run for presidency, she worried about his safety. Despite her concerns, Jacqueline campaigned for Robert and supported him. The next tragedy came on June 5, 1968, when Robert was killed. No surprise that Jacqueline had a relapse of her depression she had suffered in the days following her husband's assassination. Barbara Leaming vividly described her pain which finally led her to seek professional help:

"The old invasive memories, nightmares, and 'difficult times' persisted, as did those strange moments when, exclusive of any act of will on her part, intimations of danger and doom became manifest in her body, which 'remembered' what had happened in 1963 and 1968, and therefore remained in a permanent state of alert for the next attack in whatever form it threatened to take. Jackie's decision to seek psychiatric treatment was a huge step, an important acknowledgement that she needed help" [75, p. 277].

Jacqueline came to fear for her life and those of her children and wanted to get out of the USA. It is interesting to remind here that while Schopenhauer felt himself homeless, Jackie's belief was: "The trouble with me is that I'm an outsider. And that's a very hard thing to be in American life."

On October 20, 1968, she married her Greek friend Aristotle Onassis (1906-1975). She hoped that he would be able to provide the privacy and security she sought. Yet the tragedies continued. In 1973 Onassis's son Alexander died in a plane crash. Afterwards Aristotle Onassis' health deteriorated rapidly, and he died at the age of 69.

After her second husband's death Jacqueline had a strength of will to develop her independent career. Her pathway to enlightenment included books. She began to reinvent and transform herself as a literary editor and writer. This was a huge step for her. Looking back, she reflected: "What is sad for women of my generation is that they weren't supposed to work if they had families."

The carrier brought a short relief. Yet like in Prokofiev's case it could not solve all the problems. As the life went on, the violent accidents continued to come back. In 1993 Jacqueline was thrown from her horse while participating in a fox hunt in Middleburg, Virginia. Following this accident her health began to deteriorate rapidly. She was diagnosed with cancer and in 1994 she began chemotherapy. She died the same year at the age of 64.

Her colleagues remembered that Jackie had her share of idiosyncrasies, foibles, and character flaws. Yet she touched many lives, her fate having led her onto the pages of history. As a woman of a new generation she spoke to her contemporaries, urging women to achieve something irreconcilable: to be first of all the mothers, but at the same time not to give up their professional aspirations. To people of both genders she reminded: "If you mess up your children, nothing else you do really matters."

As a mother, a wife and at the same time a much venerated celebrity, she left us one of the most universal messages: "Even though people may be well known, they hold in their hearts the emotions of a simple person for the moments that are the most important of those we know on earth: birth, marriage and death."

She could not say that her own life was an example to be followed. She did not see herself as a spiritual teacher. She saw herself neither as a fighter, nor as a philosopher, but rather as a survivor:

"I think my biggest achievement is that, after going through a rather difficult time, I consider myself comparatively sane" [71].

In the introduction to this chapter, I wrote that according to Lundsted, the people with the Sun-Moon challenging aspects should seek spiritual development. As if echoing this statement, Jacqueline in her legacy reveals the sources of her inner strength and the reasons for her weakness: "If you cut people off from what nourishes them spiritually, something in them dies" [71].

Jacqueline belonged to a generation of the first phase of the new Phoenix Year. Maybe she made many mistakes, but she gave all the women of the world a new hope for meaningful life. She also tried to encourage each person in his/her ability to make a difference:

"One [person] can make a difference and every[one] should try."

A concluding personal remark: I hesitated whether to include this case in this study, since it lacks Jacqueline's first-hand prenatal experiences and Jacqueline's personal feelings about her relationships with her brilliant but promiscuous husband, JFK. Yet we can feel the tensed atmosphere of the family. We can touch Jackie's frustrations and grief. And we can give Jacqueline's legacy a new chance by at least trying to make a difference. Her belief in the ability of a single person to make a difference was the most meaningful conclusion of her own spiritual work, and I hope that we can diminish the level of violence by encouraging conscious respect, kindness and love inside our own families.

Case 12. BD – The Intensity of Pain

This concluding case does not tell a story of a well-known person. On the contrary, I try to conceal the real name of BD, and for that I even must somewhat alter a few details. Nevertheless, this contemporary story brings us even closer to the roots of the self-destructiveness.

BD was born in Israel on one of the full moons of 1942. Her parents were refugees from Eastern Europe who succeeded in flight from the Holocaust. They came to Israel penniless. All their relatives died in the Holocaust. BD was born into the dark atmosphere of fears, instability, grief and poverty. After the birth, her mother was exhausted. She became gravely ill and died when BD was just one year old.

BD's father was devastated. He could not take care of his baby daughter. With all the sorrow he had to give her away to an orphanage. Unimaginable as it can be, she remembers her horror to stay in the orphanage. She hated every moment of being there. She cried, but nothing could help the poor baby.

After three long years as a widower, her father met a nice and kind woman. The second wife of BD's father was a survivor of Auschwitz concentration camp. She lost her family in the Holocaust and could not have any more children of her own. Her first wish was to bring BD home. That was one of the best periods in the girl's life. Of course, the atmosphere in her new-old home remained as gloomy as we can imagine in those days, yet it was HER home, and she sincerely loved her stepmother.

Days went on, and BD decided to become a medical doctor. She was a bright student who studied hard and worked to support her parents. Eventually the girl became a good doctor who tried to help other people to avoid the tragedy of early parental loss.

While BD's career was developing successfully, her personal life was not successful at all. She was married twice, both times for about half a year. She felt guilty for "killing" her biological mom. Thinking about her basic family triad father-mother-child, she decided that as a child she was a sole cause of her mom's death and her father's grief and misery. She did not want children and had two abortions. Her third pregnancy ended in miscarriage. Afterwards she had a hysterectomy and could not have any more children.

After the death of her parents she remained alone. In her forties she became interested in the spiritual development. She studied Jung's works and practiced meditations. Her work of self-growth widened dramatically her healing abilities. She began introducing alternative medicine into her common practice. The results were amazing, and people were thankful to their healer.

Today, in her late seventies, BD feels that she still can help many people. She told me that reading stories of other remarkable people with similar problems brings her a relief. And she added: such inner split as she had experienced is still too painful to be touched directly. Therefore, an opportunity to see it like in a film about other people is a blessing for her. The understanding that her spiritual work is her inborn necessity brought her to a conclusion that it is time to stop looking for whom to blame for her suffering. Like Bely, she recites an affirmation: "It is my responsibility and my lesson in life. The Creator and cosmos brought me in this special timing to reconcile different Elements and different people."

Is BD happy? I cannot know. But I do know that: she does not feel angry or miserable anymore. She reached that point of her life when she accepts that it is impossible to change the past, but it is worth changing our attitude towards it.

Case 13. The Mother-Father-Child Triad

Mother and Father are engaged in a perpetual dialogue about nurturing, teaching and learning. Our behavior may shape our children's identities within our own conscious or unconscious wishes, dreams and desires. Despite our best intentions, each of the parents may both contradict the other and interrupt or hinder the child's own dreams of his or her life-path, and vise-versa. Each child can change his or her parent's life in a profound way when his/her timing of birth may catch them at the most challenging moments of their lives.

The main difference is that the parents are already adult people who are responsible for their actions and words. The little children cannot yet either talk or act as responsible human beings. They are learning from adults to express themselves in the most appropriate way for them.

When the parental dialogue is conducted in a non-confrontational way, with the feelings of self-worth as well as with respect and kindness to the other human beings, the child may eagerly follow such a pattern. There is a good chance that as an adult such a child will respect versatility and become a tolerant and kind human being. On the contrary, when each parent is trying to alienate the child from their spouses or the outer world, the child feels torn apart and outraged. He might develop a violent and stern personality.

Is it possible to find a middle way and to reconcile all the contradictive needs and strivings of all the members of that triad? One of the suggestions for solving this problem is to gain an understanding that while our entire life is a process of learning and self-growth, the learning is done by collaboration and conversation with the others. The difference between the four Elements, which are the basic constituents of the creation, makes this world ever changing and ever living [4, 8, 76]. When there will be a struggle between them, there will be no versatility, the world would become dull and stagnation will overpower it. Our respect to the importance of all the Elements in us (namely to all the wishes, dreams, feelings and actions) may contribute to the more harmonious relationships in the triad.

Conclusions

Believing in the cosmic rhythms and cycles, Bely claimed that "It's not me who is to blame, but time." In my research I do confirm Bely's intuitive insights about cyclicity. He is right: each epoch has its specific limitations which can create the tensions between the generations. On the contrary, I cannot share his attitude of blaming either his parents or his times. Time should not be identified with immutable fate. What has been done wrong or spoiled by the generations of our parents can be improved through gaining new knowledge, awareness and kind understanding. Success depends, however, on both: proper deliberation and proper timing. It is our responsibility to find out and to name the causes of the past misunderstandings in order that the endings of past faults may be followed by new beginnings.

In those memoirs we saw how the children were influenced by the conflicts between their parents. There is no doubt that a strong authority is needed in the family; this is represented by the parents. When the parents respect each other's personalities and both respect their child's unique needs and temperament, then the family is in harmony, and the baby's inborn inclinations are properly taken care of and nourished.

The family is a tiniest cell or an embryo of the society. When harmonic family ties are created, they will be gradually widened to include all the human relationships. But when the parents do not respect each other and do not respect the child's own needs, such attitude can lead the offspring to resent their parents. As a result, frustration, hatred, and violence are created and propagated.

After many years of lecturing and educating I presume that our most important long-life lessons are the ones we learn at home from our families. Our parents may not be teaching us sciences, arts or poetry, but they can teach us the lessons of kindness, respect and gratitude. The challenge of improving relationships in the family cell might be not easy, but the efforts of setting human values for the future and stirring up current public opinion can become praiseworthy.

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