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Список трудов по теме доклада:

1) Boldyreva L.B. (2023)."Formula E=mc2 as a Properties of a spin vortex in the Physical vacuum. The Force of Inertia. " Journal of Physics & Optics Sciences v.5(5), ISSN: 2754-4753, doi.org/10.47363/JPSOS/2023(5)224 <https://www.onlinescientificresearch.com/journal-of-physics-optics-sciences-inpress-jpsos.php (см. приложение на стр.2).

2) Детальное рассмотрение свойств виртуальных частиц проведено в книге. Л. Б. Болдырева "Теория спиновых вихрей в физическом вакууме, состоящем из квантовых осцилляторов." М. ЛЕНАНД 2022, ISBN 978-5-9710-9460-9, ББК 22.3щ 22.313 22.314 22.336 22.6 28.071.URS.

3) Марков Геннадий Александрович. Нейтринная пушка. https://science-freaks.livejournal.com/726200.html, https://ratayana.com/rak-pobedit-mozhno

https://patentdb.ru/author/971697

Алексей Иванович Черепанов, [15.03.2024 23:20]
Вашему вниманию три видеоролика.

В первом я даю ответ Шипову Геннадию Ивановичу и Болдыревой Людмиле Борисовне -
По следам доклада к.т.н. Болдыревой Людмилы Борисовны - Сила инерции , 13 марта 2024 года, часть 1 - https://www.youtube.com/watch?v=XliIK-L0F_Q

Алексей Иванович Черепанов, [15.03.2024 23:21]
Во втором ролике собственно доклад Людмилы Борисовны —
По следам доклада к.т.н. Болдыревой Людмилы Борисовны - Сила инерции , 13 марта 2024 года, часть 2 - https://www.youtube.com/watch?v=sZXJKxbziuY

Алексей Иванович Черепанов, [15.03.2024 23:21]
И в третьем ролике обсуждение доклада Людмилы Борисовны —
По следам доклада к.т.н. Болдыревой Людмилы Борисовны - Сила инерции , 13 марта 2024 года, часть 3 - https://www.youtube.com/watch?v=EX29U6gOedM

Приложение

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Formula $E=mc^2$ as a Property of a Spin Vortex in the Physical Vacuum. The Force of Inertia

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ABSTRACT

The aim of this work is to show that in well-known expression $E=mc^2$ symbols m and E denote respectively the mass and energy of spin vortex (of photon or virtual photon) in the physical vacuum, and the energy may be written by expression: $E = \hbar\omega$, where $\hbar$ is the Planck constant, ω is the precession frequency of spin in the spin vortex.

For this purpose, the properties of spin vortex (spin, mass, electric dipole moment) are analyzed. Based on the conducted investigation, the expression for the force of inertia of a moving body is deduced, and it is proven that experimentally observed change in the weight of body during its rotation can be accomplished by the force of inertia. It is shown that the mass connected with the motion of quantum object is formed in a virtual photon like the rest mass of quantum object is formed in a photon, and this formation is carried out by pseudomagnetic interaction.

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Note: This work can be considered in some aspect as a prolongation of article by L Boldyreva "The Physical Vacuum Models with Intrinsic Angular Momentum: From Vorticity of Maxwell's Luminiferous Ether to Pseudomagnetism" Physics & Optics Science v.5(6), ISSN: 2754-4753, doi.org/10.47363/JPSOS/2023(5)223.

1. Introduction

In this work, two types of spin vortices (objects with precessing spin), i.e. photon and virtual photon, are considered.

According to experiments by Weber and Kelvin conducted in 2000 with positron and positronium, photon's spin $\mathbf{S}_{ph}$ is oriented perpendicularly to its velocity **c** [1]:

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

This condition means that the angle of deflection of photon's spin is determined as:

$$\beta = \pi/2. \quad (2)$$

Consequently, in a circularly polarized photon, the spin performs a precession motion with frequency of photon $\boldsymbol{\omega}_{ph}$ and thus the photon can be considered as a spin vortex in the physical vacuum (Figure 1).

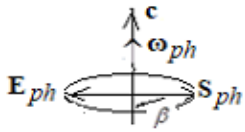

Figure 1: Schema of a right-hand polarized photon. $\mathbf{S}_{ph}$ is spin, $\boldsymbol{\omega}_{ph}$ is the frequency of precession, **c** is the velocity, β is the angle of deflection, $\mathbf{E}_{ph}$ is the electric component.

The history of the physical conception suggesting the connection of energy of photon with its mass starts from Newton's assumption about the possibility of converting the light into mass [2]. 1n 1919 it was discovered the deflection of light rays by Sun that might indicate the existence of light's mass [3]. The experiments demonstrating the possibility of decay of a photon into a pair of particle-antiparticle (for example, the electron-positron pair) are very informative from this point of view; the total mass of the emerging pair (total rest mass) equals (or is no less) the kinetic mass m_{ph} of decaying photon [4]. The magnitude of photon kinetic mass is determined by its frequency $\boldsymbol{\omega}_{ph}$:

$$m_{ph} = \hbar\omega_{ph}/c^2, \quad (3)$$

where $\hbar$ is the Planck constant, c is the speed of light.

Besides of rest mass, a moving quantum object has mass determined by the speed of its motion. In the work, based on the Lorentz formula for mass of moving body [3], it is shown

that the mass connected with the motion of quantum object is the mass of virtual photon created by this object (Section 3).

The virtual photon was introduced by R. Feynman in 1949 [5]. Feynman developed the diagram of force fields in which any force interaction is performed by the virtual particles created by interacting objects; in particular, electric and magnetic interactions are accomplished by so-called virtual photons consisting of a pair of electric oppositely charged virtual particles. The properties of virtual photon are similar to the properties of photon spreading electromagnetic interaction, as well [5, 6]: spin of virtual photon performs precession motion (with frequency ω_v), that is, the virtual photon is a spin vortex. The mass m_v of virtual photon, like in Eq. (3), is determined as:

$$m_v = \hbar\omega_v/c^2. \quad (4)$$

In more detail the properties of virtual photon will be considered in Section 2.

The spin vortices with precessing spins possess gyroscopic properties and these properties results in the emergence of a force acting on the quantum object at change in its velocity. It is shown in this work (Section 4) that the force of inertia may emerge at a change in the magnitude of projection of spin of virtual photon to the direction of velocity of motion of the quantum object creating the virtual photon. In this work it is shown that the force of inertia can cause both the translation motion of rotating magnets at absence of external force [7] and a change in their weight [8, 9].

The similarity of expressions determining the relation of mass and energy in a photon and in a virtual photon (Eqs (3) and (4)) indicates the identity of physical processes determining the emergence of mass in those spin vortices. According to works [10, 11], this physical process can be pseudomagnnetism: the spin-spin interaction of charged parts of quantum oscillators constituting the physical vacuum (Section 5). In 1913 Einstein and Stern basing on the formula derived by Planck [12] for the energy ε_o of the atomic oscillator vibrating with frequency ν: $\varepsilon_o = h\nu/2 + h\nu/\left(exp\left(h\nu/(kT)\right) - 1\right)$, supposed that the physical vacuum free from magnetic and electric fields (without taking into account the gravitational energy) can be defined not as an empty space but as the ground state of a field that consists of the oscillators with zero-point energy $h\nu/2$ [13, 14]. These oscillators have no generally accepted name but they can be called quantum oscillators. The pseudomagnetic interaction of quantum oscillators is discussed in detail in Section 5.

2. The Properties of Virtual Photon

According to the Feynman hypothesis, the properties of virtual photon are similar to the properties of photon spreading electromagnetic interaction, as well [5, 6]. For clarity, let us present this analogy in the form of following table.

Table I

Characteristic	Photon	Virtual photon
The value of spin	$S_{ph} = \hbar$	$S_v = \hbar$
Precession frequency and velocity (**c** or **u**)	$\boldsymbol{\omega}_{ph} \parallel \mathbf{c}$	$\boldsymbol{\omega}_v \parallel \mathbf{u}$
The energy	$\hbar\omega_{ph}$	$\hbar\omega_v$
The kinetic mass	$\hbar\omega_{ph}/c^2$	$\hbar\omega_v/c^2$
The spin and electric component	$\mathbf{S}_{ph} \uparrow\downarrow \mathbf{E}_{ph}$ (see [6])	$\mathbf{S}_v \uparrow\downarrow \mathbf{E}_v$

As the virtual photon created by the quantum object is a gyroscope, the virtual photon's spin $\mathbf{S}_v$ performs a precession motion, under action of moment $\mathbf{M}_v$, with frequency $\boldsymbol{\omega}_v$ determined by expression [15]:

$$\mathbf{M}_v = \boldsymbol{\omega}_v \times \mathbf{S}_v. \quad (5)$$

This formula determines the Barnett effect [16]: magnetization of rotating ferromagnet in direction of angular momentum; consequently, it must determine the similar action of the spin $\mathbf{S}_q$ of quantum object on spin $\mathbf{S}_v$ of virtual photon created by the object:

$$\mathbf{S}_q \uparrow\downarrow \mathbf{S}_v. \quad (6)$$

By definition, a virtual photon consists of a pair of electric oppositely charged "virtual" particles. Consequently, a virtual photon has electric dipole moment $\mathbf{d}_v$ and connected with it electric component $\mathbf{E}_v$ $\mathbf{d}_v \uparrow\downarrow$. Then, from Condition $\mathbf{S}_v \uparrow\downarrow \mathbf{E}_v$ (see Table I) the following condition takes place:

$$\mathbf{d}_v \uparrow\uparrow \mathbf{S}_v. \quad (7)$$

The electric charge of quantum object influences the orientation of electric dipole moment of virtual photon which is created by the quantum object. Taking into account Eqs (5) and (7) and the fact that the quantum object is followed by the virtual photon, the following can be valid:

$$\boldsymbol{\omega}_v \uparrow\uparrow \eta\mathbf{u}, \quad (8)$$

where

$$\eta = \begin{cases} 1, for\ positively\ charged\ quantum\ object \\ -1, for\ negatively\ charged\ quantum\ object \end{cases}. \quad (9)$$

The schematic images of virtual photons created by positively electric charged and negatively electric charged quantum objects are given in Figure 2: $\boldsymbol{\omega}_v$ is the precession frequency of spins $\mathbf{S}_v$; $\mathbf{d}_v$ are electric dipole moments; β is a deflection angle - angle between $\mathbf{S}_v$ and $-\boldsymbol{\omega}_v$; $\mathbf{u}$ is a velocity of quantum object.

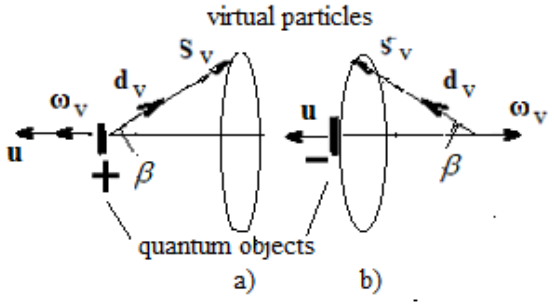

Figure 2: Schematic images of virtual photons produced by positively charged quantum objects - variant (a); and by negatively charged quantum object - variant (b). $\boldsymbol{\omega}_v$ is the precession frequency of spins $\mathbf{S}_v$; $\mathbf{d}_v$ are electric dipole moments; β is a deflection angle; **u** is a velocity of quantum object.

The validity of above-mentioned properties of a virtual photon is proved by the possibility of explanation with its help of many physical phenomena: the spin-orbital interaction, emergence of force of inertia, wave-particle dualism [6, 17]. In the latter case, in the non-relativistic approximation according to Schrodinger's theory [18], the precession frequency ω_v of virtual photon spin is determined by kinetic energy E_k of quantum object creating the virtual photon:

$$\omega_v = E_k/\hbar. \qquad (10)$$

As an example, let us consider **spin-orbital interaction** of electron in a hydrogen atom.

In Feynman's model [5], the virtual photon is created in the area whose size δ equals wavelength $\lambda\!\!\!^{-}_q$ of wave function of quantum object creating this virtual photon, that is: $\delta = \lambda\!\!\!^{-}_q$; using expression $\lambda\!\!\!^{-}_q = \hbar/p_q$ (p_q is the momentum of quantum object [4]) we obtain:

$$\delta = \hbar/p_q. \qquad (11)$$

According to Feynman's model, the virtual photon is characterized by electric dipole moment d_v:

$$d_v = q_v\delta = q_v\hbar/p_q, \qquad (12)$$

where q_v is the electric charge of virtual particle constituting the virtual photon.

Based on the results of experiments conducted by W. Kaufmann [19] on the deflection of the beta-rays emitted by radium, which showed that the mass of the electron m_e is purely of an electromagnetic nature, we assume that the same is valid for the virtual particles that constitute the virtual photon created by electron: that is, the following holds: $e/m_e = 2q_v/m_v$ (e is the electric charge of electron). Then, from Eqs (4) and (10)-(12) and taking into account that in this case $p_q = m_e u$ (u is the speed of electron in an atom of hydrogen) the following expression is valid for d_v:

$$d_v = \mu_B u/(2c). \qquad (13)$$

Due to existence of electric dipole moment $\mathbf{d}_v$ there exists the spin-orbital interaction of quantum object creating the virtual photon with the electric field where the object moves. As an example, let us consider the spin-orbital interaction of electron in the atom of hydrogen. In electric field $\mathbf{E}_n$ of nucleus moment **M** acts: $\mathbf{M} = \mathbf{d}_v \times \mathbf{E}_n$. At conditions $\mathbf{d}_v \uparrow\uparrow \mathbf{u}$ (and Eq. (13)) the expression for **M** is the same as for the maximum, experimentally tested, value of the spin-orbital interaction energy U_{s-o} of the electron in a hydrogen atom: $(U_{s-o})_{max} = |\mu_B(\boldsymbol{u} \times \boldsymbol{E}_n)/(2c)|$. This expression was derived also by L. Thomas based on the general requirements of relativistic invariance [20].

The condition $\mathbf{d}_v \uparrow\uparrow \mathbf{u}$, with taking into account Eqs (8) and (7), is compatible with the Condition:

$$\beta \approx 0. \qquad (14)$$

It should be kept in mind that condition $\mathbf{d}_v \uparrow\uparrow \mathbf{u}$ is written for the electron in a hydrogen atom where electron's speed u satisfies the condition:

$$u<<c. \qquad (15)$$

3. The Determination of Mass of Quantum Object

According to Lorentz transformation in the non-relativistic case [2] (at Condition (15)) the mass of quantum object can be represented by two summands: the rest mass m_0 and the mass m_m determined by the speed of motion of the quantum object ("mass of motion"). Let consider both masses in detail.

The rest mass.

In the case where the quantum object occurs as a result of decay of photon then, with taking into account that two quantum objects arise at decay of photon, with rest mass m_0, according to Eq. (3), is determined as:

$$m_0 = \hbar\omega_{ph}/(2c^2). \qquad (16)$$

The mass of motion.

The mass of motion m_m, with using the Lorentz transformation, can be determined as:

$m_m = m_0/\sqrt{1-u^2/c^2} - m_0 = m_0\big(u^2/(2c^2) + o(u^2/c^2)\big)$, where $o(u^2/c^2)$ are the summands of a lower order of magnitude than (u^2/c^2). In the non-relativistic case (at u<<c), $m_m = m_0u^2/(2c^2)$ (see also [21]). As expression $m_0u^2/2$ determines kinetic energy E_k of quantum object, m_m can be written in the form:

$$m_m = E_k/c^2. \qquad (17)$$

The analysis of Eqs (4), (10) and (17) allows us to suppose that the mass emerging at motion of quantum object is a mass of virtual photon created by this quantum object:

$$m_m = m_v. \qquad (18)$$

The total mass of quantum object according to Eqs (4), (16) and (18) is determined to be as:

$$m_0 + m_m = \hbar\big(\omega_{ph}/2 + \omega_v\big)/c^2. \qquad (19)$$

Note: The change in the kinetic energy of quantum object by value ΔE_k means, according to Eq. (17), the change in the value of total mass $\Delta(m_m + m_0)$ of quantum object by value $\Delta E_k/c^2$.

Thus, both components of quantum object's mass: the rest mass and mass of motion can be formed in spin vortices: the rest mass in the photon; the mass of motion in the virtual photon, and the energy of these vortices is determined by the frequency of precession of their spins. The spin vortices with precessing spins possess gyroscopic properties and these properties result in arise of the inertia force acting on the quantum object. It is shown in this work that the force of inertia can arise at a change in the magnitude of projection of spin of virtual photon to the direction of velocity of motion of quantum object creating the virtual photon.

4. The Determination of the Force of Inertia

In the comparison of the value of angle of deflection β (Eq. 2) at $u=c$ and its value (Eq. (14) at $u<<c$ the following conclusion can be made: in the general case the value β is determined by expression:

$$sin\,\beta = u/c. \qquad (20)$$

As it follows from Eq. (20), at speed u of quantum object equal to speed of light c, the virtual photon acquires the properties of photon. This case takes place in the effect by Cherenkov [22]: the conversion of virtual photon created by quantum object to photon when the speed of the object equals the speed of light. The existence of the Cherenkov effect supports the Feynman hypothesis about similarity of the properties of virtual photon and the properties of photon.

According to Condition (8), the angle of deflection β in a virtual photon is also the angle between its spin $\mathbf{S}_v$ and velocity $\mathbf{u}$ of quantum object creating the virtual photon. It follows from Eq. (20) and Figure 2 that the projection of spin $\mathbf{S}_v$ to the direction of velocity $\mathbf{u}$, $(\mathbf{S}_v)_\mathbf{u}$, is determined to be as:

$$(\mathbf{S}_v)_\mathbf{u} = -\eta S_v\, cos\,\beta = -\eta S_v\sqrt{1-u^2/c^2}, \qquad (21)$$

where η is determined by expression (9).

As follows from Eq. (21), the change in value of $\mathbf{u}$ results in a change in the magnitude of projection of spin of virtual photon created by the quantum object to the velocity of this object, $(\mathbf{S}_v)_\mathbf{u}$. Taking into account the gyroscopic properties of spin, it can be supposed that the change in magnitude $(\mathbf{S}_v)_\mathbf{u}$ of moving body results in arise of force of inertia acting on this body.

Let us consider two cases: the change in the magnitude of speed; the change in the direction of velocity.

1 case: The change in the magnitude of speed.
Let us determine the force of inertia $(F_{in})_u$ in the form:

$$(F_{in})_u = \gamma_{in}\partial(\mathbf{S}_v)_\mathbf{u}/\partial t, \qquad (22)$$

where γ_{in} is a factor of proportionality. If $\gamma_{in} > 0$ and taking into account Eq. (22), $(\mathbf{F}_{in})_\mathbf{u}$ is determined to be:

$$(\mathbf{F}_{in})_\mathbf{u} = -\gamma_{in}S_v\mathbf{u}/\left(c^2\sqrt{1-u^2/c^2}\right)\partial u/\partial t. \qquad (23)$$

Thus, the force of inertia $(\mathbf{F}_{in})_\mathbf{u}$ is aligned with the velocity of moving quantum object, which is in accordance with experimental observation.

2 case: the change in the direction of velocity.
The change in the direction of velocity $\mathbf{u}$ by $\mathbf{u}_n$ means a change in the value of projection of spin $\mathbf{S}_v$ to two directions: $\mathbf{u}$ and $\mathbf{u}_n$ (new velocity), see Figure 3. Consequently, the total force of inertia $\mathbf{F}_{in}$ acting on the quantum object will be determined as: $\mathbf{F}_{in} = (\mathbf{F}_{in})_\mathbf{u} + (\mathbf{F}_{in})_{\mathbf{u}_n}$. The component $(\mathbf{F}_{in})_\mathbf{u}$ is caused by the reduction of velocity $\mathbf{u}$ to zero. The component $(\mathbf{F}_{in})_{\mathbf{u}_n}$ caused by the rise of velocity $\mathbf{u}_n$ is determined similar to Eq. (23) as:

$$(\mathbf{F}_{in})_{\mathbf{u}_n} = -\gamma_{in}S_v\mathbf{u}_n/\left(c^2\sqrt{1-u^2/c^2}\right)\partial u_n/\partial t \qquad (24)$$

Thus, the total force of inertia $\mathbf{F}_{in}$ acting on the quantum object will be determined, according to (23) and (24), as:
$\mathbf{F}_{in} = -\gamma_{in}S_v\mathbf{u}/\left(c^2\sqrt{1-u^2/c^2}\right)\cdot\partial u/\partial t - \gamma_{in}S_v\mathbf{u}_n/\left(c^2\sqrt{1-u_n/c^2}\right)\cdot\partial u_n/\partial t.$

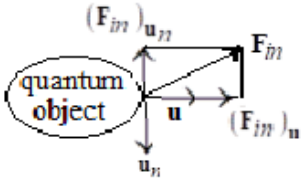

Figure 3. The components $(\mathbf{F}_{in})_\mathbf{u}$ and $(\mathbf{F}_{in})_{\mathbf{u}_n}$ of force of inertia $\mathbf{F}_{in}$ acting on the quantum object. $\mathbf{u}$ is the initial velocity, $\mathbf{u}_n$ is a new velocity.

The change in the angle of deflection β can be accomplished by rotating bodies due to the Barnett effect: the magnification of the magnetization of ferromagnet [16] along the axis of rotation. This means that the rotation (with angular momentum $\mathbf{\Omega}$) of magnet results in the orientation of spins constituting its "magnetic" electrons' spin $\mathbf{S}_e$ as: $\mathbf{S}_e \uparrow\downarrow \mathbf{\Omega}$. Due to Eq. (6) spin $\mathbf{S}_v$ of virtual photon created by "magnetic" electron will be aligned with $\mathbf{\Omega}$, that is, the change in projection of spins $\mathbf{S}_v$ of virtual photons to direction $\mathbf{\Omega}$ takes place.

$$\mathbf{S}_v \uparrow\uparrow \mathbf{\Omega}, \qquad (25)$$

The arising force of inertia $(\mathbf{F}_{in})_\mathbf{\Omega}$ in this case is determined by expression similar to Eq. (22):

$$(\mathbf{F}_{in})_\mathbf{\Omega} = (-\mathbf{\Omega}/\Omega)\gamma_{in}\partial(\mathbf{S}_v)_\mathbf{\Omega}/\partial t. \qquad (26)$$

Under the action of force $(\mathbf{F}_{in})_\mathbf{\Omega}$ "magnetic" electron moves at velocity:

$$\mathbf{u} \uparrow\downarrow \mathbf{\Omega}. \qquad (27)$$

According to Eqs (8)-(9), spin $\mathbf{S}_v$ of virtual photon created by a "magnetic" electron is oriented as:

$$\mathbf{u} \uparrow\downarrow \boldsymbol{\omega}_v. \qquad (28)$$

According to Eq. (5),

$$\boldsymbol{\omega}_v \downarrow\uparrow \mathbf{S}_v. \qquad (29)$$

According to Eqs (27)-(29), $\mathbf{S}_v \uparrow\downarrow \boldsymbol{\Omega}$. From the comparison of obtained Condition with (25) it follows that force of inertia $(\mathbf{F}_{in})_{\boldsymbol{\Omega}}$ counteracts the change in the reorientation of spin $\mathbf{S}_v$.

Let us consider two cases: 1 case - $\boldsymbol{\Omega}$ is oriented along the Earth surface (may result in the motion of body); 2 case - $\boldsymbol{\Omega}$ is oriented normal to the Earth surface (may result in a change in the weight of rotating body).

1 case. $\boldsymbol{\Omega}$ is oriented along the Earth surface.
An example of action of force of inertia during the rotation of ferromagnetic cylinder is given in Figure 4. $\boldsymbol{\Omega}$ is the angular velocity, $\mathbf{S}_{te}$ is the total precessing spin of "magnetic" electrons, $\mathbf{S}_{tv}$ is the total precessing spin of virtual photons created by those "magnetic" electrons, $\mathbf{F}_{in}$ is the force of inertia.

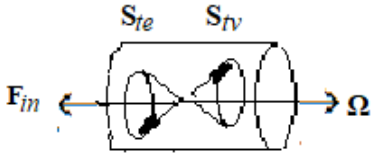

Figure 4: Characteristics of ferromagnetic cylinder: $\boldsymbol{\Omega}$ is the angular velocity, $\mathbf{S}_{te}$ is the total precessing spin of "magnetic" electrons, $\mathbf{S}_{tv}$ is the total precessing spin of virtual photons created by those "magnetic" electrons, $\mathbf{F}_{in}$ is the force of inertia.

2 case. $\boldsymbol{\Omega}$ is oriented normal to the Earth surface.
The examples of action of force of inertia during rotation of two gyroscopes (clockwise and counterclockwise) are given in Figure 5.The action of force of inertia in variant (a) results in a decrease in the weight of gyroscope. The action of force of inertia in variant (b) results in an increase in the weight of gyroscope. $\boldsymbol{\Omega}$ is the angular velocity, $\mathbf{S}_{te}$ is the total precessing spin of "magnetic" electrons of gyroscope, $\mathbf{S}_{tv}$ is the total precessing spin of virtual photons created by those "magnetic" electrons, $\mathbf{F}_{in}$ is the force of inertia.

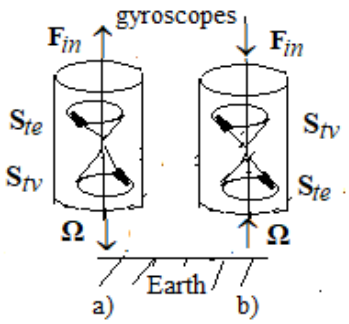

Figure 5: Characteristics of gyroscopes: $\boldsymbol{\Omega}$ is the angular velocity, $\mathbf{S}_{te}$ is the total precessing spin of "magnetic" electrons of gyroscope, $\mathbf{S}_{tv}$ is the total precessing spin of virtual photons created by those "magnetic" electrons, $\mathbf{F}_{in}$ is the force of inertia. Variant (a) – clockwise rotation. Variant (b) – counterclockwise rotation.

The theoretical conclusion was supported by many experiments. In 1990-1993, the experiments with rotating magnets were performed by V. Godin and S. Roshchin [8]. Let us consider these experiments in detail. At a definite speed of rotation, the effect of the changes in the weight was observed: the weight change was as much as 35% of the weight of the experimental setup in the state of rest (the weight was 350 kg in the discussed experiments). The observed effect of the changes in the weight (increase or decrease) was reversible relative to the direction of the rotor rotation under the complete symmetry of the rotor. At the clockwise rotation, a force emerged directed opposite to the gravitation vector (that is, the weight of the setup decreases). On rotating anticlockwise, a force emerges which is directed along the gravitation vector.

Let us analyze another experiment that was conducted by H. Hayasaka [9] with the gyroscope's rotations around the vertical axis relative to the Earth. At the right-hand rotation, a decrease in the weight of gyroscope took place. The magnitude of the decrease in weight did not depend on shielding the gyroscope from the external magnetic field (0.35 G). A decrease in the weight of gyroscope was not observed in the left-hand rotation. The scheme of the experimental setup is shown in Figure 5.

Note: If the rotating body has a complex form, the forces of inertia in different points of body can have different directions that can result in a deformation of the body.

The change in the mass center of rotating body.
The rotation of body results not only in a change in the orientation of spins of virtual particles created by quantum objects of body, but in a change in precession frequencies ($\boldsymbol{\omega}_v$) of these spins, as well. Due to Eq. (19), it means the change in the mass of quantum objects constituting the rotational body. As a result of change in mass the replacement of the mass center can arise. This phenomenon was observed in experiments by G. Shipov [23].

5. The Physical Process Creating Mass in Spin Vortices
The similarity of expressions determining the relation of mass and energy in a photon and virtual photon ((Eq. 3 and Eq. 4)) indicates the identity of physical processes determining the emergence of mass in those spin vortices. Let us consider this physical process. According to works [10, 11, 17], this physical process can be pseudomagnetism: the spin-spin interaction of charged parts of quantum oscillators (QO-particles) having mass and spin, and constituting physical vacuum according to the model by A. Einstein and O. Stern. The existence of mass and electric dipole moment of virtual photon can be a result of two processes: "collapse" of the electrically like charged QO-particles and separation of the unlike charged QO-particles. These processes are possible if there is a force depending on the electric sign of interacting electric charges and mutual orientation of their spins. The force is observed in experiments and it is called pseudomagnetic. For example, pseudomagnetic force, F_{pm}, between two QO-particles with spins $(\mathbf{S}_{qo}/2)_1$ and $(\mathbf{S}_{qo}/2)_2$

respectively, and electric charges q_1 and q_2, respectively, is determined by the following expressions:

$$\begin{cases} \mathbf{F}_{pm} > 0, if \left(\mathbf{S}_{qo}/2\right)_1 \rightarrow\rightarrow \left(\mathbf{S}_{qo}/2\right)_2 \; and \; q_1 q_2 > 0 \\ \qquad\qquad or \left(\mathbf{S}_{qo}/2\right)_1 \longleftrightarrow \left(\mathbf{S}_{qo}/2\right)_2 \; and \; q_1 q_2 < 0; \\ \boldsymbol{F}_{pm} < 0, if \left(\mathbf{S}_{qo}/2\right)_1 \rightarrow\rightarrow \left(\mathbf{S}_{qo}/2\right)_2 \; and \; q_1 q_2 < 0 \\ \qquad\qquad or \left(\mathbf{S}_{qo}/2\right)_1 \longleftrightarrow \left(\mathbf{S}_{qo}/2\right)_2 \; and \; q_1 q_2 > 0 \end{cases}$$

If $F_{pm} > 0$, it is an attractive force, if $F_{pm} < 0$, it is a repulsive force. Schematic image of structure of virtual photon, with taking into account the pseudomagnetic interaction, is given in Figure 6. $\mathbf{S}_v$, $\mathbf{d}_v$, $\boldsymbol{\omega}_v$, $\lambda\!\!\!^{-}_q$, q_v are respectively spin, electric dipole moment, frequency of precession of spin; $\lambda\!\!\!^{-}_q$ is the wavelength of quantum object creating the virtual photon; q_v is an electric charge of "collapses" of QO-particles (area **1** is a "collapse" of positively charged QO-particles, area **2** is an "collapse" of negatively charged QO). The total mass of all QO-particles constituting the virtual photon equals m_v.

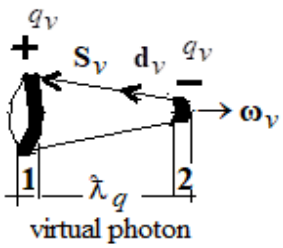

Figure 6: Schematic image of structure of virtual photon, with taking into account the pseudomagnetic interaction. $\boldsymbol{\omega}_v$ is the frequency of precession of spin $\mathbf{S}_v$, $\mathbf{d}_v$ is the electric dipole moment, $\lambda\!\!\!^{-}_q$ is the wavelength of quantum object creating the virtual photon, area **1** and area **2** are collapses respectively of positively and negatively charged QO-particles with total charges q_v.

Conclusion

1. In this work it is considered two types of spin vortices (objects with precessing spin) a photon and virtual photon. The mass m of every spin vortex is connected with precession frequency $\boldsymbol{\omega}$ of spin $\mathbf{S} = \hbar$ of spin vortex by expression: $m = \hbar\omega/c^2$.

The total mass of quantum object consists of two components: rest mass and mass connected with motion of quantum object: the first mass is created in the photon, the second mass is created in the virtual photon.

2. The spin vortices with precessing spins possess gyroscopic properties and these properties result in the emergence of force of inertia. The force of inertia acting on the quantum object emerges at a change in the magnitude of projection of spin of virtual photon created by the object to the direction of velocity of quantum object motion.

3. Two characteristics of spin vortices: mass and electric dipole moment - owe their origin to the pseudomagnetic interaction. This is the spin-spin interaction depending on mutual orientation of these spins and electric signs of interacting charged objects.

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