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REVIEW ARTICLE

Quantum Theory of Gravity and Arthur Eddington's Fundamental Theory

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ABSTRACT

For the first time, the article presents the Quantum Theory of Gravity, covering not only the microcosm of elementary particles, but also the macrocosm of planets, stars and black holes. This relational approach to gravity was consistently presented in Arthur Eddington's monograph "Fundamental Theory". In the theory of quantum gravity proposes to consider instead of gravity holes in the curved space-time of Einstein's general relativity, gravitational funnels formed by the rotation of planets, stars and galaxies in a dark matter halo. The change in the gravitational potential in the funnels occurs instantly in all areas of the gravitational funnel space in accordance with the pressure gradient described by the Euler-Bernoulli equation for superfluid continuous media. The new cosmological theory represents the evolution of the universe and dark holes without a singularity. The disordered alternation of the processes of contraction and expansion of individual regions of the infinite Universe realizes the circulation of baryonic and dark matter, which allows it to exist indefinitely, bypassing the state of equilibrium. Numerical modeling allows us to assert that the theory of quantum gravity is the most reliable of the three generally accepted theories of gravity.

INTRODUCTION

Relativistic invariance, which is based on subjective space-time representations, does not agree with quantum-mechanical nonlocality, which has an objective character. This reveals a deep internal contradiction of the unified quantum-relativistic field theory, leading to insurmountable difficulties in solving the problem of the quantum theory of gravity, unified theories and the derivation of representations of space and time from the physics of the microworld. Perhaps the absence of a quantum theory of gravity is due to the fact that specialists in the field of quantum field theory paid main attention to the mathematical formalism. Numerous versions of string theory are also at a dead end, primarily because they are based on Einstein's SRT and GRT and frozen time [1]. Within the framework of the new quantum theory, the gravitational interaction between bodies can be considered as an exclusively quantum effect. Such an approach to gravity was laid down by the Mach principle - "a statement covering three types of questions: The existence of space and time is inextricably linked with the existence of physical bodies. Removal of all physical bodies ceases to exist space and time. The reason for the existence of inertial reference frames is the presence of distant cosmic masses. The inert properties of each physical body are determined by all other physical bodies in the Universe and depend on their location".

Eddington's Fundamental Theory-The Basis for a Unified Theory of Quantum Gravity

The last work of the outstanding English physicist and philosopher Arthur Eddington, which he called "Fundamental Theory"[2], remained incomplete due to the death of the author in 1944. Thanks to the participation of his colleagues, the book was published in 1946. The fate of the book is mysterious and dramatic, it is pursued by a conspiracy of silence, there are practically no references to it in the scientific literature, and her never were not translated into Russian.

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Eddington's "Fundamental Theory" was the basis on which Arthur Eddington created a unified theory of quantum gravity and electromagnetism, made the hidden dimensions of T. Kalutsa's five-dimensional world explicit and overcame the contradictions and limitations of Einstein's general theory of relativity in fundamental issues of cosmology. A. Eddington believed that the construction of a macroscopic theory of space-time is possible only when taking into account the impact on the studied object of its entire environment, or, in modern language, adhered to a relational understanding of the world. He wrote: "It is useless to investigate an atom without its environment. We cannot recognize the concept of the atom as a thing in itself." This statement is entirely consistent with Mach's principle. From the point of view of the new theory, gravitational interaction can be regarded as a quantum effect. Near a large mass, the uncertainty in the motion of an electron (or other particle) decreases, as a result of which the electron moves towards a large mass. The proposed mechanism of gravitational interaction explains why all bodies attract each other. In "Fundamental Theory" Eddington tried to constructively implement the idea of deriving the classical concepts of length and time from the physics of the microworld [2]. The elementary particles themselves are endowed with three basic parameters: spin, charge and mass. To describe their space, the metric ħ, e, m is used, while the spin is measured in units of the Planck constant and is equal to Jħ, where J is an integer (including zero) or half-integer positive number characteristic of each type of particle. It is called the spin quantum number it is the proper angular momentum of elementary particles (degree of freedom). Among the physical attributes of elementary particles, there is no speed of light, since for each specific particle the speed is a derived attribute. For example ultra-light neutrinos in the form of particles of "hot dark matter" can propagate with superluminal speed [3]. Later, in lectures on gravity, Feynman also expressed the idea that, perhaps, the natural space-time scale, that is, the scale expressed in terms of c, ħ, m (here m is the rest mass of an electron or some other particle), is determined distribution of all masses in the Universe, and, therefore, changes slightly near a large mass. Based on the equations of the general theory of relativity, Feynman tried to guess how the space-time scale should depend on the distribution of all masses in the Universe, in order to eventually arrive at the equations of the general theory of relativity. But his attempt failed. Thus, the main drawback of general relativity from the point of view of quantum mechanics is as follows. In the framework of the general theory of relativity, time is considered as an independent physical quantity, completely independent of the course of specific physical processes. A similar disadvantage of the general theory of relativity is also the fact that it considers distance as an independent physical quantity, completely independent of real physical objects. The above deficiency of the general theory of relativity was already quite clear to Einstein. Here is what he wrote about this in his autobiography: "Let us now make a critical remark about the theory as it is described above. It can be noted that the theory introduces (in addition to four-dimensional space) two kinds of physical objects, namely: 1) length and time, 2) everything else, for example, an electromagnetic field, a material point, and etc. This is illogical in a sense; in fact, the theory of scales and clocks should be derived from the solutions of the basic equations (given that these objects have an atomic structure and move), and not consider it independent of them. This sin cannot be legitimized to such an extent as to allow, for example, using the concept of distance as a physical entity of a special kind, significantly different from other physical quantities (to reduce physics to geometry, etc.)" [4].

If in Euclidean space the metric has the form $ds^2 = dx^2 + dy^2 + dz^2$, then in GR the metric has the form [5]:

$$ds^2 = c^2dt^2 - \left(dx^2 + dy^2 + dz^2\right) \quad (1)$$

where c is the speed of light;

t is time;

x, y, z is coordinates in Euclidean space.

Stephen Hawking suggested introducing the imaginary time $\tau = ict$ into the GRT metric and for imaginary time c^2dt^2 becomes $-d^2\tau$. In this case, the differences between time and space disappear in the interval ds^2 of the GRT metric [6]. This is frozen time.

Lee Smolin - American theoretical physicist, lecturer at the Perimeter Institute for Theoretical Physics, associate professor of physics at the University of Waterloo, proposed to unfreeze the time that appears in Einstein's SRT and GRT. Lee Smolin writes: "We must find a way to unfreeze time - to imagine time without turning it into space. I have no idea how to do this. I cannot imagine mathematics that cannot imagine the world as if it were frozen in eternity" [1]. Only complex time, consisting of imaginary cyclical time and real cosmological time ("Eddington's time arrow"), in a space consisting of a base and a layer, offers the researcher a way to unfreeze time and turn to the modern apparatus of projective geometry to describe evolutionary processes in the Universe [7]. In 1955. M. Bunge introduced the complex time Te into the theory of the electron

$$Te = (t + i\tau) \quad (2)$$

where t is the lifetime of an electron in a given orbit ("Eddington's time arrow"),

τ is the imaginary cyclic time, equal to an electron spin period ($\tau=h/4\pi mc^2$, $\tau = 10^{-21}$s.)

Arthur Eddington, 70 years ahead of his time, responded to Lee Smolin's call to unfreeze time. The Eddington uranoid is the environment of the object under study (the entire Universe consisting of elementary particles) contains, in addition to four dimensions of the Minkovsky continuum (x1, x2, x3, t), the fifth is the time coordinate t0, directed perpendicular to the axes of the continuum ("Eddington's arrow of time"):

$$X = E15\ ix1 + E25\ ix2 + E35\ ix3 + E45\ t + E05\ t0, \quad (3)$$

where, "according to the conditions of reality, t0 must be real" [2].

In the 20th century, many scientists including Albert Einstein undertook repeated unsuccessful efforts to unite gravitation and electromagnetism geometrically in the framework of four dimensions of Minkowski continuum, and only T.Kaluza has managed to do it, but in the five-dimensional formal world of four spatial dimensions and one-time dimension. Arthur Eddington in his last work, having turned to the consideration of the five-dimensional world formed by three spatial dimensions and two time dimensions, managed to unite gravity and electromagnetism based on the nature of elementary particles and the characteristics of the environment (Uranoid), including its electroneutrality and equality of particles with opposite charges and left and right polarization. The fifth component of the particle velocity has the physical meaning of the ratio of the electric charge q to the mass m of the particle. The fifth equation of the geodesic line means a constant q / m ratio for the current state of the planets in the solar system (current time horizon). It is even true that the momentum of particles in the fifth coordinate is an electric charge [8]. Spatial and temporal diversity of different dimensions different properties introduced into these discrete transformations P-space conversion, the conversion time T and C charge conjugation. The 5-dimensional manifold instead of the square of the 4-dimensional interval $ds^2 = g_{\alpha\beta}\, dx^a dx^\beta$ should take $dI^2 = GAB\ dx^A\ dx^B$, where the indices A and B have the meanings: 0,1,2,3,5.

GAB values are components of the five-dimensional metric tensor. They form a square matrix having a generally 15 independent components:

$$GAB = \begin{matrix} G00\ G01\ G02\ G03\ G05 \\ G00\ G01\ G02\ G03\ G05 \\ G10\ G11\ G12\ G13\ G15 \\ G20\ G21\ G22\ G23\ G25 \\ G30\ G31\ G32\ G33\ G35 \\ G50\ G51\ G52\ G53\ G55 \end{matrix} \quad (4)$$

In the curved Riemannian space-time, operating with the components of five-dimensional metric tensor, one can obtain ten components of metric tensor of the Einstein's general theory of relativity, four components of electromagnetic vector potential Ā of the Maxwell theory, and one component which theoretically can describe any new scalar field [8]. The new scalar field may belong to a hypothetical particle of dark matter the protophobic X boson, which, like the Higgs boson, creates the scalar field responsible for the fifth interaction between dark matter and ordinary (baryonic) matter.

Quantum gravity in cosmology

In the new cosmological model, the quantum vacuum is understood as a superfluid heterogeneous medium of dark energy and dark matter forming the galactic and intergalactic environment, which account for 95% of the average density of matter in the universe [9]. In this case, ordinary baryonic matter accounts for only about 5%. Under these conditions, I propose a new interpretation of recent astrophysical discoveries within the framework of a new theory of quantum gravity. In this theory, gravitational funnels around planets, stars and galaxies are formed as a result of the rotation of dark matter halos together with celestial bodies [10]. The last discovery by astrophysicists of the rotation of space-time around a white dwarf in the PSR J1141-6545 binary star system is my statement [11]. Pulsar is located 10,000 - 25,000 light-years from Earth in the constellation Muska (fly), which is located near the famous constellation of the Southern Cross. PSR J1141-6545 surrounds a white dwarf with a mass roughly equal to that of the Sun White dwarfs are the superdense cores of dead Earth-sized stars that are left behind after medium-sized stars have exhausted their fuel and lost their outer layers. A rapidly rotating white dwarf pulling dark matter caused the pulsar's orbit to gradually change its orientation (Figure 1).

This prediction is a phenomenon known as frame dragging, or the Tearing effect. It says that space-time will revolve around a massive rotating body, although, of course, it is not space-time that revolves, but a sphere of dark matter along with a star. Satellite experiments have revealed dragging and dropping frames in the gravitational field of a rotating Earth, but the effect is extremely small and therefore difficult to measure. Objects with stronger gravitational fields, such as white dwarfs and neutron stars, offer a better chance of seeing this phenomenon. The lead author of the study is Vivek Venkatraman Krishnan, an astrophysicist at the Institute of Radio Astronomy. Max Planck in Bonn, Germany, said the researchers measured when pulses from the pulsar hit Earth to within 100 microseconds for nearly 20 years using the Parkes and UTMOST radio telescopes in Australia. This allowed them to detect long term drift. The rapid rotation of the white dwarf in space-time caused the pulsar's orbit to slowly change its orientation over time. Scientists have detailed their findings in the journal Science [11].

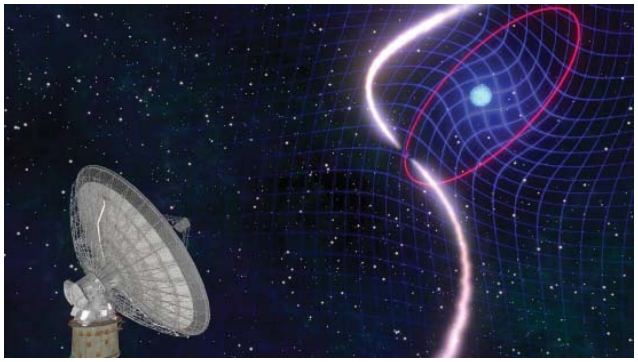

Figure 1 The illustration of Lense-Thirring frame-dragging resulting from a rotating white dwarf in the PSR J1141-6545 binary star system.

Today observational astronomy has established the presence of dark matter halos, which form spheres around galaxies, stars and planets and rotate with them. The research is published in the journal Nature. It is known that the share of ordinary, visible matter, of which everything that can be observed in the Universe consists of, is only 5%. Until now, it has not been possible to find about half of this share. A team of scientists led by Dominique Eckert from the University of Geneva in Switzerland found out where she disappeared. In their study, they used data obtained using the orbiting telescope XMM-Newton while observing the galaxy cluster Abell 2744, known as the "Pandora Cluster" [12] (Figure 2).

The presence of a sphere formed by dark matter near the Sun can explain the strange acceleration noted by American scientists when the automatic interplanetary stations Pioneer 10 and Pioneer 11 moved away from the Sun at a distance of more than 20 AU. When the effects of solar radiation have practically disappeared. The halo of dark matter allowed researchers to change Newton's law of gravity and propose a new formula for the calculation. Now, when calculating the motion of a spacecraft according to Newton's law of gravitation, it is necessary to take into account the additional variable mass of dark matter, which forms a sphere around the Sun. experiments. When the spacecraft leaves the solar system, the position of the center of gravity in the Sun - sphere of dark matter system will constantly shift in accordance with the flight of the spacecraft due to the displacement of dark matter [13]:

$$F = G\frac{(M_o + Md)m}{R^2} \qquad (5)$$

where M_o is the mass of the Sun,

Md is variable mass of dark matter in near-solar space,

m is the mass of the spacecraft,

R is the distance between the ship and the center of gravity of the system.

Pioneer 10 and 11 were launched in the early 1970s and explored the outer solar system. But in 1980, mission scientists noticed that spacecrafts have unexpectedly drifted off course. Both spaceships experienced a slightly stronger force of attraction to the sun than expected, and since their launch, they have drifted off course by hundreds of thousands kilometer. Coherent radio Doppler data generated by the Deep Space Network with the Pioneer 10 and 11 spacecraft show an anomalous, constant, frequency drift that can be interpreted as an acceleration directed towards the Sun of magnitude $(8.74 \pm 1.33) \times 10^{-10}$ m·s^{-2} at distances between 20 and 70 AU (Anderson et al., Phys. ... Rev. D 65, 082004).

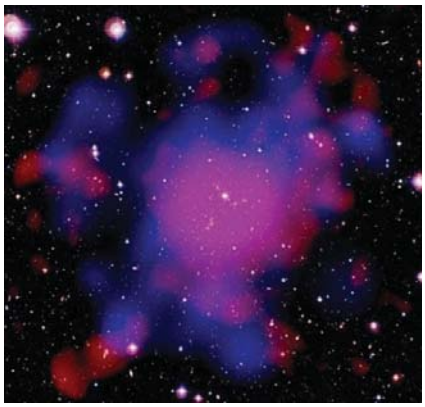

Figure 2 Components of the cluster of galaxies Abell 2744. White color - galaxies, red color-hot gas and blue color-dark matter.

In contrast to the "geometric" concept of gravity, the theory of quantum gravity allows you to describe the gravitational interactions of bodies in a similar way to the electrical and magnetic interactions. In this case, gravitational fields should have properties similar, but not identical to the properties of electromagnetic fields. The theory of quantum gravity does not contradict other experimentally substantiated approaches to describing the phenomenon of gravitation and inertia, in particular, for example, some models involving a quantum vacuum (dark matter) [14]. In this case, the nature of the gravity pit, described by the speculative curvature of the space-time of Einstein's general theory of relativity, can be replaced by a gravitational funnel created in the cosmic environment (dark matter) around a rotating celestial body of astronomical size [7] (Figure 3).

In this case, the nature of gravitational funnel, described by the speculative curvature of space-time of Einstein's general relativity, can be replaced by a gravitational funnel created in a space environment (dark matter) around rotating heavenly body of astronomical dimensions. The change in the gravitational potential occurs instantaneously in all regions of the gravitational funnel space in accordance with the pressure gradient described by Euler's-Bernoulli's equation for superfluid continuous media:

$$\frac{\partial v}{\partial t} + \left(Vx\frac{\partial}{\partial x} + Vy\frac{\partial}{\partial y} + Vz\frac{\partial}{\partial z}\right)V = g - \frac{1}{\rho}\,\text{grad}\,p \qquad (6)$$

This equation was established by L.Euler, 1755.

For a stationary flow without vortices, expression (6) is simplified, since in such a flow rotV at each point is equal to zero. It follows that for all flow points the motion of an incompressible fluid will be a potential:

$$\frac{v^2}{2} + U + \frac{p}{\rho} = \text{const} \qquad (7)$$

where U is the gravity potential. U = gz (z is the height).

Equation (7) is the Bernoulli's equation, 1738.

Thus, we apply Newton's second law to describe the motion in a gravitational field of particles of a medium in a small volume element dV whose density is (ρ). The mass (m=ρdV) of the volume, multiplied by its acceleration ($a = \frac{\partial v}{\partial t}$), is equal to the resultant force acting on it. The

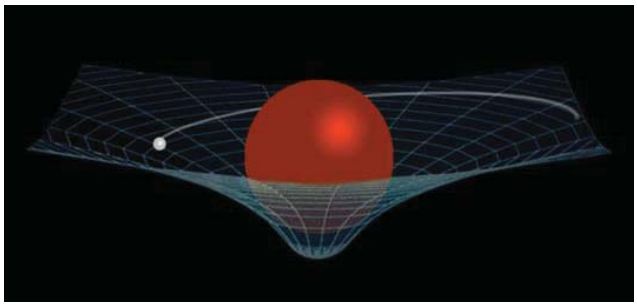

Figure 3 Gravity funnel.

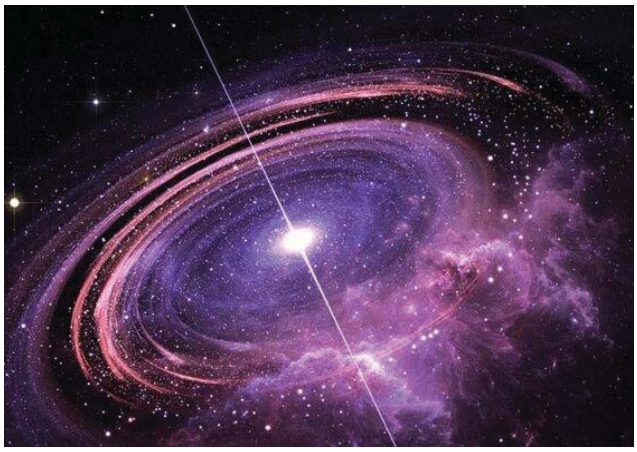

Figure 4 The light emitted by the quasar J1120 + 0641, 13 billion light years from Earth.

resulting force consists of gravity (ρdVg) and force arising from the difference in the value of pressure (p):

$$\rho dV \frac{\partial v}{\partial t} = \rho dVg - dV \text{ grad } p \quad (8)$$

From the equation of motion, after dividing each term (8) by ρ dV, we obtain the Euler formula (7). The potential motion of the medium in a homogeneous gravitational field will be obtained by multiplying all the terms of the Bernoulli's equation (6) by the density:

$$\rho \frac{v^2}{2} + \rho gz + p = \text{const} \quad (9)$$

where ρgz = U is the gravitational potential.

It has been experimentally established that the radius of the Earth's gravitational funnel is approximately 900,000 km, and the distance from the Earth to the Sun is 150,000,000 km. In the solar system, the action of the gravity of the sun and the gravity of the planets are delimited! Planetary gravity funnels have finite dimensions and do not overlap. The practice of interplanetary flights shows that there is no smooth transition from the region dominated by solar gravity to the region dominated by planetary gravity. At the moment the spacecraft crosses the boundaries of these areas, there is an abrupt change in the "true" speed of the spacecraft. Moreover, for the correct calculation of interplanetary flight, the "true" speed of the apparatus within the planetary gravitational funnel should be counted only in the planetary centric frame of reference, and in interplanetary space - only in the heliocentric frame of reference. A jump in the speed of the ship (by tens of kilometers per second) when entering the gravitational funnel of Mars or Venus is an experimentally confirmed physical effect. The consequence of this jump is an unexpected Doppler shift of the carrier frequency during radio communication with the device and a change in the type of its trajectory. For this reason, a number of Soviet and American vehicles were lost during the first flights to Venus and Mars. The fact of delimiting the gravitational planetary funnels naturally follows from the hypothesis of gravitation, which is based on the excitation of the cosmic environment (dark matter) by bodies of astronomical size.

Quantum Theory of Black Holes

In the new cosmology, a dark matter halo can appear in the primary Universe as a rather dense object that can collapse (collapse) under the action of gravitational forces into a black hole. The question arises whether such astrophysical configurations of the core - dark matter halo can be formed at all and whether they remain stable on cosmological time scales. An affirmative answer to this question is given by a new article by Carlos R. Arguelles, Manuel I Diaz, Andreas Krut, Rafael Younis "On the formation and stability of fermionic dark matter halos in the cosmological framework" [15]. Moreover, the results obtained prove that a dark matter halo with a core-halo morphology is a very likely outcome at the nonlinear stages of structure formation of black holes. In my article "Roger Penrose and Black Holes" it is indicated that further development of the theory of the origin and evolution of black holes lies in the path of abandoning Einstein's geometric theory of gravity in the general theory of relativity and recognizing the fifth interaction between dark and baryonic matter [16]. You can learn more about the hypothesis explaining the evolution of black holes into quasars from the work of Professor Valery Etkin [17]. Thus, the densification of any area of the Universe, once begun, does not stop until the appearance of a singularity (a state with infinite density and temperature), unless the growing internal pressure forces cause its "explosion". Such an "explosion" is inevitable, since as the singularity is approached, the relative density gradients $\nabla\rho/\rho$ and the gravitational forces weaken, and the forces of internal pressure caused by thermonuclear reactions, on the contrary, increase. This phenomenon of violation of hydrostatic equilibrium should be called the "explosion" of a black hole, but the evolution of a black hole does not end there. The local expansion that accompanies the explosion ends in the so-called "big rupture" of all structures of the black hole and baryonic matter, including atoms. This "break" returns the substance to its original (non-baryonic) state. The disordered alternation of the processes of contraction and expansion of individual regions of the infinite Universe realizes the circulation of matter, which allows it to exist indefinitely, bypassing the state of

equilibrium. A distinctive feature of the explosion of a black hole is that it can occur not simultaneously, but gradually, in several stages. This is confirmed by the variable luminosity of the observed quasars. In practice, this means that, having dropped part of its mass, the black hole extinguishes the rotation speed below the speed of light and goes into a mode of further mass accumulation. At the edge of a black hole, the quantum vacuum is in a conditionally stressed state, as a result of which it is quantum polarized. Nothing of the sort follows from Einstein's general theory of relativity. Studying the behavior of quantum fields around a black hole, Stephen Hawking predicted that a black hole necessarily radiates particles into outer space and thereby loses mass [6]. This effect is called Hawking radiation (evaporation). Simply put, the gravitational and magnetic fields polarize the vacuum (dark matter), as a result of which the formation of not only virtual, but also real particle-antiparticle pairs is possible. According to Hawking, on the surface of the event horizon, the direction of expansion of the generated particles ceases to be random, i.e. becomes polarized, namely, orthogonal to the BH surface [6]. In September 2021, Professors Xavier Calmette and Folkert Kuipers of the Department of Physics and Astronomy at the University of Sussex published a report that the structure of black holes is more complex than previously thought, and quantum gravity can push black holes into the surrounding quantum environment. Xavier Calmette said: "Our discovery that Schwarzschild black holes have pressure as well as temperature is even more exciting given that it was a complete surprise. Hawking's remarkable intuition that black holes are not black, but have a spectrum very similar to black body theory, makes black holes an ideal laboratory for exploring the interactions between quantum mechanics, gravity, and thermodynamics. It is hoped that when quantum field theory is included in general relativity, we will be able to find a new description of black holes" [18]. The existence of stable Hawking radiation - the process of emission of various particles by a black hole - was first proved by specialists at the Israel Institute of Technology. The experiment, conducted by Israeli scientists, had to be repeated 97 thousand times over 124 days. To create an analog of a black hole 0.1 millimeter long, the researchers needed 800 rubidium atoms. It is assumed that in the future, specialists will be able to extract energy from black holes using a singular reactor. According to the theory, the energy will be generated by Hawking radiation [19]. In the laboratory, for the first time, a substance was obtained that has properties identical to the plasma in the vicinity of a black hole [19]. In laboratory conditions, accretion disks of a black hole were obtained. This is the kind of structure that results from a diffuse material with a rotational moment on a massive central body. As a result, a huge amount of matter is thrown into the surrounding space of the black hole. This matter is a plasma of the most elementary particles of the universe. In fact, it is a huge and still very dense cloud of plasma, retaining the shape of a disk. Its rotation speed is close to the speed of light, and the direction of rotation coincides with the direction of rotation of the original black hole. Modern astronomers call such a disk a quasar.

Quantum Theory of Gravity and the Principle of Equivalence

As mentioned earlier, the quantum theory of gravity relies on Mach's principle, which states that the inert properties of each physical body are determined by all other physical bodies in the Universe and depend on their location. This statement contradicts the principle of equivalence of masses, adopted by Albert Einstein as a basis in the General Theory of Relativity. The Equivalence Principle (PE) predicts the same acceleration for bodies of different composition in the same gravitational field and allows us to consider gravity as a geometric property of space-time, which leads to the interpretation of gravity from the point of view of general relativity [5]. As a result, A. Einstein's gravitational mass became equal to the inertial mass under any conditions. Newton knew that the inert mass m_i, which appears in his second law $F = m_i a$, may differ from the gravitational mass mg, which refers to the strength of the gravitational field $F = mg\ g$. Indeed, comparing the two equations, we find that $a = (mg / m_i)\ g$ and, in principle, bodies with different values of the ratio (mg / m_i) could accelerate in different ways in the same gravitational field. However, after checking this possibility on simple pendulums of the same length, but with different mass and composition of the load, he did not find any differences in the period of their oscillations. On this basis, Newton concluded that the quantity (mg / m_i) is constant and with an appropriate choice of the system of units, this ratio can be reduced to unity. Experiments related to the verification of the principle of equivalence are carried out to this day, using the most modern equipment, but no significant deviations have been identified. However, many extensions of the Standard Model containing macroscopic quantum fields predict a violation of the equivalence principle. In the Brans-Dicke theory, the intensity of the gravitational interaction depends on the additional scalar field. Within the framework of this theory, it is possible to formulate the Mach principle, according to which the inertia of bodies manifests itself due to the interaction with distributed matter in the Universe [14]. It turned out that it is possible to reveal a violation of the equivalence principle only in experiments carried out in non-equilibrium systems with irreversible processes. That is why the Nobel Prize Laureate Professor I. Prigogine wrote about this: "In a steady state, the active influence from the outside on the system is insignificant, but it can become very important when the system goes into a nonequilibrium state, while the principle of equivalence is violated" [20]. In the new cosmological model of the Universe, where the rotation of planets, stars and galaxies occurs in a halo of superfluid dark matter, the reason for the violation of the principle of equivalence may be the added (added) mass, the nature of which is associated with the excitation of a field around a moving cluster with a hydrodynamic velocity $\upsilon_i(r)$ and the appearance in connection with this additional kinetic energy. The macroscopic approach, in which the hydrodynamic attachment of

mass to spherical bodies of any nature in a liquid medium was outlined by Stokes back in the two centuries ago. In superfluid ^{3}He-B (analogue of dark matter), this effect was experimentally substantiated substantiated by Vladimir Shikin, an employee of the Institute of Solid State Physics, Russian Academy of Sciences, in 2013. We are talking about a complex force F (ω), acting from the side of the liquid on a sphere of radius R, performing periodic oscillations with frequency ω. Within small Reynolds numbers, we have:

$$F(\omega) = 6\pi\eta R\left(1+\frac{R}{\delta(\omega)}\right)V(\omega)+3\pi R^2\sqrt{\frac{2\eta\rho}{\omega}}\left(1+\frac{2}{9}\frac{R}{\delta(\omega)}\right)i\omega V(\omega), \quad (11)$$

$$\delta(\omega) = (2\eta/\rho\omega)^{1/2}$$

where ρ - fluid density, η – viscosity, V - velocity amplitude sphere, δ (ω) - the so-called viscous penetration depth, which increases with an increase in viscosity and a decrease of the oscillation frequency.

The real part of the expression (11) is a known Stokes force derived from the movement of fluid in the sphere. Imaginary component (coefficient of iωV) is naturally identified with the effective mass of the cluster added:

$$Meff\ (\omega R) = \frac{2\pi\rho R^3}{3}\left[1+\frac{9}{2}\frac{\delta(\omega)}{R}\right] \quad (12)$$

Origin added (attached) mass Meff (ωR), depending on the frequency ω and the radius R of the sphere of the cluster associated with the excitation of the field around a moving cluster of hydrodynamic velocity υ_i (r) and the appearance in connection with this additional kinetic energy. In superfluid, additional mass has two components: superfluid and normal.

For the terrestrial planets (Earth, Venus, and Mars) moving in low-excited orbits in the dark matter halo, the added mass is insignificant, but for planets with a highly disturbed orbit (Mercury and Pluto), the added mass can reach a significant value. For Mercury and Pluto, a noticeable violation of the principle of equivalence is possible. This can be judged from the analysis of the values of Kepler's constant. Johannes Kepler formulated his laws of celestial mechanics on the basis of analysis of long-standing astronomical observations of Tiho de Braga in 1609-1619 and Isaac Newton fifty years later received Kepler's third law, as a consequence of the law of universal gravitation and the second law of dynamics, introducing into the spatial model of the universe the forces of gravity and inertia. This was a brilliant confirmation of the correctness of Newton's theory of gravitation.

$$K = G_0 M_0 \frac{m\,g}{m\,i} = \frac{R^3}{T^2.} \quad (13)$$

where

mg is the planet gravitational mass, interacting with the Sun, the M_0 mass, produces a centripetal force of gravity;

mi is the inertial mass of the planet. It is rotating around a circle of R radius and producing a centrifugal force of repulsion,

R is a average value distance from the centre of the planet to the centre of the Sun,

T is a period of the planet rotation around the Sun,

G_0 is the gravitational constant, K is Kepler's constant.

Johannes Kepler calculated the value of the constant K for 8 planets:

Earth, Venus, Mars $K = 3.35 \cdot 10^{24}\ km^3 \cdot year^{-2}$

Saturn, Jupiter, Uranus $K = 3.34 \cdot 10^{24}\ km^3 \cdot year^{-2}$

Mercury, Pluto $K = 3.33 \cdot 10^{24}\ km^3 \cdot year^{-2}$

Note the difference in the meaning of Kepler's constant. For planets of the terrestrial group, rotating along stable, slightly perturbed orbits, K = 3.35, and for Mercury, whose orbit is subject to strong perturbations due to its proximity to the Sun, the value of K = 3.33, that is, less [5].

The Equivalence Principle (PE) predicts the same acceleration for bodies of different composition in the same gravitational field and allows us to consider gravity as a geometric property of space-time, which leads to the interpretation of gravity from the standpoint of the General Relativity [5]. The equivalence principle test can be performed by comparing the gravitational acceleration α_r of different test bodies. When the bodies are at the same distance from the source of gravity, the expression for the PE takes on a compact form:

$$\frac{\nu\alpha}{\alpha} = \frac{2(\alpha 1-\alpha 2)}{\alpha 1+\alpha 2} = \left[\frac{m_{g1}}{m_{v1}}\right]-\left[\frac{m_{g2}}{m_{v2}}\right] = \nu\left[\frac{m_g}{m_v}\right] \quad (14)$$

Since the mass of the Sun (M) and the gravitational constant (G) for all planets in formula (13) is unchanged, the difference in the value of K between the terrestrial planets and Mercury can be explained only by the inequality of the ratio of the gravitational mass to the inertial mass, that is, a violation of the equivalence principle:

$$\left[\frac{m_{g\,Earth}}{m_{i\,Earth}}\right] \neq \left[\frac{m_{g\,Mercury}}{m_{i\,Mercury}}\right];\ \Delta(m_g/m_i) \sim 2\cdot 10^{-2} \quad (15)$$

The added inert mass can explain the violation of the equivalence principle for Mercury by $\Delta (mg / m_i) \sim 10^{-2}$ when it moves in the halo of superfluid dark matter in an orbit subject to strong disturbances [15]. Analysis of the Newton - Kepler formula (13) allows us to estimate the approximate value of the gravitational constant for Mercury Gm from the solution of proportion (16) (we have neglected the violation of the equivalence principle for the planet Mercury [15]):

Analysis of the formula (13) of Newton-Kepler allows you to assess the approximate value of the gravitational constant for the Mercury G_M from solving the proportion (16) (we neglected the violation of the equivalence principle for the planet Mercury [15]):

$$3.35.10^{24}\ km^3.year^{-2} = G_0 M_0\left[\frac{m_{g\,Earth}}{m_{i\,Earth}}\right], \text{for Earth}\ \frac{m_g}{m_i} = 1 \quad (16)$$

$$3.33.10^{24}\ km^3\ .\ year^{-2} = G_i\ M_0\left[\frac{m_{g\ Mercury}}{m_{i\ Mercury}}\right],\ for\ Mercury\ \frac{m_g}{m_i} \sim 1$$

$G_M \sim 0.994\ G_0$ or $G_M \sim 6.63403 \cdot 10^{-8}\ dyn \cdot cm^2 / g^2$,

In a heliocentric system, the gravitational constant in Einstein's general relativity for all planets must have the same value. However, as shown above, the gravitational constant for each planet can have its own meaning, depending on the nature of the movement of the planet in orbit. Unlike general relativity, Newton's Law of Universal Gravitation allows this:

$$F = G\frac{M\,m}{R^2} \quad (17)$$

where G is the gravitational constant for each planet in the solar system;

M is the mass of the Sun;

m is the mass of the planet;

R is distance from the center of the planet to the center of the Sun.

In 2013, the scientific world was shocked by the article by the Chinese mathematician Academician Hua Di "Einstein's Explanation of Perihelion Motion of Mercury", published in the collection of articles "Unsolved Problems in Special and General Relativity", edited by Florentin Smarandach USA [16]. In the article, he showed that, when calculating the magnitude of the perihelion precession of the orbit of Mercury, Einstein made a gross error in the integration. As a result, the result was 71.5″, and not the expected 43″. The magnitude of the error ~ 71.63 '' was also obtained by direct numerical simulation of the perihelion precession of the orbit of Mercury in the field of the spherical Sun in the framework of general relativity, carried out by Professor Kupryaev NV [17]. The consequences of this mistake can be huge. Since the time of Einstein, the touchstone on which the reliability of the theory of gravity was checked was the calculation of the motion of the perihelion of Mercury. Observational astronomy has long known that due to its proximity to the Sun and the influence of gravity of other planets, Mercury moves not just along an ellipse, but an ellipse, which itself slowly rotates 575″ over a hundred years. The corrections calculated on the basis of Newton's theory gives an error of 43″, which means a perihelion rotation of 532″, and Albert Einstein in 1915 obtained the expected value 43″ using the field equations of general relativity [18]. And now, more than a hundred years later, an error was discovered and instead of the observed rotation of the orbit of Mercury 575″ in 100 years, Einstein received in the framework of general relativity only 503.5″ in 100 years. Most modern physicists dismissed this annoying “misunderstanding”, but the result obtained by Einstein demanded an explanation. In my article, I found an explanation for Einstein's mistake, but the consequences of this may entail a complete rejection of Einstein's geometric theory of gravity and its replacement by the quantum theory of gravity. The reason for the error may be the added inert mass leading to the violation of the equivalence principle for Mercury by $\Delta\ (mg / m_i) \sim 10^{-2}$ when it moves in the halo of superfluid dark matter in an orbit subject to strong disturbances.

Since the time of Einstein, the calculation of the motion of the perihelion of Mercury has served as a touchstone on which the reliability of the theory of gravity was tested. Direct numerical modeling of the precession of the perihelion of Mercury's orbit, taking into account all planets, as well as taking into account the contraction of the Sun, carried out within the framework of the modified Newton's law of universal gravitation with a value of $Gm \sim 6.63403 \times 10^{-8}$ [dyn × cm²/g²], allows us to estimate the result with an accuracy of ~ 570 "± 5" [20]. This is the most accurate calculation result.

Thus, numerical modeling allows us to assert that the theory of quantum gravity is the most reliable of the three generally accepted theories of gravity, since it gives an error in calculating the precession of the perihelion of Mercury 5″, while Einstein's general relativity gives an error of 71.63”, and not the modernized Isaac Newton's Law of Universal Gravitation gives an error of 43″.

CONCLUSION

Thus, within the framework of the new gravitational quantum theory, a new approach to gravity based on Mach's principle and the Fundamental theory of Arthur Eddington is presented. For the first time, the article presents the Quantum Theory of Gravity, covering not only the microcosm of elementary particles, but also the macrocosm of planets, stars and black holes. From the standpoint of the quantum theory of gravity, in the new cosmological model of the quantum vacuum (dark matter), gravitational funnels formed by the rotation of planets, stars and galaxies are proposed. The change in the gravitational potential in the funnels occurs instantly in all areas of the gravitational funnel space in accordance with the pressure gradient described by the Euler-Bernoulli equation for superfluid continuous media. In the new cosmological model, the singularity is absent, since as the singularity is approached, the relative density gradients $\nabla\rho/\rho$ and the gravitational forces weaken, while the internal pressure forces caused by thermonuclear reactions, on the contrary, increase. The disordered alternation of the processes of contraction and expansion of individual regions of the infinite Universe realizes the circulation of dark and baryonic matter, which allows it to exist indefinitely, bypassing the state of equilibrium. Numerical modeling allows us to assert that the theory of quantum gravity is the most reliable of the three generally accepted theories of gravity.

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