

Spin System of Physical Vacuum as a Source of Energy

Liudmila B. Boldyreva *

State University of Management, Moscow 109542, Russia

*Corresponding author: boldyrev-m@yandex.ru

Received May 08, 2018; Revised June 24, 2018; Accepted August 07, 2018

Abstract In experiments with rotating nonlinear magnetic fields, cavity structures, and in some molecular reactions, an abnormally high release of energy is observed. This phenomenon may be accompanied by emergence of optic radiation, a change in weight of experimental setup, its disappearance for a short time, emergence of energy “walls” around the setup, which cannot be shielded by screens of reinforced concrete. The aim of this work is to show that these phenomena may be explained by the properties of physical vacuum characterized by zero-point energy (in this article such a vacuum is called “the vortex-type physical vacuum”). The main properties of the vortex-type physical vacuum as a continuous medium are: positive density; negative pressure; intrinsic degrees of freedom – spin and electric dipole moment associated with spin; the possibility of emergence of wave-vortex-spin process, jumps of density, emergence of a force directed contrary to or along the direction of gravitation vector. The motion of the vortex-type physical vacuum causes magnetic phenomena. The equations describing the above-mentioned properties of vortex-type physical vacuum are derived.

Keywords: spin vortex, vortex-type physical vacuum, zero-point energy, magnetism, wave-vortex-spin process, source of energy, cavity structure, levitation, dark matter, spin supercurrent

Cite This Article: Liudmila B. Boldyreva, “Spin System of Physical Vacuum as a Source of Energy.” *International Journal of Physics*, vol. 6, no. 4 (2018): 128-138. doi: 10.12691/ijp-6-4-5.

1. Introduction

For the first time, the concept of physical vacuum, free from magnetic and electric fields (without regard to gravitational energy) but characterized by non-zero energy was developed in Germany by a group of physicists, including M. Planck, A. Einstein, and O. Stern. In 1913, using the formula derived by Planck [1] for energy ε of atomic oscillator vibrating with frequency ν : $\varepsilon = h\nu / 2 + h\nu / (\exp(h\nu / (kT)) - 1)$, A. Einstein and O. Stern published a paper [2] in which they classified the energy $h\nu / 2$ (h is the Planck constant) as “residual energy” that all atomic oscillators have at absolute zero. Later, “residual energy” was called zero-point energy. In subsequent years, some papers were published, in which there were the results of experiments testifying a possibility of emergence of energy in the physical vacuum, whose value exceeded that of zero-point energy and was not connected with an electric or magnetic interaction.

One of the most striking examples of such experiments is a series of experiments conducted by J. Searl in 1940-1950 [3,4]. In the experimental setup there was a magnetic ring (stator), along which cylindrical rollers could move, a pair of magnetic poles being attached to roller heads, that is a rotating nonlinear magnetic field could be created. The following phenomena are observed at the critical value of speed of rotation: emergence of abnormally high energy (enabling subsequent operation of the setup without external energy sources), a change in the

weight of setup, emergence of radiation of pink color, ionization of air, invisibility of the setup. Similar experiments with rotating magnets were conducted by S. Godin and V. Roshchin in 1990-1993 [5,6], and not only the phenomena analogous to those for Searl’s setup were observed but also there arose recurring zones of elevated magnetic field strength (so-called walls), which could not be shielded by screens of reinforced concrete. In 1977-1987, one of the pyramid researchers J. Parr experimented with the pyramids rotating in an alternating magnetic field, and he observed the following phenomena: increase in release of energy, weight loss, impact on gamma rays [7,8].

Though the above-mentioned phenomena take place in alternating magnetic field, the researchers of these phenomena concluded that they were of non-electric and non-magnetic nature. These conclusions are in accordance with that the analogous phenomena are observed in the physical vacuum near cavity structures (pyramids, rings, bee combs, etc.) in the absence of electric and magnetic fields. Let us consider these phenomena.

In 1891, German scientist O. Korschelt was granted a patent for the use of specially fabricated cavity structures for medical purposes without using a source of energy [9]. Therapeutic qualities of such structures depend on their orientation with respect to the Earth and Sun, and feeble glow of the structures in the dark was observed. In 1952, Czech researcher K. Drbal was granted a patent for maintaining razor blades and straight razors sharp without an auxiliary source of energy, the razors being placed in a pyramid [10]. In 1968-2000, Russian scientist V. Grebennikov studying bee combs discovered that empty

bee combs were embanked by a system of invisible “shells” detected by specially devised instruments. These “shells” could not be shielded by brick screens [11,12]. V. Grebennikov also was conducting experiments with cocoon of an ichneumon of the Ichneumonidae family, belonging to *Bathyplectes anurus* species (cocoon of parasitic fly or wasp), the cocoon being a cavity structure. It is known [13] that the cocoon could jump upon exposing it to sunlight. In experiments of Grebennikov the jumps were 30 mm long and 50 mm high, that is, exceeding the cocoon width by factor of 30; such jumps (which is levitation) were performed even when the cocoon had been placed on a “cloud” of loose cotton wool. During its jumps a short time invisibility of the *Bathyplectes anurus* cocoon took place [12].

At present, extensive studies of chemical reactions are carried out (for example, saturation of nickel by hydrogen [14], characterized by abnormally high heat release, emergence of optical radiation and a change in elemental and isotope composition of the complex of reacting molecules. These effects can be related to phenomena in which the physical vacuum proves itself as a source of energy. Besides, a great number of various nuclides produced as a result of cold nuclear transmutations [15] are indicative as well of energy processes taking place in the physical vacuum.

That in different research areas, such as magnetism, the effect of cavity structures, biology, chemistry, the same above-mentioned phenomena are observed may be interpreted as follows. In all the cases considered: in rotating nonlinear magnetic fields, in location of cavity structures and molecular complexes, identical objects are created in the physical vacuum. The interaction of those objects with each other and with the physical vacuum determines emergence of the above-mentioned phenomena. It is shown in this work that these identical objects are spin vortices (areas of physical vacuum with precessing spin).

In more detail, the quantum entity (the entity whose behavior is described by a wave function) which is a singularity in electric and/or magnetic fields (electric charge or/and magnetic dipole) produces in the physical vacuum a virtual particles pair (virtual photon) having spin [16,17].

Cherenkov’s effect (the radiation of light by a quantum entity moving at a speed exceeding that of light [18]) may be explained by that the properties of the virtual photon created by a quantum entity are analogous to some properties of the real photon (photon), and at the speed of quantum entity equal to the speed of light this analogy appears to be absolute, i.e. a virtual photon becomes a real photon. As photon’s spin performs precession, the kinetic mass connected with the photon is characterized by circulation and consequently the photon may be classified as a spin vortex. Due to similarity of the properties of virtual photon to the properties of photon, a virtual photon may be classified as a spin vortex in the physical vacuum as well. In this work, it will be shown that spin vortices may be created in rotating nonlinear magnetic fields. (Here the characteristics of spin of an elementary particle with non-zero rest mass (see, for example, [19]) are not considered). Spin supercurrents may arise between spin vortices, the properties of these currents are analogous to those of spin supercurrents in superfluid $^3\text{He-B}$ [20,21,22].

It is shown in this work that the physical vacuum in which quantum entities create spin vortices consists of oscillators characterized by zero-point energy that are at present referred to as “quantum harmonic oscillators” (in this paper the abbreviation QHOs is used).

The main properties of this vacuum as a continuous medium (in this work we shall call this vacuum “vortex-type physical vacuum”) are the following: positive density, negative pressure, intrinsic degrees of freedom – spin and electric dipole moment associated with spin, the possibility of emergence of wave-vortex-spin process, jumps of density, the possibility of emergence of a force directed contrary to or along the direction of gravitation vector. The motion of the vortex-type physical vacuum causes magnetic phenomena. The latter explains in particular why the rotating nonlinear magnetic field may create spin vortices in the vacuum.

It is shown in this work, that all above described physical phenomena testifying a possibility of emergence in the physical vacuum of energy, whose value exceeds that of zero-point energy and is not connected with an electric or magnetic interaction may be a result of action of processes taking place in the spin “system” of vortex-type physical vacuum. It should be mentioned that in 1967-1968 Russian scientist A. Sakharov advanced a hypothesis [23] about a possibility of emergence of a force acting in vacuum characterized by quantum fluctuations (which, according to principles of quantum mechanics, may be characterized by zero-point energy).

It should be noted that such properties of the vortex-type physical vacuum as positive density, negative pressure, the possibility of emergence of a force directed oppositely to the vector of gravitation are identical to those of dark energy [24,25]. The possibility of emergence in the vortex-type physical vacuum of an area of invisibility might explain the main property of dark matter: invisibility [24].

2. Spin Vortices in the Physical Vacuum

The spin vortex is an area of physical vacuum in which precession of spin takes place. Let us consider three types of spin vortices in the physical vacuum: (1) spin vortices that constitute photons (real photons); (2) spin vortices that constitute virtual photons (a pair of virtual particles created, according to postulates of quantum mechanics, by a quantum entity that is a singularity in electric or magnetic fields: electric charge or/and magnetic dipole) [16]; (3) spin vortices (QHOs) characterized by zero-point energy and constituting the physical vacuum called the vortex-type physical vacuum [2].

2.1. Properties of the Spin Vortex that Constitutes a Photon

2.1.1. Spin

The most well-known spin vortex is the photon in the pure state, that is photon not interacting with other objects. The data of the three photon annihilation of electron and positron with total spin equal to one (orthopositronium)

[26] suggest that spin \mathbf{S}_{ph} of any photon is directed transverse to light's velocity \mathbf{c} , that is:

$$\mathbf{S}_{ph} \perp \mathbf{c}. \quad (1)$$

If to take into account that photon's electric component \mathbf{E}_{ph} is directed as well transverse to the light velocity [27], then according to condition (1) and data of [28], the following may hold:

$$\mathbf{E}_{ph} \uparrow\uparrow \mathbf{S}_{ph}. \quad (2)$$

The photon in the pure state is a circular-polarized photon, that is its electric component \mathbf{E}_{ph} performs precession motion at photon's frequency ω_{ph} (photon's frequency is equal to frequency of photon's wave function [27,29], which may be interpreted as follows: the precession frequency of spin of spin vortex equals the wave function frequency of quantum entity that created this vortex). According to condition (2), not only electric component \mathbf{E}_{ph} but also spin \mathbf{S}_{ph} performs a precession motion in a circular-polarized photon. Depending on the type of photon's circular polarization we have: for the left-hand one $\omega_{ph} \uparrow\downarrow \mathbf{c}$, for the right-hand one $\omega_{ph} \uparrow\uparrow \mathbf{c}$ (\mathbf{c} is the velocity of light), that is in general:

$$\omega_{ph} \parallel \mathbf{c}. \quad (3)$$

2.1.2. Electric Component

The photon exhibits electric properties: first, the photon has an electric component, secondly, the photon may decay into a pair of oppositely charged particles in the electric field of heavy nuclei [27]. Consequently, the photon may be considered as a pair of unlike-charged particles, namely as an electric dipole, and the photon electric component \mathbf{E}_{ph} is an electric field inside the electric dipole, that is by definition [30]:

$$\mathbf{E}_{ph} \uparrow\downarrow \mathbf{d}_{ph}, \quad (4)$$

where \mathbf{d}_{ph} is the electric dipole moment of photon.

2.1.3. Mass

According to [30,31], photon has kinetic mass m_{ph} , and this mass is related to photon energy U_{ph} by equality:

$$m_{ph} = U_{ph} / c^2. \quad (5)$$

2.1.4. Angular Momentum

As the photon mass is determined by masses of a pair of unlike-charged particles, with the electric field between them being the electric component \mathbf{E}_{ph} of photon, the precession motion of \mathbf{E}_{ph} means a circular motion of the mass. Thus mass m_{ph} takes part in two types of motion: translational motion at group velocity \mathbf{c} and circular one at frequency ω_{ph} ; the latter may be characterized by angular momentum \mathbf{J}_{ph} .

2.1.5. Energy of Spin Vortex

The energy W_{ph} associated with mass m_{ph} contains two terms. The first term is the kinetic energy $m_{ph}c^2/2$ of translational motion of the center of mass, in which all the mass m_{ph} is assumed to be contained. The second term is energy of circular motion defined as $J_{ph}\omega_{ph}/2$ [33]. That is

$$W_{ph} = m_{ph}c^2/2 + J_{ph}\omega_{ph}/2. \quad (6)$$

The experimentally obtained energy U_{ph} of photon is determined as:

$$U_{ph} = \hbar\omega_{ph}. \quad (7)$$

Since experimentally obtained energy U_{ph} of photon must be equal to energy W_{ph} associated with photon mass m_{ph} , then from Eqs. (5)–(7) it follows:

$$J_{ph} = \hbar. \quad (8)$$

2.2. Properties of Spin Vortex that Constitutes Virtual Photon

The properties of the virtual photon (a pair of virtual particles with precessing spin) are analogous to some properties of the real photon (see section 2.1). This is supported by Cherenkov's effect: the radiation of light by a quantum entity moving at a speed exceeding that of light [18]. This effect may be explained by that at a speed equal to the speed of light the properties of virtual photon appear to be identical to the properties of real photon.

The characteristics of virtual photon are given in Figure 1: Γ_v is circulation of the velocity \mathbf{v}_v of the circular motion of m_v , \mathbf{J}_v is the angular momentum, \mathbf{d}_v is the electric dipole moment, α is the precession angle relative to the reference line (ref. line), θ is the deflection angle between the precession frequency ω_v and spin \mathbf{S}_v . According to [28], angle θ depends on speed u of quantum entity that created the virtual photon, i.e. on the speed of virtual photon:

$$\sin\theta = u/c. \quad (9)$$

(It should be noted that equation (9) is in accordance with conditions (1) and (3) for photon).

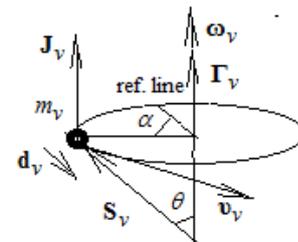


Figure 1. The characteristics of a virtual photon: \mathbf{S}_v is spin; m_v is the mass; \mathbf{d}_v is the electric dipole moment; ω_v is the precession frequency; \mathbf{J}_v is the angular momentum associated with m_v ; \mathbf{v}_v is the velocity of the circular motion of m_v ; θ is the deflection angle; α is the precession angle (phase); Γ_v is circulation of \mathbf{v}_v ; ref. line is the reference line

If a virtual photon is created by electrically charged quantum entity, then electric field \mathbf{E}_q of this entity acts on the virtual photon as on an electric dipole. The emerging moment \mathbf{M}_q is determined [30] as $\mathbf{M}_q = \mathbf{d}_v \times \mathbf{E}_q$. At the speed of motion of quantum entity $v < c$, because of the action of moment \mathbf{M}_q (with due account for conditions (2)-(4) and (9)) the orientation of $\boldsymbol{\omega}_v$ shall be determined by the sign of the quantum entity. Thus we may assume:

$$\boldsymbol{\omega}_v \uparrow \uparrow \eta \mathbf{u}, \quad (10)$$

where $\eta = 1$ for positively charged quantum entity and $\eta = -1$ for negatively charged quantum entity.

The circulation Γ_v of velocity \mathbf{v}_v of the mass m_v is related to its angular momentum \mathbf{J}_v as $\Gamma_v = \mathbf{J}_v \cdot 2\pi / m_v$. At $u=c$, that is for photon, \mathbf{J}_v is determined by equation (8), and consequently $J_v = \hbar$. At $u < c$ from equations (8)-(9) and Figure 1 it follows that $J_v = \hbar u / c$. Then taking into account condition (10), the expression for circulation Γ_v of velocity \mathbf{v}_v of mass m_v may be determined as follows: $\Gamma_v = \eta \mathbf{u} \cdot \mathbf{h} / (c m_v)$ [33]. Thus the electric current that consists of moving like-charged quantum entities is a vortex line in the vortex-type physical vacuum.

2.3. Properties of Spin Vortices Characterized by Zero-point Energy

According to the concept of zero-point energy, it is the energy of the vacuum which in quantum field theory is defined not as an empty space but as the ground state of the field whose features are as follows [34]:

1) It consists of oscillators with oscillation frequency Ω_{QHO} (the oscillator is called at present “quantum harmonic oscillator”; in this paper the abbreviation QHO is used). These oscillations are similar to precession motion of spin in spin vortices that constitute both real and virtual photons.

2) The energy of QHO is equal to $\hbar \Omega_{QHO} / 2$, the energy is referred to as zero-point energy. The expression for energy of QHO coincides with the expression for energy of immobile spin vortex (see equations (6) and (8)), that is, the vortex that does not have any translational motion of the center of mass.

3) The existence of electric polarization of physical vacuum suggests that QHO is an electric dipole. This is in accordance with the properties of spin vortices that constitute both real and virtual photons.

4) The fact that the quantum entity may create a virtual photon having spin, while preserving the value of its own spin, suggests that if the principle of conservation of angular momentum holds true in the vortex-type physical vacuum, then spin of virtual photon consists of spins of QHOs that constitute this vacuum.

5) The existence of electric dipole moment means that the QHO is a tangible carrier of charge, and therefore a mass of such carrier can be introduced. Note that the spin vortices that constitute both real and virtual photons have mass as well.

6) The neighboring oscillators interact with each other. As well as it takes place between spin vortices that constitute real and virtual photons, there exist the following interactions between QHOs: (1) the gravitational one (QHO has a mass); (2) the electric dipole-dipole one (QHO has an electric dipole moment); (3) as will be shown in section 2.4, an interaction by means of spin supercurrents may exist as well between spin vortices.

Thus the properties of QHO are analogous in many respects to the properties of spin vortices that constitute photon and virtual photon. Consequently, some relations between these spin vortices (equations (2), (4)-(5), (9)-(10)) hold true for QHO as well.

2.4. The Spin Supercurrent

Spin supercurrent was discovered in experiments with superfluid $^3\text{He-B}$. The spin supercurrent arises between regions with identically oriented and coherently precessing spins of ^3He atoms [20,21,22], with the spin supercurrent equalizing the respective characteristics of their spins. For example, the value of spin supercurrent j_z in the direction of orientation (axis z) of precession frequencies of spins of ^3He atoms is determined as follows:

$$j_z = -g_1 \partial \alpha / \partial z - g_2 \partial \theta / \partial z, \quad (11)$$

where α is the precession angle (phase), θ is the deflection angle (see Figure 1), g_1 and g_2 are coefficients depending on θ and the properties of the superfluid. One of the arguments in favor of possibility of the emergence of spin supercurrents not only between quantum entities but between photons as well (that is between spin vortices that constitute photons) is the existence of correlation of phases of spatially separated photons of the same frequency [35]. In the study by L. Boldyreva [36], it was shown that this correlation is accounted for by emergence of spin supercurrents between spin vortices that constitute interacting photons.

3. Properties of the Physical Vacuum Consisting of QHOs (the Vortex-type Physical Vacuum)

3.1. The Equation Describing the Vortex-type Physical Vacuum in a Stationary State

The vortex-type physical vacuum consists of QHOs. The existence of electric dipole moment of QHO means the existence of two electrically unlike-charged parts inside the QHO that in turn suggests the existence of a repulsive force between unlike-charged parts inside the QHO, which force balances the attractive Coulomb force between unlike charges. The existence of such repulsive force may be treated as the existence of omniradial tensions inside the QHO. In terms of hydrodynamics it means that the vortex-type vacuum as a continuous medium may be regarded as a medium with negative pressure [33]. This medium has a positive density due to the mass of QHO. The dissipation-free motion of celestial bodies, such as the planets of the solar system, allows one

to look upon the vortex-type physical vacuum as a medium without shear viscosity (without regard to gravitational interaction). If to accept that such a medium in a stationary state is an ideal incompressible liquid, then it can be described by the following equation [33]:

$$\rho u^2 / 2 - p = \text{const}, \quad (12)$$

where u , ρ and p are respectively the speed, density and pressure of the liquid.

Note. The spin vortices in the vortex-type physical vacuum may terminate in the bulk of the vortex-type vacuum due to complete transfer of the angular momentum of spin vortex to intrinsic motions (to intrinsic degrees of freedom) of vortex-type physical vacuum.

3.2. The Jumps of Density in Vortex-type Physical Vacuum

Based on equations (9) and (10) (see also Figure 1) one may suppose that projection $(S_{QHO})_u$ of spin of QHO, S_{QHO} , on the direction of QHO's velocity \mathbf{u} depends on the deflection angle θ_{QHO} of this spin as:

$$(S_{QHO})_u = S_{QHO} \sqrt{1 - \sin^2 \theta}. \quad (13)$$

Thus at a change in θ_{QHO} , a change in the size of QHO in the direction of its motion takes place and it may result in a change of density ρ . According to equations (9) and (11), there are two factors that can change the deflection angle θ : first, the change in speed of QHO and secondly, spin supercurrent. Thus in general the density of vortex-type physical vacuum may not be constant and may be a function, φ , of speed u and spin supercurrent j :

$$\rho = \varphi(u, j). \quad (14)$$

If the speed of spin supercurrent is greater than the speed of propagation of contraction in the vortex-type physical vacuum (similar to speed of sound in a molecular medium), the zones of jumps of density appear in this vacuum [33]. An analogous phenomenon is observed near output of the nozzle of a jet engine (for example, de Laval nozzle) [37].

3.3. Wave-vortex-spin Process

Due to the existence of interaction of QHOs (the electric dipole-dipole interaction and spin supercurrents), the vortex-type physical vacuum should feature the rotational viscosity being apparent in a nonstationary case. The wave-vortex-spin process may arise in the vortex-type physical vacuum (see also [38]).

3.3.1. The First Equation Describing the Wave-vortex-spin Process

The photon may decay into a pair of oppositely charged particles in the electric field of heavy nuclei [27]. In this case, the total spin of emerging particles equals the photon spin, which suggests that the principle of conservation of angular momentum holds true in the vortex-type physical vacuum.

Due to conservation of angular momentum, the Einstein-de Haas effect takes place in this vacuum [39]: a change of spin \mathbf{S} of a unit volume of vortex-type physical vacuum ($\partial \mathbf{S} / \partial t \neq 0$) results in the rotation of the vacuum ($\text{curl} \mathbf{u} \neq 0$). That is the following holds true:

$$\partial \mathbf{S} / \partial t = -(1/k_1) \cdot \text{curl} \mathbf{u}, \quad (15)$$

where t is time, $k_1 > 0$ is a proportionality factor.

3.3.2. The Second Equation Describing the Wave-vortex-spin Process

According to equations (9) and (10), at the emergence of $\partial \mathbf{u} / \partial t$ in the vortex-type physical vacuum the following cases may take place:

1) at a change in the direction of velocity \mathbf{u} the precession motion of \mathbf{S} relative to a new direction of \mathbf{u} arises;

2) at a change of only the value of u , the angle θ changes and consequently a precession motion of \mathbf{S} emerges in a new area of vortex-type physical vacuum.

As a result, the following equation must be taken to be true:

$$\partial \mathbf{u} / \partial t = k_2 \text{curl}(k_3 \mathbf{S}), \quad (16)$$

where $k_2 > 0$ and k_3 are proportionality factors.

If to introduce the factor $y = \sqrt{k_2 k_3 / k_1}$, then equations (15) and (16) may be rewritten as:

$$\frac{\partial (k_1 y \mathbf{S})}{\partial t} = -y \text{curl} \mathbf{u} \quad (17)$$

$$\frac{\partial \mathbf{u}}{\partial t} = y \text{curl}(k_1 y \mathbf{S}). \quad (18)$$

The dimension of factor y is the same as that of speed. If in the vortex-type physical vacuum there is a mechanism that suppresses the vortex at a point of space and simultaneously transports the vortex energy to adjacent areas, then a wave-vortex-spin process (described by equations (17) and (18)) will propagate at speed y in the vortex-type physical vacuum. It should be noted that the speed of wave-vortex-spin process may be constant relative to any inertial system independent of its motion relative to vortex-type physical vacuum. This is due to interaction between the spin vortices that arise in this process and the virtual photons (as with spin vortices) created by quantum entities that constitute the inertial system.

3.3.3. The Third Equation Describing the Vortices that Accompany the Wave-vortex-spin Process

According to equations (13) and (9), projection S_ω of spin \mathbf{S} on the direction of spin precession frequency ω is determined by the following expression: $S_\omega = S \sqrt{1 - u_\omega^2 / c^2}$, where u_ω is the value of projection of velocity \mathbf{u} on ω (in the stationary case $\mathbf{u} \parallel \omega$). Let us consider the case where a change in u_ω takes place. From expression for S_ω it follows: $\partial S_\omega / \partial t = - \left(S u_\omega / \left(c^2 \sqrt{1 - u_\omega^2 / c^2} \right) \right) \partial u_\omega / \partial t$.

Using equation (15), we have:

$$\frac{\partial u_{\omega}}{\partial t} = \frac{c^2 \sqrt{1 - u_{\omega}^2 / c^2}}{k_1 u_{\omega} S} (\text{curl} \mathbf{u})_{\omega}. \quad (19)$$

The above equation means that a change in the velocity of vortex-type physical vacuum results in emergence in this vacuum of a vortex accompanying the wave-vortex-spin process described by equations (17) and (18).

3.3.4. The Condition of Disappearance of Wave-vortex-spin Process

Equation (17) describing the wave-vortex-spin process contains $\partial \mathbf{S} / \partial t$. Consequently, this process could not spread in the area where the orientation of spins of QHOs that constitute the vortex type physical vacuum cannot change, i.e. spins can be considered to be “frozen”:

$$\partial \mathbf{S} / \partial t = 0. \quad (20)$$

This may take place for example, in rotation of vortex-type physical vacuum and/or at emergence of spin supercurrents causing a definite orientation of spins, which suppresses any disturbances causing a change in the orientation.

3.4. The Force Arising in the Vortex-type Physical Vacuum with Oriented Spins in Nonhomogeneous Electric Field

According to conditions (2) and (4), in the area of vortex-type physical vacuum with oriented spins of QHOs the orientation of total electric dipole moment \mathbf{d}_t of QHOs that constitute this area takes place:

$$\mathbf{d}_t \uparrow \downarrow \mathbf{S}_t, \quad (21)$$

where \mathbf{S}_t is the total spin in the area of vortex-type physical vacuum with oriented spins of QHOs. In nonhomogeneous electric field \mathbf{E} , the force \mathbf{F}_d will act on these QHOs. This force is determined [33] as:

$$\mathbf{F}_d = (\mathbf{d}_t \nabla) \mathbf{E}, \quad (22)$$

where ∇ is the nabla operator.

As an example of action of force \mathbf{F}_d let us consider the results of experiments on gyroscope's rotations around the vertical axis relative to the Earth [40]. At right-hand rotation, the decrease in weight of gyroscope took place. The magnitude of decrease in weight did not depend on shielding the gyroscope from external magnetic field (0.35 G). That is, the change in weight was not of magnetic nature. This phenomenon can be accounted for by the emergence of force \mathbf{F}_d in the vortex-type physical vacuum under action of the electric field of the Earth. Due to the Barnett effect [41], at rotation of gyroscope the orientation of spins of the vortex-type physical vacuum at the location of gyroscope takes place. At the right-hand rotation these spins are pointed downwards, that is towards the Earth. If to take into account that the surface of Earth has a negative charge, then, according to equations (21-22), force \mathbf{F}_d acting on QHOs that constitute this vacuum is directed from the Earth, that is opposite to the vector of gravitation. In the experiments, it

may look as decreasing of weight of the objects in this region of vacuum.

4. Magnetism

It is shown in [33] that there is a complete analogy between the structures of formulas describing the magnetic interactions of current-carrying wires and the structures of formulas describing the interactions of vortices in an ideal incompressible liquid with positive density and negative pressure. Consequently, one may suppose that equation (12) that holds for the vortex-type physical vacuum describes as well the medium whose motion determines magnetic phenomena.

Let us derive equations that establish relationships between the characteristics of magnetic field and both kinematic and dynamic characteristics of the vortex-type physical vacuum whose stationary motion is described by equation (12). We assume that the density ρ in this equation has a constant value (see also [38]). These equations are written, first, for the vacuum whose permeability $\mu = 1$, and, secondly, they are written in the CGSE system of units, so that the equations include constant c , that is the characteristic of the medium whose motion results in magnetic phenomena.

4.1. Relationships between the Characteristics of Magnetic Field and both Kinematic and Dynamic Characteristics of the Vortex-type Physical Vacuum

4.1.1. Interaction of Infinite Vortex Lines and Interaction of Infinite Current-carrying Wires

If (as it is conceived in hydrodynamics) to consider the force \mathbf{F} as the integral $\mathbf{F} = - \int_s p \mathbf{n} ds$, where \mathbf{n} is an external normal to the impermeable surface s , then, taking into account equation (12), we have $\mathbf{F} = -(1/2) \int_s \rho u^2 \mathbf{n} ds$.

(That is, all dynamic characteristics will have the sign opposite to what they would have for the conventional ideal incompressible liquid with the same kinematic properties.) The force acting on a unit length of either of the two infinite mutually parallel vortex lines having the same values of circulation Γ is $F = \rho \Gamma^2 / (2\pi r_w)$, where r_w is the distance between the vortex lines with circulation Γ [33]. The force acting on a unit length of either of the two infinite mutually parallel current-carrying wires having the same values of current \mathbf{I} (in the CGSE system of units) is $F = 2I^2 / (r_w c^2)$, where r_w is here the distance between the current-carrying wires [30]. By equating the above expressions for the forces and taking into account that the forces are attractive if the currents as well as velocity circulations around the vortex lines have the same direction, we obtain:

$$\Gamma = \mathbf{I} \sqrt{4\pi} / (c \sqrt{\rho}). \quad (23)$$

In section 2.2, it is shown that the electric current that consists of moving like-charged quantum entities is a vortex line in the vortex-type physical vacuum.

4.1.2. The Field of Velocities Generated by a Closed Vortex Line and the Magnetic Induction around a Current Loop

The field of velocities \mathbf{u} generated by a closed vortex line having circulation Γ along an arbitrary loop enclosing the vortex line is defined [33] as

$$\mathbf{u} = \frac{\Gamma}{4\pi} \int_L \frac{d\mathbf{l} \times \mathbf{r}}{r^3}, \text{ where } d\mathbf{l} \text{ is an infinitesimal vector}$$

element of the vortex line, L is the length of the line, \mathbf{r} is a radius vector from $d\mathbf{l}$ to the point of observation. Outside the vortex line, $\text{curl} \mathbf{u} = 0$. The structure of equation for \mathbf{u} is the same as the structure of equation for the Biot-Savart law in the CGSE system of units, defining the magnetic induction \mathbf{B} generated by a loop with current

$$I: \mathbf{B} = \frac{I}{c} \int_L \frac{d\mathbf{l} \times \mathbf{r}}{r^3} \quad (L \text{ is the length of the loop, } d\mathbf{l} \text{ is the}$$

wire element) [30]. Having solved simultaneous equations for \mathbf{u} , \mathbf{B} and equation (23), we obtain an equation relating the magnetic induction \mathbf{B} to the velocity \mathbf{u} of the medium:

$$\mathbf{B} = \mathbf{u} \sqrt{4\pi\rho}. \quad (24)$$

Notes.

1. The velocity \mathbf{u} in equation (24) and electric current I in equation (23) are determined relative to the same reference frame.

2. Using expression (24), equations (17) and (18) describing the wave-vortex-spin process may be written in the form:

$$\frac{\partial(k_1 y \mathbf{S})}{\partial t} = -y \text{curl}(\mathbf{B} / \sqrt{4\pi\rho}), \quad (25)$$

$$\frac{\partial(\mathbf{B} / \sqrt{4\pi\rho})}{\partial t} = y \text{curl}(k_1 y \mathbf{S}). \quad (26)$$

If to take into account as well condition (2) between spin and electric field, the following conclusion can be drawn: the wave-vortex-spin process in the vortex-type physical vacuum is also an electro-magnetic process. This process is accompanied by emergence of additional vortices in the vortex-type physical vacuum; while using equations (19) and (24) these vortices can be described by the following equation.

$$\frac{\partial B_\omega}{\partial t} = \frac{c^2 \sqrt{4\pi\rho - B_\omega^2 / c^2}}{k_1 B_\omega S} (\text{curl} \mathbf{B})_\omega. \quad (27)$$

At present, there are proofs of existence of additional components of electro-magnetic radiation in addition to those described by Maxwell's equations [42].

4.2. Corollaries

There are two corollaries following from equations (12) and (24).

- Equation (12) describes the medium with negative pressure, that is the medium consisting of spin vortices

inside of which omniradial tensions are created. Consequently, in a vortex-free area this equation must not hold and therefore magnetic interaction will be impossible in this area.

- From equation (24) it follows that the motion in the vortex-type physical vacuum of any body is equivalent to exposing it to a magnetic field.

Let us consider examples confirming the validity of these corollaries and consequently the validity of equations (12) and (24).

4.2.1. The Expulsion of Magnetic Field from a Superconductor

Let us consider expulsion of magnetic field from a superconductor [43]. The effect takes place both in the case where the superconductor is exposed to an external magnetic field $B < B_c$, at $T < T_c$ (B_c is the critical value of magnetic induction at arbitrary T , T_c is the critical temperature) and in the case where the superconductor is exposed to magnetic field B at $T > T_c$, the superconductor being cooled down to the temperature of $T < T_c$ after that (the so-called Meissner–Ochsenfeld effect). This effect cannot be explained in classical mechanics, since if a regular conductor exposed to field B became superconducting at $T < T_c$, the magnetic field that was present in the conductor at the time of transition into the state of superconductivity would persist in the conductor.

Superconductivity is caused by formation of pairs of electrons (Cooper pairs) [44]. Electrons as quantum entities create virtual photons, that is spin vortices, in the vortex-type physical vacuum. The electrons in Cooper pairs have equal energies and equal but oppositely directed velocities. The equality of energies, according to equation (7), means the equality of precession frequencies. The equality and mutually opposite directions of velocities of electrons in Cooper pairs, according to equations (9)-(10), means that the total spin of spin vortices created by electrons of Cooper pairs in the vortex-type physical vacuum may be equal to zero. From this follows that in the area of location of Cooper pairs the vorticity of physical vacuum may disappear, and equation (12) will not be valid. Consequently, magnetic field will not be formed in the area of location of Cooper pairs.

It should be noted that if the size of area where equation (12) does not hold is smaller than the entire volume of superconducting medium, the magnetic field may penetrate in this medium in part. It may be an explanation of the existence of so-called Abrikosov's vortices: penetration of magnetic field into superconducting medium in the form of discrete lines [45].

4.2.2. The Magnetic Field in the Reference Frame of a Moving Body

There is indirect experimental evidence that in the absence of magnetic field in the frame of physical vacuum there is a magnetic field in the frame of a moving object. The term "indirect" is used because in the experiments in question the evidence refers to the neutrino whose properties are mysterious in some respects. At present, the concept of massive neutrino with its magnetic moment aligned with its spin is considered to be most acceptable to

physicists. From observations it follows that the spin of a left-handed neutrino moving relative to the “cosmic” vacuum is oriented opposite to its velocity \mathbf{v} ; according to equation (24), this motion is equivalent to placing the neutrino in the magnetic field with magnetic induction $\mathbf{B} = -\mathbf{v}\sqrt{4\pi\rho}$. At the same time, in an external magnetic field (whose magnetic induction in the experiments was much greater than that of the Earth) the neutrino spin got oriented with the magnetic induction direction [46,47].

5. The Vortex-type Physical Vacuum as a Source of Energy

Production of energy in the vortex-type physical vacuum, with due account for the properties of this vacuum, may be carried out by the following methods:

1st method. Creation of translational motion of the vortex-type physical vacuum. The specific kinetic energy W of this motion at speed u , according to equation (12), is determined as $W = \rho u^2 / 2$. According to equation (24), W may be expressed in terms of magnetic induction B created by this motion: $W = B^2 / (8\pi)$.

2nd method. Creation of wave-vortex-spin process in the vortex-type physical vacuum (see equations (17)-(18)). The energy density flux \mathbf{N} of this process is determined by Umov's vector [48]: $\mathbf{N} = \mathbf{w}\mathbf{y}$ (w is the density of energy, \mathbf{y} is the velocity of the process). According to equations (2) and (24), this wave-vortex-spin process is an electromagnetic process as well.

3d method. Creation in the vortex-type physical vacuum of spin vortices having respectively different precession angles α or/and deflection angles θ . In this case, according to equation (11), spin supercurrent arises between these spin vortices. As a result of action of spin supercurrent the jumps of density may emerge in the vortex-type physical vacuum (see equation (14)).

4d method. Creation in the vortex-type physical vacuum of an area with definite orientation of spins of QHOs constituting the area (the orientation may be produced at rotation of the medium or by spin supercurrents). In this case, an electric dipole moment arises in this area (see condition (21)). In a nonhomogeneous electric field there would be the force determined by equation (22).

Let us explain the results of experiments with the generator of rotating nonlinear magnetic field, cavity structures, and complexes of molecules, taking into account the above mentioned methods of production of energy in the vortex-type physical vacuum.

5.1. Rotating Generator of Nonlinear Magnetic Field

The following phenomena are observed in experiments with rotating nonlinear magnetic field [3-8].

1. Abnormally high release of energy. According to equation (24), all above considered types of motion may emerge in the vortex-type physical vacuum exposed to rotating nonlinear magnetic field and consequently all

above considered types of energy may emerge in these experiments.

2. Emergence of bluish-pink radiation. This is in accordance with the possibility of emergence of electromagnetic process in the vortex-type physical vacuum.

3. The short-time disappearance of experimental setup. Due to equation (24) the rotation of magnetic field means the rotation of vortex-type physical vacuum, which, according to the Barnett effect, may result in the orientation of spins of QHOs constituting this vacuum in the same direction (this can be termed as “freezing” of spins). Then, according to equation (20), the electromagnetic process described by equations (25)-(26) with taking into account condition (2) cannot spread in the vortex-type physical vacuum and the bodies placed in it become invisible.

4. The change in weight of experimental setup. Due to equation (24) the rotation of magnetic field means the rotation of vortex-type physical vacuum, which, according to the Barnett effect, may result in the orientation of spins of QHOs constituting this vacuum in the same direction that in turn means emergence in this vacuum of electric dipole moment (see equation (21)). Consequently, in electric field of the Earth (the surface of the Earth has a negative charge), according to equation (22), a force acting on QHOs arises. The direction of the force depends on the orientation of spins: if the spins are oriented towards the Earth (the right-hand rotation of the vortex-type physical vacuum), the force is directed oppositely to the gravitation vector; if the spins are oriented from the Earth (the left-hand rotation of the vacuum), the force is aligned with the gravitation vector. Thus in experiments this force manifests itself as decreasing or increasing of weight of experimental setup, respectively.

5. The emergence of recurring zones of elevated magnetic field strength (so-called walls), which could not be shielded by screens of reinforced concrete. According to equation (24), the strength of magnetic field is determined by two characteristics of vortex-type physical vacuum: by speed u and density ρ . According to equation (14), spin supercurrents affect the value of ρ . If the speed of spin supercurrent is greater than the speed of propagation of contraction in the vortex-type physical vacuum, the so-called jumps of density emerge [33]. According to equation (24), an increase in density in any area of vortex-type physical vacuum means an increase in magnetic field strength in this area.

Spin supercurrent takes place between spins of QHOs that constitute the vortex-type physical vacuum, that is they arise in the medium which is “finer” than the vortex-type physical vacuum and consequently may not be shielded by molecular substances. Consequently, zones of elevated magnetic field strength will not be shielded by molecular substances as well.

5.2. Cavity Structures

The processes that take place in the physical vacuum in the area of location of cavity structures were considered by L. Boldyreva in [49]. Like all quantum entities that are singularities in electric and/or magnetic fields, the quantum entities that constitute the substance of cavity structure create virtual photons, i.e. spin vortices in the

vortex-type physical vacuum. According to equation (10), the orientations of precession frequencies of spin vortices created by the quantum entities are determined by the directions of their orbital velocities. As the mutual space arrangement of orbits of quantum entities that constitute the substance of the cavity structure depends on the form of the latter, the mutual orientation of precession frequencies of spin vortices created by these quantum entities cannot be arbitrary. In particular, precession frequencies of spins of spin vortices created by quantum entities of cavity structures may not be aligned with the same straight line. An example of possible configuration of r spin vortices created by quantum entities that constitute the substance of a cavity structure is shown in Fig. 2: the directions of precession frequencies ($\omega_1, \dots, \omega_p, \dots, \omega_q, \dots, \omega_r$) of spins of these spin vortices are tangential to a ring. In this configuration, according to definition of spin supercurrent (see equation (11)), spin supercurrent \mathbf{J}_{pq} between arbitrary p and q spin vortices will never be zero, that is: $\mathbf{J}_{pq} \neq 0$.

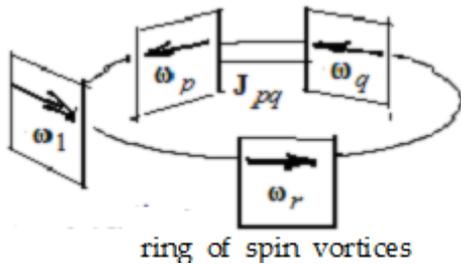


Figure 2. A ring of spin vortices with respective precession frequencies $\omega_1, \dots, \omega_p, \dots, \omega_q, \dots, \omega_r$; \mathbf{J}_{pq} is spin supercurrent

Thus the space inside the ring will be constantly “filled” with spin supercurrents. The action of spin supercurrents results in emergence of jumps of density of vortex-type physical vacuum and in changes in the characteristics of its spins, which in turn (according to equations (17)-(19)) results in emergence of wave-vortex-spin process in this vacuum. Thus the processes arising in the vortex-type physical vacuum at the location of cavity structure are analogous to the processes that take place in the vacuum in rotating nonlinear magnetic fields. Consequently, the phenomena that are observed in the experiments with these fields must be observed in cavity structures as well. This is exactly what takes place in experiments with cavity structures, that is the following phenomena are observed [9-13]: an abnormally high release of energy; the emergence of optical radiation; a short-time disappearance of cavity structure; a change in the weight of cavity structure, the nature of the change in weight depending on the structure’s orientation to the Earth; the existence of invisible “shells” with changed energy properties around the cavity structure. The “shells” were not screened by brick walls.

5.3. Complex of Molecules

The complex of molecules contains quantum entities: protons, neutrons, electrons. According to postulates of quantum mechanics, these quantum entities produce in the physical vacuum virtual photons having precessing spin,

that is, spin vortices. Spin supercurrents may arise between these vortices. As a result of action of spin supercurrents, processes may emerge in the vortex-type physical vacuum that are similar to the processes that take place in experiments with rotating nonlinear magnetic field. This is exactly what takes place in this case. For example, in experiments with nickel–hydrogen reactions abnormally high release of heat and emergence of optical radiation are observed [14].

In a chemical reaction, the following may take place: due to interactions of spin vortices created by quantum entities that take part in the reaction, the properties of some vortices may become identical to the properties of vortices created by a chemical element which was not present in this reaction before its beginning. It is possible that cold transmutations that result in emergence of a great number of various nuclides take place as a result of such interactions [15].

6. Discussion

6.1. Dark Energy

According to cosmological models, about 70 percent of all energy of the Universe is in the form of so-called dark energy, which is characterized by the homogeneous distribution of positive density, negative pressure, the possibility of anti-gravitation [24,25]. The properties of the dark energy are identical to the properties of vortex-type physical vacuum: positive density, negative pressure, the possibility of emergence of the force directed oppositely to the vector of gravitation.

6.2. Dark Matter

According to cosmological models, about 22 percent of all mass-energy of the Universe is in the form of so-called dark matter, which is invisible but takes part in gravitation interactions. The invisibility is explained in particular by that the strong gravitation field of the matter does not allow photons to leave the location of the matter [24]. The model of vortex type physical vacuum considered in this work accounts for the invisibility by emergence of “freezing” of spins of the vortex-type physical vacuum at the location of this matter. The “freezing” might take place for example at large angular speed of rotation of this dark matter.

7. Conclusion

I. The experimentally observed physical phenomena characterizing the physical vacuum as a source of energy may be explained on the basis of the properties of the physical vacuum consisting of quantum harmonic oscillators (QHOs) possessing zero point energy. In this work, the physical vacuum is called “vortex-type physical vacuum”. The main properties of the vortex-type physical vacuum as a continuous medium are as follows.

1. The existence of intrinsic degrees of freedom: precessing spin and electric dipole moment associated with the spin.

2. The motion of the vortex-type physical vacuum causes magnetic phenomena.

3. The possibility of emergence of wave-vortex-spin process (with electric and magnetic components).

4. The possibility of emergence of spin supercurrent between spin vortices (the areas of vortex-type physical vacuum with precessing spins), the value of which is determined by mutual orientation of spins of interacting spin vortices.

5. The possibility of emergence of jumps of density. They may take place as a result of influence of spin supercurrent on density of the vortex-type physical vacuum if the speed of spin supercurrent is greater than the speed of propagation of contraction in the vacuum.

6. At creation in the vortex-type physical vacuum of an area with definite orientation of spins of QHOs a non-zero electric dipole moment arises in this area. The force will act in a nonhomogeneous electric field on QHOs that constitute the area as on electric dipoles.

II. The experimentally observed physical phenomena characterizing the spin system of physical vacuum as a source of energy are explained in the following way.

1. The possibility of operation of experimental setup without supply of external energy may be explained by emergence in the vortex-type physical vacuum of the following types of processes: the translational motion, the wave-vortex-spin process, spin supercurrents.

2. Optical effects at the location of experimental setup take place because in the vortex-type physical vacuum the arising wave-vortex-spin process is an electromagnetic process as well.

3. The short-time disappearance of experimental setup may be explained by impossibility of spreading of wave-vortex-spin process (with electric and magnetic components) in the area of location of experimental setup due to impossibility of changing the orientation ("freezing") of spins of the vortex-type physical vacuum in this area.

4. The changes in weight of experimental setup is a consequence of emergence in the electric field of the Earth of the force that acts on spin-oriented QHOs that constitute the vortex-type physical vacuum, as on electric dipoles. The direction of the force depends on the orientation of spins: if the spins are oriented towards the Earth the force is directed oppositely to the gravitation vector; if the spins are oriented from the Earth the force is aligned with the gravitation vector.

5. Emergence of recurring zones of elevated magnetic field strength (so-called walls) around a generator of rotating nonlinear magnetic field or emergence of recurring zones with changed energy properties (so-called shells) around cavity structures is a result of emergence of jumps of density in the vortex-type physical vacuum. Such jumps may arise at presence of spin supercurrent in the vortex-type physical vacuum due to influence of these currents on the density of the vacuum, provided the speed of spin supercurrent is greater than the speed of propagation of contraction in the vortex-type physical vacuum. (An analogous phenomenon is observed near the output of nozzle of a jet engine, for example, de Laval nozzle.)

III. The main properties of the vortex-type physical vacuum: positive density, negative pressure, the possibility of emergence of force contrary to the direction

of gravitation vector, are identical to those of dark energy. The possibility of emergence in the vortex-type physical vacuum of an area of invisibility might explain the main property of dark matter: invisibility.

References

- [1] Planck, M., "Über die Begründung des Gesetzes der schwarzen Strahlung", *Annalen der Physik*, 342 (issue 4), 642-656, 1912.
- [2] Einstein, A.; Stern, O., "Einige Argumente für die Annahme einer molekularen Agitation beim absoluten Nullpunkt", *Annalen der Physik*, 345 (3), 551-560, 1913.
- [3] Sandberg, S.G., *Searl-Effect Generator: Design & Manufacturing Procedure*, School of Engineering & Applied Sciences, University of Sussex, June 1985. <http://www.research.com/searl/htm>
- [4] Thomas, J.A. Jr., "ANTI-GRAVITY: The Dream Made Reality", *Extraordinary Science*, VI (issue 2), 1994.
- [5] Roshchin, V.V.; Godin, S.M., *A device for generation of mechanical energy and a process of generation of mechanical energy*. Russian Federation patent, Application 99122275/09, 27.10.1999.
- [6] Roshchin, V.V.; Godin, S.M., "An Experimental Investigation of the Physical Effects in a Dynamic Magnetic System", *Tech Phys Lett*, 26 (12), 1105-1107, 2000.
- [7] Parr, J., "Tests Prove Pyramid Affects Gamma Rays", *Pyramid Guide Journal*, issues 47-53, 1980-81.
- [8] Parr, J., "Pyramid Research", *Advance Sciences Advisory*, Mar-April 1985, Nov-Dec 1985, July-Aug 1987, March-April 1988.
- [9] Kaiserliches Patentamt, Patentschrift Nr. 69340, ausgegeben am 22.6.1893 Klasse 30: Gesundheitspflege. Oskar Korschelt in Leipzig. *Ein Apparat für therapeutische Zwecke ohne bestimmte oder bewußte Suggestion*. Patentiert im Deutschen Reich vom 14. Juni 1891.
- [10] Drbal, K., *Method of Maintaining Razor Blades and the Shape of Straight Razors*. Republic of Czechoslovakia, Office For Patents And Inventions, Patent File Number 91304, Patent valid from 1 April, 1952, Published 15 August, 1959.
- [11] Grebennikov, V.S., "The secret of breeding sites of solitary bees", *Beekeeping* No.2, 28-29, 1984 [In Russian].
- [12] Grebennikov, V.S., Flight - Chapter V. (from Grebennikov's book: "My World" 2006). Novosibirsk. Soviet Siberia, Translated into English from Russian by Dr Cherednichenko. Accessed on March 20, 2012. www.keelynet.com/greb/greb.htm.
- [13] *The ranger of insects in the European part of the USSR*, v. III (part 3), 26, 1981 (in Russian).
- [14] Focardi, S.; Habel, R.; Piantelli, F., "Anomalous Heat Production in Ni-H Systems", *Nuovo Cimento*, 107 A, (N.1), 163-167, 1994.
- [15] Fukuhara, M., "New Approach to Cold Nuclear Transmutation Theory", *Japanese Journal of Applied Physics*, 46 (5A), 3035, 2007.
- [16] Milonni, P.W., *The quantum vacuum*. Academic Press, Inc. Harcourt Brace & Company, Publishers, 1994.
- [17] Myakishev, G.Ya., "Virtual Particles". In book *Physics of Microworld. Little encyclopedia*. 132-133, Soviet Encyclopedia Publishing House, Moscow, 1988 (In Russian).
- [18] Čerenkov, P.A., "Visible radiation produced by electrons moving in a medium with velocities exceeding that of light", *Physical Review*, 52, 378, 1937.
- [19] Rivas, M., "The Spinning Electron" In book: *What is the Electron?* Publisher: C. Roy Keys Inc., Editors: Volodimir Simulik, pp. 59-82, 2005.
- [20] Borovic-Romanov, A.S.; Bunkov, Yu.M.; Dmitriev, V.V.; Mukharskii, Yu.M.; Sergatskov, D.A., "Investigation of Spin Supercurrents in $^3\text{He-B}$ ", *Phys Rev Lett*, 62 (14), 1631, 1989.
- [21] Bunkov, Yu.M., "Spin Superfluidity and Coherent Spin Precession", *Journal of Physics: Condensed Matter*, 21(16), 164201, 2009.
- [22] Dmitriev, V.V.; Fomin, I.A., "Homogeneously precessing domain in $^3\text{He-B}$: formation and properties", *Journal of Physics: Condensed Matter*, 21(16), 164202, 2009.
- [23] Sakharov, A.D., "Vacuum quantum fluctuations in curved space and the theory of gravitation", *Sov. Phys. Dokl.* 12, 1040-1041, 1968.

- [24] Chernin, A.D., "Reviews of topical problems: Cosmic vacuum", *Physics Uspekhi*, 44 (issue 11), 1099-1118, 2001.
- [25] Peebles, P.J.E.; Bharat, R., "The cosmological constant and dark energy", *Reviews of Modern Physics*, 75, 559-606, 2003.
- [26] Weber, M.H.; Lynn, K.G., "Three photon annihilations of Positrons and Positronium in Solids with Two Detectors in Coincidence", *Radiation Physics and Chemistry*, 58 (5-6), 749-753, 2000.
- [27] Wichmann, E.H. *Quantum Physics*. Berkeley physics course, v. IV. McGraw-Hill Book company, 1971.
- [28] Boldyreva, L.B., "The Theory of Virtual Particles as an Alternative to Special Relativity", *International Journal of Physics*, 5 (4), 141-146, 2017.
- [29] Bialynicki-Birula, I., "Photon Wave Function" in book *Progress in Optics*, vol. XXXVI, Ed. E. Wolf, Elsevier, Amsterdam 1996.
- [30] Purcell, E.M. *Electricity and Magnetism*. Berkeley physics course, v.2, McGraw-Hill Book company, 1965.
- [31] Okun, L.B., "Mass versus relativistic and real masses", *Am J Phys*, 77, 430-431, 2009.
- [32] Einstein, A., "Zur elektrodynamische bewegter Körper", *Annalen der Physik*, 322, 891-921, 1905.
- [33] Sedov, L.I. *A Course in Continuum Mechanics*, Wolters-Noordhoff, v. 1-4, 1971-1972.
- [34] Puthoff, H.E., "On the Source of Vacuum Electromagnetic Zero-Point Energy", *Physical Review A*, 40, 4857-4862, 1989.
- [35] Klyshko, D.N., "Quantum optics: quantum, classical, and metaphysical aspect", *Physics Uspekhi*, 37, 1097-1122, 1994.
- [36] Boldyreva, L.B., "Quantum correlations—Spin supercurrents", *International Journal of Quantum Information*, 12 (1), 1450007 (13 pages), 2014.
- [37] Ronald, D.F. *Fundamentals of Jet Propulsion with Applications* (Part of Cambridge Aerospace Series). University of Virginia, 2005.
- [38] Boldyreva, L.B., Sotina, N.B., "Superfluid Vacuum with Intrinsic Degrees of Freedom", *Physics Essays*, 5 (4), 510-513, 1992.
- [39] Einstein, A.; de Haas, W.J., "Proefondervindelijk bewijs voor het bestaan der moleculaire stroom van Ampere", *Amsterdam: Akad Verl*, D 23, Biz. 1449-1464, 1915.
- [40] Hayasaka, H., "Anomalous weight reduction on a gyroscope's right rotations around the vertical axis on the Earth", *Phys Rev Lett*, 63 (25), 2701-2704, 1989.
- [41] Barnett, S.M., "Optical angular-momentum flux", *Journal of Optics B: Quantum and Semiclassical Optics*, 4 (No. 2), 2002.
- [42] Miyaji, G.; et al, "Intense longitudinal electric fields generated from transverse electromagnetic waves", *Appl Phy Lett*, 84 (no. 19), 3855-3857, 2004.
- [43] Meissner, W.; Ochsenfeld, R., "Ein neuer Effekt bei Eintritt der Supraleitfähigkeit", *Naturwissenschaften*, 21 (44), 787-788, 1933.
- [44] Bardeen, J.; Cooper, L.N.; Schrieffer, J.R., "Theory of Superconductivity", *Phys Rev*, 108 (5), 1175-1204, 1957.
- [45] Abrikosov, A.A., "The magnetic properties of superconducting alloys", *Journal of Physics and Chemistry of Solids*, 2 (3), 199-208, 1957.
- [46] Tsuji, K.; Nakamura, S.; Sato, T.; Kubodera, K.; Myhrer, E., "Neutrino magnetic moment contribution to the neutrino-deuteron reaction", *Physics Letters B*, 602, 60-66, 2004.
- [47] Eidelman, S.; et al, "(Particle Data Group): Leptons in the Review of Particle Physics", *Physics Letters B*, 592 (issue 1), 1-5, 2005.
- [48] Umov, N.A., "Theorem über die Wechselwirkungen in Endlichen Entfernungen", *Zeitschrift für Mathematik und Physik*, 19, 97-114, 1874.
- [49] Boldyreva, L.B., "The cavity structure effect in medicine: the physical aspect", *Forschende Komplementärmedizin / Research in Complementary Medicine*, 20, 322-326, 2013.
- [50] Registered with the IP Rights Office Copyright Registration Service. Ref: 4157649598.