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# Model of Gravitational Interaction in the Concept of Gravitons

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***ABSTRACT:*** The law of Newton for the attraction of bodies is derived with the help of the concept of gravitons. The expression for the gravitational constant is obtained through the momentum of gravitons and the absorption coefficient. Calculations of the values of the coefficient of absorption and of the energy power of flows of gravitons in the space were made. It is shown that during the movement with constant speed the law of inertia is acting.

***KEYWORDS:*** Gravitation, Force, Shielding, Inertia.

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## *I. INTRODUCTION*

One of the oldest ideas, concerning the nature of gravity, is the kinetic theory of Le-Sage [1], in which the mechanical action of particles (gravitons) causes the attraction of bodies to each other. Gravity is not only responsible for the attraction of bodies, but also essentially ensures integrity and stability of bodies themselves. The standard objections against the theory of Le-Sage are: 1) its inability of precise prediction concerning the possible gravitational shielding, 2) the nature and the properties of the flows of gravitons, 3) explanation of the free movement of bodies by inertia, 4) the possible thermal effect from the gravitons' action, 5) contribution of the gravitational field to the mass of bodies.

We should notice, that in [2] gravitons were accepted as cosmic quanta, the components of photons. The analysis of interaction of these quanta with the substance on the basis of Compton effect allows deducing formulas for the mass of bodies, inertia and gravitational interaction. The model of gravitational interaction suggested below in its own way solves the problems in the concept of gravitons, but as gravitons involves not only the photons, but also neutrinos and relativistic particles, similar to cosmic rays.

## II. THE INVERSE-SQUARE LAW

We will derive the formula of Newton for the force of the gravitational attraction of two bodies on the basis of the approach, presented in [3]. Let us designate through $A_0$ the quantity, equal to the number of gravitons $dN_0$, which fly from the outside per time unit $dt$ into the unit solid angle $d\alpha$ and thus have the component of momentum inside this angle:

$$A_0 = \frac{dN_0}{dt\,d\alpha}.$$

According to the definition, $A_0$ is the graviton flux, which must be connected to the gravitational constant $\gamma$. We will consider that the change in the quantity of gravitons per time unit in the substance layer with the density $\rho$ and the thickness $dx$ is proportional to the number of incoming gravitons:

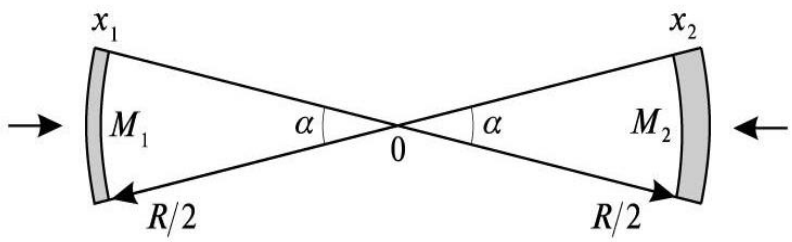
$$dA = -A\chi\rho y\,dx, \qquad A = A_0 \exp(-\chi\rho y x), \tag{1}$$

Where, $\chi$ – the absorption coefficient,
$y$ – half of the characteristic transverse dimension of the substance layer.

Relation (1) reflects the dependence between the quantity of gravitons falling to the substance layer and outgoing from it from the point of view of the transfer of momentum from the gravitons to the substance. We shall take now two separate bodies at the distance $R$ from each other, the densities of their substance can be different. Despite of different density we shall consider, that the bodies are identical in the sense that their absorption coefficient is the same. In these bodies we should select round surface areas with the radius, equal to $y$, and we should connect them as it is shown in figure 1. Then the small solid angle $\alpha$ will meet the condition of the equality of the areas:

$$\alpha \cdot \left(\frac{R}{2}\right)^2 \approx \pi y^2. \tag{2}$$

The solid angle cuts out in the bodies in question the volumes, close to the ball segments, with the masses $M_1$ and $M_2$ respectively. The masses of segments $M_1$ and $M_2$ depend on the




thickness $x_1$, $x_2$, and the densities $\rho_1$, $\rho_2$, respectively.

**Fig.1.** Masses $M_1$ and $M_2$ in the form of ball segments with different thickness and the density of the substances, located at the distance $R$ from each other.

We should show first that in this configuration the attraction of segments under the action of gravitons is due to the Newton's law. We will prove thus that the law of attraction will be valid for the both bodies on the whole. It follows from the arbitrariness of selection of the areas on the surface of these bodies and the possibility of the vector summing up of forces between all the possible pairs of the substance units.

It is evident from figure 1 that the masses of the segments are equal to:

$$M_1 = \rho_1 x_1 \pi y^2, \qquad M_2 = \rho_2 x_2 \pi y^2, \tag{3}$$

Where, the masses can be selected infinitely small with the suitable selection of $y$. Accordingly, infinitely small will be the solid angle $\alpha$.

The acting force is the momentum, transmitted to the substance by gravitons per time unit:

$$F = p\alpha\, \Delta A, \tag{4}$$

Where, $p$ – the momentum of one graviton.

We should examine the propagation of the flow of gravitons from the left side in figure 1, first through the substance unit with the mass $M_1$, then in the space between the masses $M_1$ and $M_2$, and finally through the substance unit with the mass $M_2$.

The force acting on $M_1$ from the left side, taking into account (4) and (1) is equal to:

$$F_1 = p\alpha\,(A_0 - A_1) = p\alpha\, A_0\left[1-\exp(-\chi\rho_1 y x_1)\right] \approx p\alpha\, A_0\, \chi\rho_1 y x_1\left(1-\frac{\chi\rho_1 y x_1}{2}\right). \tag{5}$$

In (5) the exponent was expanded to the terms of the second order. In the general case the distance $R$ can be so large that it is necessary to consider weakening of the flow of gravitons with their propagation in the space from $M_1$ to $M_2$. For evaluating this weakening a formula (1) of the following type is used:

$$A_{11} = A_1 \exp\left(-\chi\int\rho(r)\, y(r)\, dr\right), \tag{6}$$

Where,

$A_1$ – the intensity of the flow of gravitons, which passed from the left side through the substance unit with the mass $M_1$,

$A_{11}$ – the intensity of the flow of gravitons, which reached from the left side the substance unit with the mass $M_2$,

$\rho(r)$ – the substance density between $M_1$ and $M_2$.

The force acting on $M_2$ from the left side similarly to (5) is equal to:

$$F_2' = p\alpha\,(A_{11} - A_2') = p\alpha\, A_{11}\left[1 - \exp(-\chi\rho_2\, yx_2)\right] \approx p\alpha\, A_{11}\, \chi\rho_2\, yx_2 \left(1 - \frac{\chi\rho_2\, yx_2}{2}\right).$$

Taking into account the same considerations for obtaining (5), (6) and the quantity $A_1 = A_0\exp(-\chi\rho_1\, yx_1)$, for the force $F_2'$ we find:

$$F_2' = p\alpha\, A_0\, \chi\rho_2\, yx_2 \left(1 - \frac{\chi\rho_2\, yx_2}{2}\right)\exp\left(-\chi\rho_1\, yx_1 - \chi\int\rho(r)\, y(r)\, dr\right). \qquad (7)$$

For the flow of gravitons on the right side similarly to (5) and (7) we have:

$$F_2 \approx p\alpha\, A_0\, \chi\rho_2\, yx_2 \left(1 - \frac{\chi\rho_2\, yx_2}{2}\right).$$

$$F_1' = p\alpha\, A_0\, \chi\rho_1\, yx_1 \left(1 - \frac{\chi\rho_1\, yx_1}{2}\right)\exp\left(-\chi\rho_2\, yx_2 - \chi\int\rho(r)\, y(r)\, dr\right).$$

The gravity force, which acts on the mass $M_1$ from the side of mass $M_2$, is equal to:

$$\begin{aligned} F_{01} = F_1 - F_1' = p\alpha\, A_0\, \chi\rho_1\, yx_1 \left(1 - \frac{\chi\rho_1\, yx_1}{2}\right)\times \\ \times\left(\chi\rho_2\, yx_2 + \chi\int\rho(r)\, y(r)\, dr\right)\left(1 - \frac{\chi\rho_2\, yx_2 + \chi\int\rho(r)\, y(r)\, dr}{2}\right). \end{aligned} \qquad (8)$$

The force which acts on the mass $M_2$ from the side of mass $M_1$, is equal to:

$$F_{02} = F_2 - F_2' = p\alpha A_0 \chi \rho_2 y x_2 \left(1 - \frac{\chi \rho_2 y x_2}{2}\right) \times$$
$$\times \left(\chi \rho_1 y x_1 + \chi \int \rho(r) y(r) dr\right) \left(1 - \frac{\chi \rho_1 y x_1 + \chi \int \rho(r) y(r) dr}{2}\right). \qquad (9)$$

Let us remember that in the general case the gravitational masses are subdivided into the passive and the active. By passive mass of the body is understood such mass, which characterizes the body with its acceleration in the specified gravitational field (for example, with the weighing). Accordingly, the active mass of the body is responsible for creation of gravitational field around this body.

Comparison of (8) and (9) shows that the forces $F_{01}$ and $F_{02}$ are not equal to each other because of the presence of additional forces from the sources of mass, which are located between the bodies. Besides, the nonequivalence of the entry of the substance densities $\rho_1$, $\rho_2$ in (8) and (9) means that the passive and the active gravitational masses of bodies differ from each other. In this case, the effective active mass exceeds the passive mass due to weakening of the flows of gravitons in the space between the interacting bodies. It is also possible to say that the presence of the gravitating medium near the body effectively increases its passive mass to the value of the effective active gravitational mass.

The more precise equality of forces between the masses $M_1$ and $M_2$ is achieved when the distance between the masses is relatively small, the density $\rho(r)$ of the intermediate substance and the characteristic transverse dimension $y(r)$ are small. Then the change of the flows of gravitons in the space between the masses can be disregarded.

For evaluating the absorption coefficient $\chi$ in the substance we will consider that the term $\chi \int \rho(r) y(r)\, dr$ in (8) and (9) is insignificant and it is possible to disregard it. After substitution (3), taking into account (2), we obtain for the gravity force between the elements of substance $M_1$ and $M_2$ the following:

$$F = F_{01} = F_{02} = \frac{4pA_0 \chi^2 M_1 M_2}{\pi R^2} \left(1 - \frac{\chi \rho_1 y x_1}{2}\right) \left(1 - \frac{\chi \rho_2 y x_2}{2}\right) = \frac{\gamma M_{1G} M_{2G}}{R^2}, \qquad (10)$$

Here, by $M_{1G}$ and $M_{2G}$ the gravitational masses are designated, which are responsible for the force of gravity. Unlike them the masses $M_1$ and $M_2$ are calculated through the measured densities of substance and the volumes according to (3). We find from (10):

$$\gamma = \frac{4pA_0 \chi^2}{\pi}, \qquad M_{iG} = M_i \left(1 - \frac{\chi \rho_i y x_i}{2}\right), \qquad (11)$$

Where, the index $i = 1, 2$ distinguishes the masses $M_1$ and $M_2$. It is evident in (11) that the gravitational constant $\gamma$ is determined by constants – the mean momentum of a graviton, the flow of gravitons, which falls per time unit from the unit solid angle, and by the squared coefficient of absorption of gravitons in the substance, consisting of nucleons. It is obvious that in the course of evolution of the Universe and with the displacement of bodies in the space the mean momentum of gravitons and the density of their flows can change, what will influence the effective value of the gravitational constant. Changes in the composition and quality of substances through the absorption factor also contributed to the existing gravitational forces.

### *III. THE ABSORPTION COEFFICIENT AND GRAVITATIONAL SHIELDING*

In order to determine the coefficient $\chi$ we will use the formula for the gravitational mass in the general relativity theory (for the cold substance without considering the pressure energy):

$$M_G = M\left(1 - \frac{k\gamma M}{R_b c^2}\right), \tag{12}$$

Where,

$R_b$ and $M$ – the radius and the mass of the body,
$c$ – the speed of field propagation,
$k = 0.6$ in the approximation of the uniform substance density.

We should consider preliminarily that the formula (12) is valid for the body in the form of a sphere, and the masses in (11) according to figure 1 are concentrated approximately in the cylindrical form. If in the sphere we inscribe a cylinder with the height equal to the cylinder's base, then the volume of the sphere will exceed the cylinder's volume $\delta = 4\sqrt{2}/3$ times. The same relation there will be also for the masses. In this case the height of the cylinder will be more than the radius of the sphere, so that $x = 2y = \sqrt{2}\,R_b$. Introducing in (12) the coefficient $\delta$ and comparing (11) and (12), we obtain:

$$\frac{\Delta M}{M} = \frac{\chi\rho R_b^2}{2} = \frac{k\gamma M}{\delta R_b c^2}, \qquad \chi = \frac{2k\gamma M}{\delta\rho R_b^3 c^2} = \frac{\sqrt{2}\pi k\gamma}{c^2}. \tag{13}$$

In (13) the mass of the body $M$ in the form of sphere was expressed through the substance density and the volume. Substituting the constants and the value $k = 0.6$, we should estimate the value of the absorption coefficient:

$$\chi = 2\cdot 10^{-27} \text{ m/kg}, \tag{14}$$

If $c$ is equal to the speed of light.

According to its meaning $\chi$ reflects the weakening of gravitons flows during their passing in the substance from the point of view of the transfer of the momentum to the substance. The estimation of the length of the free path of gravitons inside the bodies, when they lose their ability to transfer their momentum, can be made on the basis of condition $\chi \rho y x = 1$ for the exponential term in (1). Neutron stars possess the substance density about $2\cdot 10^{17}$ kg/m$^3$. As the value $y$ it is possible to take the diameter of a neutron star. Then in the path of gravitons it is necessary to place not less than 3 neutron stars in order to noticeably decrease the extent of the flow. The penetrating power of gravitons is so large that the gravitons can be compared only to the neutrino with energy of about 100 eV.

We should compare (8), (9) with the expression for the force from [4], which describes the possible effect of the gravitational shielding:

$$F' = \frac{\gamma M_1 M_2}{R^2} \exp\left[- h \int \rho(r)\, dr\right]. \qquad (15)$$

It is assumed in (15) that the presence of the substance between the bodies decreases the force of their attraction by some means.

If we place additional substance near the body with the mass $M_1$, then according to (9) the force, which acts on the mass $M_2$ will increase. Increase in the force will occur in the manner simply as if it is the gravitational mass $M_1$ that increases. In this case the gravitational shielding is not observed, since the general effective force of the influence on the mass $M_2$ grows by means of composition of forces.

In the opposite situation the additional substance with the density $\rho(r)$ is distributed outside the two bodies from all the sides so that as the result it leads to a change of the product $p A_0$ for the flow of gravitons per unit of the solid angle. On bodies will operate, in view of the formula of type (6), the flow of gravitons:

$$A_0' = A_0 \exp\left(- \chi \int \rho(r)\, y(r)\, dr\right).$$

Replacing in (10) $A_0$ on $A_0'$, in view of (11) we shall receive:

$$F = \frac{\gamma M_{1G} M_{2G} \exp\left(- \chi \int \rho(r)\, y(r)\, dr\right)}{R^2}, \qquad (16)$$

From (16) follows that if shielding occurs because of external substance, then effective force of an attraction between bodies decreases. Unlike the force (15) prospective in [4], effect of gravitational shielding according to (16) depends not only on thickness of a layer of shielding substance, but also from the area of a layer through size $y(r)$.

## IV. STRONG FIELDS

We should consider relations for gravitational force (5) – (9) with high substance densities, when it is already impossible without error to expand the exponents into series. In particular, for the force $F_{01}$ from (8) we obtain:

$$F_{01} = p\alpha A_0 \left[1 - \exp(-\chi \rho_1 y x_1)\right] \left[1 - \exp(-\chi \rho_2 y x_2)\right].$$

We should assume that substance densities are so great that the exponents in this expression can be disregarded. Taking into account (2) for $\alpha$ , (11) for $pA_0$ , (13) for $\chi$ , and (16) we have:

$$F_{\max} = p\alpha A_0 = \frac{c^4 y^2}{2k^2 \gamma R^2} = \frac{\gamma M_{1G} M_{2G}}{R^2} .$$

Designating $M_G = M_{1G} = M_{2G}$ , the expression $1 = \frac{2k\gamma M_G}{R_b c^2}$ is obtained with the previously used condition $y = \frac{R_b}{\sqrt{2}}$ . Also we have $F_{\max} = \frac{c^4}{16k^2 \gamma}$ with condition $R = 2R_b$ , for maximum interaction of two massive bodies. We find with the accuracy to the coefficient of about 1 that the gravitational potential on the surface of the massive body cannot exceed $c^2$ .

Another case is obtained for our Metagalaxy with the observed density of its substance in the limits of $10^{-27} - 10^{-26}$ kg/m$^3$. If we substitute the dimensions of the Metagalaxy about 10 Gpc for $y$ and $x$ , then the exponents in the forces also become small. It turns out that for the Metagalaxy the gravitational potential cannot exceed $c^2$ too. In all likelihood, the gravity, created by the sources inside the Metagalaxy itself, is not able to convert the Metagalaxy into the black hole.

## V. THE MOTION OF ENERGY

Under the action of graviton flows penetrating all bodies the gravitational force appears. It is obvious that many other values in stationary bodies which seem constant to us – the gravitational acceleration, the energy of the field, the rest energy of particles, etc. – they can be the consequence of dynamic processes.

We should find, with the help of (11) for $pA_0$ and (13) for $\chi$ , the expression for the maximum energy force of the flow of gravitons, or of energy power per unit of solid angle in the given direction:

$$W = pcA_0 = \frac{c^5}{8\pi k^2 \gamma} = 4 \cdot 10^{51} \text{ W/st}, \qquad (17)$$

If $c$ is equal to the speed of light.

We can approximately calculate the effective energy density of gravitons in space. From the full solid angle $\alpha = 4\pi$ steradian per second inside a sphere can pass the energy with the value $4\pi W$. During this time, energy can leave the sphere, if the radius of the sphere will be equal to the value of light speed. The volume of such sphere is equal to $\frac{4\pi c^3}{3}$. By dividing the amount of energy $4\pi W$ on volume of the sphere, we find the effective energy density of gravitons:

$$\varepsilon_e = \frac{3c^2}{8\pi k^2 \gamma} = 1.5 \cdot 10^{26} \text{ J/m}^3.$$

We shall estimate now the maximum power of the energy generation in the material bodies. From (17) and (1) for the situation in figure 1 we have:

$$\frac{dE_G}{dt} = \alpha\, \Delta W = \alpha\, pc \Delta A = \alpha\, pc A_0 \chi \rho y x = \alpha W \chi \rho y x .$$

Using (3) in the form of $\rho_i y x_i = \frac{M_i}{\pi y}$, expressing the mass of the cylinder $M_i$ through the mass of sphere $M$, reduced in $\delta = 4\sqrt{2}/3$ times, using the condition $2y = \sqrt{2} R_b$ ( $R_b$ – the radius of the sphere) and the condition $\alpha = 4\pi$ for the complete solid angle, taking into account (13) and (17) we will obtain:

$$\frac{dE_G}{dt} = \frac{4\sqrt{2} W \chi M}{\delta R_b} = \frac{3\sqrt{2} M c^3}{8 k R_b} . \qquad (18)$$

According to (18) with an accuracy to the coefficient of about 1, the maximum power of the energy generation is equal to the rest energy of the body, radiated during the time when the gravitons pass the radius of the body: $t = R_b / c$ . Hence it follows that the rest energy of bodies is created and is supported exactly by gravity.

Actually, the flow of gravitons with the specific energy and the temperature passes through each body. In the stationary case the energy of incident and outgoing flows are equal, but the temperature of the flow of gravitons outgoing from the body must be less because of the previous interaction with the particles of the body. As the result the bodies obtain the negentropy from the outside, which is compensated by the production of the corresponding entropy. The energy, connected with the entropy of the body, is realized in the form of stresses inside the body which appear under the action of gravitational forces. Besides, the field strengths appear outside the body. For the gravitationally-bound bodies the basic contribution to the entropy is made by the potential energy of the gravitational field. This energy is connected with the body and can partially pass into kinetic energy only in the case of the imbalance between the force of gravity and the internal pressure. In the hypothetical case of the complete isolation of the body from the external gravity, the body will be converted to the state of equilibrium with an increase in the volume up to the dispersion of substance. The entropy in this case will increase, and the gravitational energy will pass into the kinetic energy of substance and emission.

The energy, connected with the entropy, is close enough to the energy of gravitational field (summed with the pressure energy). As a matter of fact, this energy is responsible for the decrease of the mass according to (12). The denser the body with the constant mass becomes, the stronger the interaction of gravitons with the substance is. This leads to the increase of the module of gravitational energy of the body, and to the increase of the module of entropy and stresses in the body. The existence of potential gravitational energy and stresses in the bodies itself is the consequence of the transfer of the energy-momentum of gravitons to the substance and the conversion of the entropy of gravitons. The energy of the flows of gravitons determines the rest energy of the bodies and the observed mass of these bodies, similarly the gravitational energy contributes to a change in the mass of the body from $M$ to $M_G$ in (12).

From the qualitative standpoint (18) can be understood from the following discourses. It is known, that in supernova a large amount of energy is radiated in the form of neutrinos. At the initial stage of collapse of the supernova substance and photodisintegration of iron nuclei and seizure of electrons by protons and nuclei, in the impulse with duration about 10 ms electron neutrinos $\nu_e$ are radiated. The share of this impulse in the general balance of neutrino radiation of the supernova equals approximately 5 %. After the collapse of the substance, a neutron star which has been formed is getting cool. At the same time the reactions with electrons and positrons are taking place and neutrinos and antineutrinos are generated, for example in reaction: $e^- + e^+ = \nu_i + \tilde{\nu}_i$, where the index $i = e, \mu, \tau$ differentiates electronic, muonic and $\tau$ – leptonic neutrinos (antineutrinos). Typical energies of the neutrinos which are formed $10-15$ MeV, their main stream is radiated during the first 4 sec. Based on the results of the measurements of the number of neutrino events fixed, different evaluations of energy of supernova SN 1987A give for the radiation of the antineutrino $\tilde{\nu}_e$ the value $(1-8)\cdot 10^{45}$ J. This energy should be increased, taking into account the radiation of other types of neutrinos and antineutrinos. The evaluation of gravitational energy of neutron star equals: $E_g = \frac{k\gamma M_s^2}{R_s} = 2\cdot 10^{46}$ J (with the mass of a typical star $M_s = 1.4 M_c$, where $M_c$ – the mass of the Sun, and the radius of the star $R_s = 14.9$ km). In [10] it is possible to find an estimation of mass of the substance turning in neutrinos and in gravitational waves – approximately $0.2 M_c$. It turns out, that in formation of a neutron star the energy of the neutrinos being radiated can be compared to the full gravitational energy of the star.

Before the substance is included in the neutron star composition, it should come through different stages of transformation. First the low density hydrogen cloud gets condensed under the influence of gravitational forces, and a star is formed in which thermonuclear reaction take place. After long stay in the main sequence and burning-out of the thermonuclear fuel, the iron nucleus is formed in the star. This nucleus collapses in a neutron star after the increase of the mass limit, admissible for such nucleus. We should move from stars to elementary particles. In [3] it was shown, how we can introduce a concept of strong gravitation which binds the substance of the elementary particles based on the analogy of nucleons and neutron stars. If nucleons are formed based on the similar scheme as the neutron stars, then in forming of each nucleon a large amount of particles of small size is also radiated. We can assume that at least some of these particles serve as the gravitons. These particles should be similar by their qualities to neutrinos and antineutrinos radiated while neutron stars are formed. The total energy of all gravitons, which appear when one nucleon is formed from smallest rarified substance, must be close to the gravitational binding energy of the substance of this nucleon and to the rest energy of the nucleon. Thus, if the average concentration of the substance in our Metagalaxy equals 1 nucleon/m$^3$, then the corresponding energy of the substance in 1 m$^3$ at rest will equal approximately $E_p = M_p c^2 = 1.5 \cdot 10^{-10}$ J, where $M_p$ – is the mass of a proton. The density of the energy of gravitons from nucleons prospective by us is of the same level as the density of the energy of substance at rest, that means $\varepsilon < 1.5 \cdot 10^{-10}$ J/m$^3$.

We should find now the relation between the density of the gravitons energy $\varepsilon$ and the value $W$ from (17). We will assume that there is a sphere of a radius $R$. The time of gravitons motion from the centre of the sphere outside does not exceed $t = \frac{R}{c}$. The value $W$ can be obtained by means of multiplication of the density of energy $\varepsilon$ to the sphere's volume, and the following division to the value of the full solid angle and the time $t = \frac{R}{c}$: $W = \frac{\varepsilon}{4\pi t} \cdot \frac{4\pi R^3}{3} = \frac{\varepsilon c R^2}{3}$. If we will insert $W$ from (17) and $\varepsilon < 1.5 \cdot 10^{-10}$ J/m$^3$, it will be possible to evaluate the radius of the sphere: $R \approx 5 \cdot 10^{26}$ m or about 17 Gpc. This value exceeds the distance to the most remote galaxies and is close to the size of Metagalaxy. Thus the streams of gravitons which are born by the nucleon substance of the Metagalaxy and are penetrating it can be the reason of generating gravitation of macroscopic bodies.

In spite of the relatively small value of the energy density of gravitons $\varepsilon$ originating from nucleons, the value of the graviton's energy capacity to a unit of a solid angle in the direction $W$ according to (17), and the effective energy density of gravitons $\varepsilon_e$ are sufficiently large. Distinction between $\varepsilon$ and $\varepsilon_e$ can be presented as follows. If we take some point $Q$, then the contributions to the stream of gravitons energy, which come to this point from a single solid angle, create different spheres of space, which are located at different distances from $Q$ within the given solid angle. The farther from $Q$ the sphere of space radiating gravitons is located, the earlier the radiation should be produced so that it could be summed up in the point $Q$ with the streams of gravitons from other spheres. Thus, the effect of accumulation of the capacity of gravitation energy stream can arise due to large size of the Metagalaxy. It is assumed that Metagalaxy is not in a stationary state, and the quantity of nucleon matter increases with time due to the formation of new nucleons from the smallest particles of substance.

In addition to the neutrino, electromagnetic radiation and cosmic rays of the lowest scale levels of a matter can do the contribution to gravitation. Indeed, usual and neutron stars constantly radiate photons and fast particles, and the same thing suppose to be at the level of nucleons. Now we can specify the meaning of the relation (18) in the following way: Strong gravitation produces substance in the form of nucleons and creates the streams of gravitons, electromagnetic quanta and fast particles; the full energy of nucleons is connected with strong gravitation, and the full energy of neutron stars – with common gravitation; gravitons can not press the substance denser to the condition when the gravitational binding energy of the substance would exceed the energy of the substance at rest.

The thermal heating in the massive bodies is usually connected with the release of energy in the processes of the gravitational differentiation of the substance, with the presence of the decomposed radioactive elements, with the nuclear reactions of synthesis. In cosmic bodies there are no other important internal sources of heat. Consequently, the action of gravitons in the stationary bodies does not lead to the essential additional thermal electromagnetic radiation from the bodies or the thermal motion of substance. We should assume that the energy flows of gravitons inside the bodies in general are converted so that they pass again in the energy of the flows of gravitons. Then the action of gravitons is reduced not to the constant increase in the internal energy of the body or to its heating, but rather to the transfer of momentum as to the source of pressure and gravitational stresses in the body.

Nevertheless gravitons if we consider them particles of the certain level of the matter, interact with substance, and in reactions for example of weak interaction energy is allocated. It means, that the gravitationally-connected bodies can have a stable source of heating of their substance. It is possible to assume, that allocated thermal energy per one nucleon does not exceed potential energy of gravitational binding calculated per one nucleon. The internal temperatures of cosmic bodies (the Earth and the Sun) calculated on the basis of it according to [3] are really close to their present average temperatures.

## *VI. LAW OF INERTIA*

Let us try to find the explanation to that fact that during the motion with the constant speed the bodies are not decelerated by gravitons, but continue inertial motion. We shall consider for example the formula for gravitational force (5). It contains the term $pA_0\,\chi = \frac{\sqrt{2}\,c^2}{8k}$, which is obtained in this form according to (16) and (13). This term includes the speed $c$, which we assume to be constant in the inertial reference systems. In (5) there are other products of values of the type $\rho yx$, where $\rho$ is substance density, $y$ and $x$ are transverse and longitudinal sizes of the body. During the motion of bodies with the constant speed along $x$ the value $\rho yx$ remains the same in all inertial reference systems according to the relativity theory.

The dependence of the coefficient $\chi$ on the speed, which is located in the expression $\left(1 - \frac{\chi \rho_1 y x_1}{2})\right)$, can be the possible source of deviation from the law of inertia. Thus, in (5) almost all the terms remain constant and the gravitational forces do not depend on the speed of motion with the accuracy at least to the second order by the mass, when it is necessary to consider the contribution of field's energy to the gravitational mass. In the same approximation it is possible to consider the special relativity theory also precise, since it includes the law of relativity of motion.

## *VII. ALTERNATIVE DERIVATION OF NEWTON'S FORMULA*

As can be seen from the above calculations in (1) and in subsequent relationships there are values $y$ and $\rho$. It turns out that it is possible to obtain Newton's formula for bodies' gravitation with the help of other physical variables. We should designate by $B_0$ the flow of gravitons which cross per time unit the unit area $dS$ from a unit solid angle $d\alpha$:

$$B_0 = \frac{dN_0}{dt\, d\alpha\, dS}\ .$$

We should designate the next formulae by numbers with a stroke, if they are similar by meaning with the formulae, which were mentioned earlier. We should assume that on the picture 1 the value $dS$ corresponds to the area of spherical segments, and the angle $\alpha$ we will understand as a unit angle $d\alpha$ .Then instead of (2) we will have:

$$d\alpha \cdot \left(\frac{R}{2}\right)^2 = dS\ . \qquad (2')$$

We can assume that changing of the gravitons' flow because of attenuation in the substance layer with width $dx$ is proportional to concentration $n$ of dispersing particles (which can be nucleons or atoms) and to the primary gravitons' flow:

$$dB = -B\sigma n\, dx, \qquad B = B_0 \exp(-\sigma n\, x), \qquad (1')$$

Where, $\sigma$ – a certain coefficient, which has the meaning of effective cross-section of the dispersion of gravitons in substance.

For the segments' mass on picture 1 we have instead of (3):

$$M_1 = M_n n_1 x_1 dS\ , \qquad M_2 = M_n n_2 x_2 dS\ , \qquad (3')$$

Where $M_n$ – the mass of a nucleon,
$n_1$ and $n_2$ - the values that assign concentration of nucleons in masses $M_1$ and $M_2$.

The effective force as the momentum per time unit from the flow of absorbed gravitons will equal:

$$F = p\, d\alpha\, dS\, \Delta B\ , \qquad (4')$$

Where, $p$ – the momentum of one graviton.

The force from the left side to mass $M_1$ on picture 1 taking into account (4') and (1') equals:

$$F_1 = p\, d\alpha\, dS\, (B_0 - B_1) = p\, d\alpha\, dS\, B_0 [1 - \exp(-\sigma n_1 x_1)] \approx$$
$$\approx p\, d\alpha\, dS\, B_0\, \sigma n_1 x_1 \left(1 - \frac{\sigma n_1 x_1}{2}\right). \qquad (5')$$

Changing of gravitons' flow during their propagation in space between masses $M_1$ and $M_2$ we can obtain with the formula:

$$B_{11} = B_1 \exp\left(-\sigma \int n(r)\, dr\right), \qquad (6')$$

Where, $B_1 = B_0 \exp(-\sigma n_1 x_1)$ – gravitons' flow, which have come from the left side through substance unit with mass $M_1$,

$B_{11}$ – gravitons' flow, which reached from the left side the mass $M_2$,
$n(r)$ – substance's concentration between $M_1$ and $M_2$ as the function of the coordinate $r$.

The force from the left side at $M_2$ similarly to (5') equals:

$$F_2' = p\, d\alpha\, dS\, (B_{11} - B_2') = p\, d\alpha\, dS\, B_{11}\left[1 - \exp(-\sigma n_2 x_2)\right] \approx$$
$$\approx p\, d\alpha\, dS\; B_{11}\, \sigma n_2 x_2 \left(1 - \frac{\sigma n_2 x_2}{2}\right).$$

If we substitute here with (6') and then use $B_1 = B_0 \exp(-\sigma n_1 x_1)$, for the force $F_2'$ we obtain:

$$F_2' = p\, d\alpha\, dS\, B_0\, \sigma n_2 x_2 \left(1 - \frac{\sigma n_2 x_2}{2}\right) \exp\left(-\sigma n_1 x_1 - \sigma \int n(r)\, dr\right). \qquad (7')$$

For the gravitons' flow from the left side similarly to (5') and (7') we obtain:

$$F_2 \approx p\, d\alpha\, dS\, B_0\, \sigma n_2 x_2 \left(1 - \frac{\sigma n_2 x_2}{2}\right).$$

$$F_1' = p\, d\alpha\, dS\, B_0\, \sigma n_1 x_1 \left(1 - \frac{\sigma n_1 x_1}{2}\right) \exp\left(-\sigma n_2 x_2 - \sigma \int n(r)\, dr\right).$$

The gravitation force which influences the mass $M_1$ from the side of $M_2$, equals:

$$F_{01} = F_1 - F_1' = p\, d\alpha\, dS\, B_0\, \sigma n_1 x_1 \left(1 - \frac{\sigma n_1 x_1}{2}\right) \times$$
$$\times \left(\sigma n_2 x_2 + \sigma \int n(r)\, dr\right) \left(1 - \frac{\sigma n_2 x_2 + \sigma \int n(r)\, dr}{2}\right). \qquad (8')$$

The mass $M_2$ from the side of mass $M_1$ is influenced by the force, which is equal to:

$$F_{02} = F_2 - F_2' = p\, d\alpha\, dS\, B_0\, \sigma n_2 x_2 \left(1 - \frac{\sigma n_2 x_2}{2}\right) \times$$
$$\times \left(\sigma n_1 x_1 + \sigma \int n(r)\, dr\right) \left(1 - \frac{\sigma n_1 x_1 + \sigma \int n(r)\, dr}{2}\right). \tag{9'}$$

To make it simpler we can assume, that section $\sigma$ of the interaction of gravitons with nucleon form of substance is equal for masses $M_1$ and $M_2$. From (8') and (9') we see, that forces $F_{01}$ and $F_{02}$ are not equal because of additional forces from the sources of mass which are between the bodies.

We can assume, that interacting masses $M_1$ and $M_2$ are situated in vacuum and concentration of substance $n(r)$ between them equals to 0. Then for the gravitation force between $M_1$ and $M_2$ taking into account (3') and (2'), we obtain:

$$F = \frac{\gamma M_{1g} M_{2g}}{R^2} = F_{01} = F_{02} = \frac{4 p B_0\, \sigma^2 M_1 M_2}{M_n^2 R^2} \left(1 - \frac{\sigma n_1 x_1}{2}\right) \left(1 - \frac{\sigma n_2 x_2}{2}\right), \tag{10'}$$

Here through $M_{1g}$ and $M_{2g}$ effective masses are designated, which are involved in gravitation. From (10') we obtain:

$$\gamma = \frac{4 p B_0\, \sigma^2}{M_n^2}, \qquad M_{ig} = M_i \left(1 - \frac{\sigma n_i x_i}{2}\right), \tag{11'}$$

Where index $i = 1, 2$ differentiates masses $M_1$ and $M_2$.

According to (11'), gravitational constant $\gamma$ is determined by constant values – the momentum $p$ of one graviton, gravitons' flow $B_0$, which falls per time unit from unit solid angle to unit area, square effective cross-section $\sigma$ of graviton absorption in nucleon substance, mass $M_n$ of one nucleon.

The maximum value $\sigma$ can be estimated from the condition $\sigma n x \approx 1$ for the exponents of (1'). As a result of the high substance density of neutron stars the concentration $n$ of nucleons in them reaches $10^{44}$ m$^{-3}$. If we take a triple diameter of the stars as the length of the gravitons' path $x$, that means a value about 90 km, we will obtain interaction section of gravitons in substance $\sigma < 10^{-49}$ m$^2$. This section is very small and can be compared to section for neutrino with energy about 100 eV. On the other hand, if the laws for change of flows of gravitons (1) and (1') are similar, then the corresponding members inside the exponents can be equated to one another: $\chi \rho y x = \sigma n x$. For a neutron star $\frac{\rho}{n} = M_n$, and when $y = \sqrt{2} R_s$ (where $R_s$ – the radius of the neutron star) for section in view of (14) is found: $\sigma = \sqrt{2} R_s \chi M_n = 7 \cdot 10^{-50}$ m$^2$.

The main conclusions about the effect of gravitational shielding, which were obtained above remain valid. If we add for example substance near mass $M_1$, then the force which influences mass $M_2$, will increase in the same way as mass $M_1$ increases. If substance's mass increases beyond the limits $M_1$ and $M_2$, then instead of (16) we will have:

$$F = \frac{\gamma M_{1g} M_{2g} \exp\left(-\sigma \int n(r)\, dr\right)}{R^2}. \qquad (16')$$

Equation (16') is close by its meaning to (15). It means that if in the absence of external substance masses $M_1$ and $M_2$ will move towards each other under influence of gravitational attraction, then with enough quantity of external substance it can decelerate the motion of $M_1$ and $M_2$ towards each other because of decrease of the effective force between $M_1$ and $M_2$.

In strong gravitational field if we would not expand the exponents into series in (5') – (9'), the expression for the forces will be different. For example for the force $F_{01}$ from (8') we obtain:

$$F_{01} = p\, d\alpha\, dS\, B_0 \left[1 - \exp(-\sigma n_1 x_1)\right]\left[1 - \exp(-\sigma n_2 x_2)\right].$$

With high concentration of substance $n_1$ and $n_2$ for two interacting masses, for example for two identical close neutron stars contribution from exponents becomes rather small and it can be not taken into account as first approximation. In this case, taking into account (2') and (11') for the maximum force we obtain:

$$F_m = p\, d\alpha\, dS\, B_0 \approx \frac{\gamma M_n^2 \Delta S^2}{\sigma^2 R^2}, \qquad \text{and} \quad F_m = \frac{\gamma M_s^2}{R^2},$$

Where $M_s$ – the mass of neutron star,
$R$ – the distance between star's centers.

It follows that $\frac{M_s}{M_n} \approx \frac{\Delta S}{\sigma}$. But relation of the mass of neutron star to the nucleon's mass is the similarity coefficient $\Phi = 1.68 \cdot 10^{57}$ in mass between star and nucleon levels of matter according to [3]. If we take as $\Delta S$ the section of a neutron star and divide it by the value of the section of gravitons' interaction with substance $\sigma < 10^{-49}$ m², then we will obtain the value close to $\Phi$.

On the other hand as force $F_m$ we can understand the force of maximum gravitational interaction of two nucleons. In this case $R \approx 2R_n$, where $R_n$ – nucleon's radius, $\Delta S \approx \pi R_n^2$. For the force we obtain:

$$F_m \approx \frac{\gamma M_n^2 \pi^2 R_n^4}{4\sigma^2 R_n^2} = \frac{\Gamma M_n^2}{4R_n^2},$$

Where $\Gamma$ – the constant of strong gravitation.

According to [3], the constant $\Gamma$ can be obtained from the condition of equality of gravitational and electrical forces between a proton and an electron at the Bohr radius in hydrogen atom. It is determined by the expression $\Gamma = \frac{e^2}{4\pi\varepsilon_0 M_p M_e} = 1.514\cdot 10^{29}$ m$^3$·kg $^{-1}$·s$^{-2}$, where $e$ and $M_e$ – electron's charge and mass, $M_p$ – proton's mass, $\varepsilon_0$ – vacuum permittivity. At the same time, as it is shown in [3], with the help of the constant $\Gamma$ the full energy of nucleon can be calculated, which is equal to its energy at rest.

From the expression for the force $F_m$ it follows that it should be $\Gamma \approx \frac{\gamma\,\pi^2 R_n^4}{\sigma^2}$. Substituting here the value of gravitational constant $\gamma$, nucleon's radius about $R_n = 8.7\cdot 10^{-16}$ m, section $\sigma < 10^{-49}$ m$^2$, we obtain the value close to $\Gamma$. We should notice that the force between two nucleons is rather big. In [3] it is shown, that the force in atomic nuclei can be balanced by electromagnetic forces and by the force from strong gravitational torsion field $\boldsymbol{\Omega}$ (see (19) and after it).

With the help of (11') we can evaluate the capacity of the flow of gravitons' energy through unit area from unit solid angle:

$$U = pcB_0 = \frac{\gamma c M_n^2}{4\sigma^2} > 10^{42}\ \text{W/(st·m}^2\text{)}, \tag{17'}$$

When $c$ is taken equal to light speed.

If we divide (17') by speed $c$ and multiply it by the full solid angle $4\pi$, we will obtain the maximum possible energy in volume unit, which is delivered by graviton's to this volume. This value equals the maximum gravitational pressure from gravitons: $P_G = 4\pi pB_0 > 4\cdot 10^{34}$ Pa. In common models of neutron stars the pressure in substance is one order less, probably because the substantial part of gravitons comes through them without interaction with transmitting force impulse. But in nucleons the density of substance and its pressure one order exceeds the corresponding values in neutron stars. Then pressure $P_G$ from gravitons could be almost enough for maintaining the integrity of nucleons. On the other hand, if gravitons like neutrino, photons and relativistic particles are generated by nucleons, their energy would not be enough for gravitational binding of the nucleon's substance. Hence the conclusion about necessity of existence gravitons of deeper levels of matter, with even greater density of energy from here follows.

Based on the section of graviton's interaction with the substance we can assume that gravitons are for example neutrino with energy $E_\nu = pc = 100$ eV $= 1.6\cdot 10^{-17}$ J. Then we can obtain the momentum $p$, and with its help the flow of gravitons $B_0 = \frac{U}{E_\nu} \approx 10^{59}$ s$^{-1}$st$^{-1}$m$^{-2}$ is determined from (17').

We should find now the capacity of energy generation in gravitationally bound bodies. With the help of (1') from (17') we have:

$$\frac{dE_G}{dt} = \Delta\alpha\,\Delta S\,\Delta U = \Delta\alpha\,\Delta S\,pc\,\Delta B = \Delta\alpha\,\Delta S\,pcB_0\,\sigma n\,x = \Delta\alpha\,\Delta S\,U\sigma n\,x\,.$$

We should use (3') in the form $nx\Delta S = \frac{M}{M_n}$, with condition $\Delta\alpha = 4\pi$ for the full solid angle, and also disclose $U$ with the help (17'). Finally, for the stars with $M = M_s$ we should use the condition obtained above $\frac{M_s}{M_n} \approx \frac{\Delta S}{\sigma}$, substituting $\Delta S = \pi R^2$, where $R$ – the star's radius. The result is the following:

$$\frac{dE_G}{dt} = \frac{4\pi U\,\sigma M}{M_n} = \frac{\pi\gamma M M_n c}{\sigma} = \frac{\pi\gamma M^2 c}{\Delta S} = \frac{\gamma M^2 c}{R^2} \approx \frac{E_G}{R/c}\,. \qquad (18')$$

From (18′) it follows that the capacity of generation of gravitational energy in bodies is approximately equal to gravitational energy of the body, which is radiated during the time of gravitons' passing the radius of the body: $t = R/c$. Gravitational energy of the nucleons' binding is almost equal to its energy at rest, that is why (18′) applied to nucleons (substituting $\gamma$ by $\Gamma$) coincides with (18) for maximum gravitation energy.

## *VIII. THE INERTIAL FORCE*

As it is known, during acceleration all bodies have resistance, which is called the inertial force. Let the body of the constant mass be accelerated rectilinearly by a certain force $\boldsymbol{F}$. If at the given moment the velocity of the body is $\mathbf{v}(t)$, then for changing of the energy of the body it is possible to write down:

$$\frac{dE}{dt} = \boldsymbol{F}\cdot\mathbf{v}(t)\,, \qquad \text{where} \qquad E = \frac{Mc^2}{\sqrt{1-\mathbf{v}^2(t)/c^2}}\,.$$

Differentiating energy by the time, we should express the force through the acceleration:

$$\boldsymbol{F} = \frac{M}{\left(1-\mathbf{v}^2(t)/c^2\right)^{1,5}}\frac{d\,\mathbf{v}(t)}{dt}\,.$$

Before the acceleration $\frac{d\,\mathbf{v}(t)}{dt}$ there is the so-called longitudinal mass. The obtained force must be equal to the inertial force according to the third Newton's law about the equality of the action and reaction forces. However, what is the reason of the inertial force, why do bodies resist a change in their velocity? Based on what was stated earlier, the action of the flows of gravitons must be the reason of the inertial forces. Firstly, the gravitons are responsible for the gravitational energy and the rest energy of the bodies at the nucleon level, and consequently the change in energy as the result of the change in bodies' motion must be connected with gravitons.

Secondly, with the constant speed of motion the inertial force is not observed, but it appears with the acceleration of bodies. Consequently, with the acceleration the work towards the body is done, simultaneously the body does work against the flows of gravitons. It is possible to consider that regardless of the form of the work done to the body, this work is done to the flows of gravitons, passing through the body.

## *IX. THE RELATIVITY OF MOTION*

We should consider the situation, when two bodies with mass $M_1$ and $M_2$ are located on a straight line along the vertical axis $OY$, and are moving with the constant speed in horizontal direction along the axis $OX$ of the reference system *K.* We will assume that in the reference system $K'$, where the both bodies are at rest, the axes $OX', OY', OZ'$ are parallel to the axes $OX, OY, OZ$ of the reference system *K.* In $K'$ there is attraction between the bodies due to the mutual shielding of gravitons' flows. But how will gravitational interaction proceed during the simultaneous motion of these bodies from the point of view of a motionless observer in *K*?

Firstly, for calculation of the forces the concept of the delay of gravitational effect due to the limited speed of gravity propagation should be used. In the case in question, the condition of equality of the time must be met: as the mass $M_1$ passes the way $\Delta x$ with the speed $\mathrm{v}$, the flow of gravitons from the mass $M_2$ is moving towards the mass $M_1$ with the speed $c$. This can be expressed in the following way: $t = \frac{\Delta x}{\mathrm{v}} = \frac{\sqrt{(\Delta x)^2 + y^2}}{c}$, where $y$ – the distance between the masses. Secondly, for an observer in *K* it seems that since the gravitons from the mass $M_2$ are moving, as if overtaking the mass $M_1$, their momentum is not directed strictly along the axis $OY$. Then a force should appear, which would decelerate the motion of $M_1$ along the axis $OX$. The same can be said about deceleration of the mass $M_2$. However, the direction of force between $M_1$ and $M_2$ must not change in the reference system $K'$, since the masses are moving with the constant speed at the constant distance from each other.

In order to avoid the contradiction, we should consider that if the masses $M_2$ and $M_1$, move with the speed $\mathrm{v}$, the flow of gravitons interacting with the masses has the component of speed, also equal to $\mathrm{v}$ and directed along the axis $OX$. The combined speed of gravitons in the reference system *K* must equal $c$, therefore the speed of gravitons along the axis $OY$ must be less than $c$ and must equal $c_y$. Consequently, $c_x = \mathrm{v} = \sqrt{c^2 - c_y^2}$. For transformation of gravitons' speed in different reference systems we should use vector formula of speed summation from relativity theory:

$$\boldsymbol{V}' = \frac{d\boldsymbol{r}'}{dt'} = \frac{\boldsymbol{V} + \left( \frac{(\beta - 1)\,(\boldsymbol{V_0} \cdot \boldsymbol{V})}{V_0^2} - \beta \right) \cdot \boldsymbol{V_0}}{\beta \left( 1 - \frac{\boldsymbol{V_0} \cdot \boldsymbol{V}}{c^2} \right)},$$

Here, $\boldsymbol{V}'$ – the speed of any object in the reference system $K'$,
$\boldsymbol{V}$ – the speed of the given object in the reference system $K$,
$\boldsymbol{V_0}$ – the speed of moving of reference system $K'$ along $K$,
$\beta = \frac{1}{\sqrt{1 - V_0^2/c^2}}$.

We obtain $V_x = c_x = \mathrm{v}$, $V_y = c_y$, $V_{0x} = \mathrm{v}$, $V_{0y} = 0$. From the speed summation formula we obtain: $V'_x = 0$, $V'_y = \frac{c_y}{\sqrt{1 - \mathrm{v}^2/c^2}} = c$. From the point of view of the second observer, who is located at the moving mass $M_1$, the flow of gravitons which falls on it from the mass $M_2$ is directed along the axis $OY'$ only. Therefore, there will be no deceleration of masses along the axes $OX$ and $OX'$. In case of parallel motion of two masses $M_2$ and $M_1$ along the axis $OX$ it follows from the calculation [3] for the gravitation force's module in reference systems $K'$ and $K$: $F' = \frac{\gamma M_1 M_2}{y^2}$, $F = \frac{\gamma M_1 M_2 \sqrt{1 - \mathrm{v}^2/c^2}}{y^2}$, where $y$ – the distance between the masses along the axis $OY$. At the same time for an observer in the reference system $K$ the force $F$ between the masses is reducing as the speed $\mathrm{v}$ of masses' motion is increasing. It conforms to the fact that the effective speed of gravitons along the axis $OY$ for the moving masses is also reducing: $c_y = \sqrt{c^2 - \mathrm{v}^2} = c\sqrt{1 - \mathrm{v}^2/c^2}$.

### *X. GRAVITONS AND THE RELATIVITY THEORY*

Above the relativity of motion was shown, where speed is transformed according to the formula of speed summation in the relativity theory. In the special relativity theory we should consider the retardation of gravitational influence not simply from a moving mass point, but from the body which is limited by its size. This makes such a correction into the potential of gravitational field, which in the result leads to the Lorentz transformation of coordinates. In this case the gravitational force between two moving bodies, calculated through the potential gradient, has deficiency in force. If analogous deficiency in electric force is compensated by the magnetic force, as it occurs in electromagnetism, then in gravitation an additional force from the torsion should be introduced.

In the Lorentz-invariant Theory of Gravitation (LITG) the equations for the field strengths have the form [3], [5]:

$$\nabla \cdot \boldsymbol{G} = -4\pi\gamma\rho, \qquad \nabla \cdot \boldsymbol{\Omega} = 0,$$

$$\nabla \times \boldsymbol{G} = -\frac{\partial \boldsymbol{\Omega}}{\partial t}, \qquad c_g^2 \nabla \times \boldsymbol{\Omega} = -4\pi\gamma \boldsymbol{J} + \frac{\partial \boldsymbol{G}}{\partial t}, \tag{19}$$

Where the vectors $\boldsymbol{G}$ and $\boldsymbol{\Omega}$ – the strength of the gravitational field (gravitational acceleration) and the torsion respectively,
$\boldsymbol{J}$ – the vector of the density of the mass flow,
$c_g$ – the speed of gravitation propagation.

The gravitational force, which acts on the mass $m$, is determined by the expression: $\boldsymbol{F} = m\boldsymbol{G} + m\boldsymbol{V} \times \boldsymbol{\Omega}$, where $\boldsymbol{V}$ – the velocity of the motion of mass.
The vectors $\boldsymbol{G}$ and $\boldsymbol{\Omega}$ can be expressed with the help of the scalar $\psi$ and the vector $\boldsymbol{D}$ potentials of the gravitational field:

$$\boldsymbol{G} = -\nabla \psi - \frac{\partial \boldsymbol{D}}{\partial t}, \qquad \boldsymbol{\Omega} = \nabla \times \boldsymbol{D}. \tag{20}$$

With the potentials of the field it is possible to compose the 4-vector of the potential $D_i$:

$$D_i = \left( \frac{\psi}{c_g}, -\boldsymbol{D} \right).$$

We should also use 4-vector of the momentum density:

$$J_i = \rho_0 u_i = \left( \frac{\rho_0 c_g}{\sqrt{1 - V^2/c_g^2}}, -\frac{\rho_0 \boldsymbol{V}}{\sqrt{1 - V^2/c_g^2}} \right) = \left( \rho c_g, -\boldsymbol{J} \right).$$

It follows from (19) and (20) that the action of four-dimensional d'Alembertian on the 4-vector of the potential gives the vector, proportional to the 4-vector $J_i$:

$$\Box^2 D_i = \frac{1}{c_g^2} \frac{\partial^2 D_i}{\partial t^2} - \nabla^2 D_i = -\frac{4\pi\gamma}{c_g^2} J_i. \tag{21}$$

Equation (21) is a wave equation for the potentials. We should say that if we move from the General Theory of Relativity (GTR) to weak gravitational fields by expanding the equations for the metric to the first order, then exactly the equations of LITG (19) are obtained. This is shown, for example, in [6] and [7], when the shielding effect of the gravitational field was searched for. Thus, the concept of gravitons will be conform to LITG, and gravitational forces do not require their substantiation through GTR. In this case, what role does GTR play in respect of the gravity from the point of view LITG?

The special relativity theory revealed the dependence of phenomena and the results of time-spatial measurements on the speed of the motion of reference systems, taken with respect to the speed of light. GTR makes the following step – it takes into account the fact that the mass-energy of the substance and the fields existing in the space influences the course of time and the measured lengths. Such influence is accompanied by a change in the speed of the electromagnetic waves (of the light), used as well in the measuring instruments.

In LITG gravitational field is an independent physical field. Therefore for the correct use of GTR (or the corresponding metric theory) it is necessary preliminarily to take the tensor of the energy-momentum of gravitational field, determined in LITG by covariant means. After this, knowing all the components of the tensors of the energy-momentum of matter, electromagnetic and gravitational fields, it is possible to substitute them in the equations for the metric.

The obtained solution in the form of components for the metric tensor, cross-linked on the boundaries between the substance and the empty space, where only the field is present, determines the degree of difference in the metric of the noninertial system in question from the inertial reference system. The metric field, which consists of the components of metric tensor and which depends on the time and the coordinates of the point, where it is determined, will be derived as summary effect from the existing density of substance, pressure in it, the state of the motion of this substance (speed, acceleration), and also from the existing gravitational and electromagnetic fields and other possible sources of energy-momentum.

The calculations, made in the book [3] with respect to the contribution of energy of gravitational field to the metric, showed that the additive has a second-order value and contains terms with the fourth power of the speed of field propagation. The growing accuracy of gravitational experiments will probably make it possible in the near future to verify the presence of the corrections indicated. In the described approach the metric field can no longer be considered the field of gravitation. At the same time the known problem with covariance of the tensor of energy of gravitational field in GTR is solved, as this tensor is present in the covariant form in LITG.

## *XI. CONCLUSION*

Taking into account what was stated above the following picture appears: the flows of gravitons from all sides penetrate the bodies almost without the loss of their total momentum. As the result of the effect of mutual shielding and interaction of gravitons with the substance all bodies have attraction to each other. Interaction of gravitons with the substance occurs in the way that the bodies are constantly obtaining and returning the energy, equal to their binding gravitational energy. In the static case, the situation reminds the phenomenon of almost perfect mirror reflection of light when the mirror is under pressure from the radiation, but the energy is transferred to the mirror only in a small degree. Similarly, all bodies have a gravitational pressure, but gravitation does not lead to significant heating of these bodies s.

In our opinion, gravitons are numerous particles of a very small size, which move with the speed close to the speed of light and which are similar to low energy neutrinos. Then the integrity of all material objects is the consequence of the balance of forces of gravity and internal forces from the pressure (motion) of the particles, which compose these objects. From the proportionality of gravity forces to the mass of bodies it follows that the gravitational mass reflects the ability of the body to obtain impulse of force from the gravitons. According to General Theory of Relativity, the mass is determined not only by the quantity of particles in the body, but also by the nature of their interaction or by full (summary) energy. If the gravitons are more or less evenly distributed in the space and are the characteristic property of matter, then this makes it possible to connect the global and the local, inert and gravitational masses in the somewhat altered Mach principle: “The accelerations of bodies during interactions are determined not only by the bodies themselves (their masses), but also by the properties of their environment”.

In assumption that gravitons are the smallest relativistic particles, we can make conclusions with the help of the theory of infinite hierarchical nesting of matter [8]. At every level of matter either nucleon or star level the most dense and gravitationally bound objects generate in different processes their own flows of gravitons. Then there is a whole range of gravitons of different energy and density levels which contribute to gravitation. As it has been shown above, all volume of the Metagalaxy participates in creation of flows of gravitons. We can assume that common gravitation is generated by relativistic particles from nucleon form of substance. Reasoning by induction we should assume that the nucleons appear under influence of relativistic particles of deeper level of matter. Besides we see that flows of neutrino or gravitons of higher levels of matter consist of flows of neutrino and gravitons of lower levels of matter. Actually, neutrino impulse of a neutron star in any of transformations of its substance is combined flow of neutrino and antineutrino from star’s nucleons. As during the motion downward by scale levels of matter the density of energy of the corresponding objects increases, then similarly the density of gravitons’ energy and the force of gravitation must also increase.

We can estimate density of energy of flows gravitons for the metagalactic level of matter which as exceeds the star level of matter as the star level exceeds the nuclear level. According to the theory of similarity, the ratio of energy density is connected with factors of similarity: $\frac{\varepsilon_m}{\varepsilon} = \frac{\Phi S'^2}{P^3}$, where $S' = 0.18$ is the factor of similarity in the speeds, $P$ – the factor of similarity in the sizes according to [3]. Substituting here $\varepsilon < 1.5 \cdot 10^{-10}$ J/m$^3$, $P = \frac{R_s}{R_n} = 2.26 \cdot 10^{19}$, $\Phi = 1.68 \cdot 10^{57}$, we find $\varepsilon_m < 7 \cdot 10^{-13}$ J/m$^3$. As gravitation at some level of matter is caused by gravitons flows of lowest level of matter it is necessary to compare $\varepsilon_m$ to density of energy of possible sources of gravitons, existing at the star level matter.

Well-known sources are the microwave background radiation with the energy density of order $4.18 \cdot 10^{-14}$ J/m$^3$, light radiation of stars with the energy density of about $8 \cdot 10^{-13}$ J/m$^3$, and cosmic rays, providing approximately $1.3 \cdot 10^{-13}$ J/m$^3$. Thus, the gravitons for metagalactic level of matter may be flows of photons, neutrinos and relativistic particles, mostly protons of high energy. From here follows, that usual gravitation at the level of planets and stars has sources of gravitons, belonging lower level, than nucleon-atomic level of matter.

It would be natural to call isotropic such reference system where all flows of gravitons are distributed isotropically in space evenly in all directions. In such reference system on condition of infinite smallness of the system’s mass, the gravitons’ flows become homogeneous, equal in all points of the reference system. Then the gravitational acceleration in the system tends to zero, and the isotropic reference system becomes inertial. Due to the inertia law such systems which move with the constant speed in relation to the isotropic reference system will be inertial too. But the isotropic reference system does not preset the absolute space according to Newton, as in space the gravitons’ flows can not be homogeneous and in every point there is its own isotropic reference system.

The existence of an isotropic reference system is one of the axioms in the extended special relativity theory (ESRT), presented in [9]. As it appears, the formulas of the special relativity theory can be derived from two main postulates – the relativity principle and the existence of isotropic reference system. One of the results of ESRT was the principle of light speed constancy in inertial reference systems. This principle could not be proven earlier and was considered to be an axiom of the relativity theory.

From the point of view of the concept of gravitons it is possible to determine the difference between the passive and the active gravitational masses, which differ also from the mass, determined from the measurements through the density and the volume. The analysis of the predicted effect of gravitational shielding proves to be true for the case, when the substance screens the bodies from the outside.

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