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Opinion

Actual Problems of Modern Physics, Astrophysics, and Cosmology

Valery Timkov[1,*]

[1]Institute of Telecommunications and Global Information Space of the National Academy of Sciences of Ukraine, 03186, Kyiv, Ukraine

*Corresponding author: valerytimkov@gmail.com

Abstract - Variants of solving actual problems of modern physics, astrophysics, and cosmology are considered. Since the observable Universe is a rotating black hole, the Kerr metric is the most optimal for solving Einstein's GR equation. New basic equations of cosmology are proposed, which take into account the effect of space rotation of the observable Universe. The expansion of space in the observable Universe after the Big Bang ended on the surface of the Hubble sphere. The radius of this sphere is half the Schwarzschild radius, so the observable Universe, like the Hubble sphere, is a black hole. The effect of redshift from distant objects of the observable Universe in all azimuths from the observer is associated with the rotation of the Hubble sphere. This means that dark energy does not exist, and the kinetic energy of the Hubble sphere creates the effect of the presence of a dark mass. The gravitational field has two fundamental properties: 1) it curves the space around any gravitating object, and 2) it creates a kinematic gravitational viscosity, which slows down the movement of some parts of matter relative to its other parts. The second property is based on the quantum-wave nature of the gravitational field. The quantum of the gravitational field is the square of the speed of light in a vacuum. The physical nature of the gravitational field quantum is the kinematic gravitational viscosity of the gravitational field of the baryonic matter of the observable Universe. The second property limits the maximum possible transfer rate of the physical interaction. Given both fundamental properties, a complete description of the gravitational field is based on a complex consideration of three equations: 1) Einstein's GR equation, and 2) two quantum-wave Maxwell-like Heaviside equations. The connection between the Standard Model of physics and gravitational interaction is proposed to be established based on the fact that the electromagnetic field is a special case of the gravitational field since the electric charge is a function of the moment of mass, Coulomb's law can be represented in gravitational form, and the basic units of measurement of electromagnetism can be expressed in terms of units of measurement gravity. The Universe has a hierarchical fractal structure. With the growth of the scale factor of the Universe, a fractal inflation of all the main attributes of matter is observed. The scale factor between the microcosm and the macrocosm is proposed to be established based on the modified Dirac Big Numbers. Gravitational-electromagnetic resonance is proposed to be used for accurate estimation of the mass of distant gravitating objects in the observable Universe. Gravitons and WIMPs, as carriers of the gravitational field and dark mass, are absent in nature. The absence of gravitons is due to the absence of mass in the formula for the quantum of the gravitational field. The absence of WIMPs is because the dark mass is determined by the kinetic energy of rotation of the observable Universe.

Keywords - Metric tensor; Einstein's GR equation; Hubble constant; Fractal structure of the Universe; Quantum wave equations of the gravitational field; Duality of time; Singularity point; Big Bang

1 Introduction

The lack of experimental data, the ambiguous representation of the real picture of the world in most models, theories, and hypotheses about the Universe, and the huge scale factor of the issues under study, have led to the fact that many problems have arisen in modern physics, astrophysics, and cosmology. Among this set, the most relevant and debatable are the following problems:
- the optimal choice of the metric tensor for solving the Einstein equation of the General Theory of Relativity, which most fully corresponds to modern experimental data. As a consequence of this optimal choice, there is a need to correct the basic equations of cosmology, which is also due to new experimental measurements of the Hubble constant;
- an ambiguous experimental estimate of the Hubble constant;
- stability of constants, the maximum transmission rate of physical interaction;
- dark energy and dark matter;
- correct choice of the coordinate system in cosmological studies;
- the physical nature of the cosmological constant;
- representations of the general structure of the Universe;
- concepts of the Big Bang, singularity point, initial conditions, and limitations;
- connections of the Standard Model of physics with gravitational interaction;
- understanding the features of the quantum-wave nature of the gravitational field;
- the physical nature of time and its relationship with real space;
- the optimal choice of the quantum-wave model of the gravitational field of the observable Universe and the development on this basis of its physical and mathematical description, which corresponds to the modern set of experimental data in astrophysics and cosmology;
- estimates of the scale factor between the microcosm and the macrocosm of the observable Universe; - estimates of the mass of distant objects of the observable Universe;
- carriers of the gravitational field and dark matter.

Consider options for solving the above problems.

2 Materials and Methods

2.1 Algorithm for the formation of the FLRW metric

Currently, in cosmology, to describe the space-time geometry of an isotropic and homogeneous Universe, its state, and evolution, the Friedmann-Lemaitre-Robertson-Walker metric is used, or in short: FLRW metric [1, 2, 3, 4]. The experimental data of recent years on measuring the Hubble constant show that the FLRW metric is not optimal for solving the Einstein GR equation. For a better understanding of this statement, consider the algorithm for its formation.

The FLRW metric is given by the square of the interval in the corresponding space. The square of the interval of the FLRW metric includes the square of the length element in 4-dimensional space, which is an invariant quantity and therefore does not depend on the chosen coordinate system. To obtain the length element in the FLRW metric, consider a 4-dimensional sphere of radius R.

The equation of a 4-dimensional sphere is:

$$R^2 = x_1^2 + x_2^2 + x_3^2 + x_4^2, \tag{1}$$

where x_1, x_2, x_3, x_4 are the coordinates of the 4-dimensional sphere.

Then the length element dl^2in 4-dimensional space has the form:

$$dl^2 = dx_1^2 + dx_2^2 + dx_3^2 + dx_4^2. \tag{2}$$

Let the surface of a 4-dimensional sphere be a 3-dimensional space of constant positive curvature, that is, a 3-dimensional sphere. To pass to the length element on the surface of a

4-dimensional sphere, it is necessary in (1) to exclude one of the coordinates, for examplex_4 :

$$x_4^2 = R^2 - x_1^2 - x_2^2 - x_3^2. \tag{3}$$

Considering that $R = const$, the differential (3) is equal to:

$$dx_4 = -\frac{(x_1 dx_1 + x_2 dx_2 + x_3 dx_3)}{x_4}. \tag{4}$$

Let's move on to 3-dimensional space x_1, x_2, x_3, which describes the surface of a 4-dimensional sphere to spherical coordinates: (r, θ, φ), where r- radial distance to a given point, θ - polar angle of a given point, φ - azimuth angle of a given point.
It's obvious that:

$$r^2 = x_1^2 + x_2^2 + x_3^2. \tag{5}$$

Then the length element $dr^2$is:

$$dr^2 = \frac{(x_1 dx_1 + x_2 dx_2 + x_3 dx_3)^2}{r^2}. \tag{6}$$

Comparing formulas (3), (4) and (6) we get:

$$dx_4^2 = \frac{r^2 dr^2}{R^2 - r^2}. \tag{7}$$

Then the length element dl^2(2) has the form:

$$dl^2 = dx_1^2 + dx_2^2 + dx_3^2 + \frac{r^2 dr^2}{R^2 - r^2}. \tag{8}$$

Given that when moving from Cartesian to spherical coordinates:

$$x_1 = r\cos\theta, x_2 = r\sin\theta\cos\varphi, x_3 = r\sin\theta\sin\varphi, \tag{9}$$

and:

$$dx_1^2 + dx_2^2 + dx_3^2 = dr^2 + r^2 d\theta^2 + r^2\sin^2\theta d\varphi^2, \tag{10}$$

the length element dl^2(8) in spherical coordinates has the form:

$$dl^2 = \frac{dr^2}{1 - \frac{r^2}{R^2}} + r^2 d\theta^2 + r^2\sin^2\theta d\varphi^2. \tag{11}$$

Formula (11) was obtained under the assumption that the tangent surface to the surface of a 4-dimensional sphere is a 3-dimensional surface of positive curvature, that is, a 3-dimensional sphere. The tangent surface to each point on the surface of the 4-sphere can be a flat Euclidean space with zero curvature, or a hyperbolic Riemann space with negative curvature. All three cases are conveniently combined using the parametric coefficient$k = \{1, 0, -1\}$. Then the square of the length element in the FLRW metric has the form:

$$dl^2 = \frac{dr^2}{1 - k\frac{r^2}{R^2}} + r^2 d\theta^2 + r^2\sin^2\theta d\varphi^2. \tag{12}$$

In a homogeneous and isotropic space, the interval $ds^2$of the FLRW metric between two events can be written as:

$$ds^2 = A^2 t^2 - dl^2,$$

whence, taking into account formula (12):

$$ds^2 = A^2 t^2 - dl^2 = A^2 t^2 - \left(\frac{dr^2}{1 - k\frac{r^2}{R^2}} + r^2 d\theta^2 + r^2\sin^2\theta d\varphi^2\right), \tag{13}$$

where $A$is the speed of light, $t$is time.
The expansion of the space of the Universe since the moment of the Big Bang is taken into account in formula (13) using scale factor $a^2(t)$.Then the interval of the FLRW metric is:

$$ds^2 = A^2t^2 - a^2(t)dl^2,$$

$$ds^2 = A^2t^2 - dl^2 = A^2t^2 - a^2(t)\left(\frac{dr^2}{1-k\frac{r^2}{R^2}} + r^2d\theta^2 + r^2\sin^2\theta d\varphi^2\right). \tag{14}$$

The operands of the right side of formula (14) are elements of the FLRW metric.

2.2 Basic equations of cosmology, which are given by the FLRW metric

The expansion of the space of the Universe since the Big Bang is described by the Hubble law, so the scale factor $a^2(t)$ in formula (14) is a modified record of the Hubble law: the rate v of expansion of the space of the Universe is directly proportional to the Hubble parameter $H(t)$, which is currently a constant H_0 and the distance l to the receding object [3]:

$$v = H(t)l. \tag{15}$$

In a homogeneous and isotropic space, Hubble's law is a consequence of the length element $dl$of the FLRW metric:

$$dl = a(t)dR, \tag{16}$$

Where $dR = const$ is a dimensionless constant, as an analog of the latitude and longitude of given points on the sphere and depending only on the radius of the sphere R.
From (16) the distance l is determined by integration within the radius R:

$$l = a(t)\int dR = a(t)R. \tag{17}$$

Let us differentiate (17) to time:

$$v = \frac{dl}{dt} = \frac{da(t)}{dt}R = \left(\frac{\dot{a}(t)}{a(t)}\right)a(t)R = H(t)l. \tag{18}$$

From (18) it follows that the Hubble parameter has the form:

$$H(t) = \frac{\dot{a}(t)}{a(t)},$$

Or for brevity, omitting the time:

$$H = \frac{\dot{a}}{a}. \tag{19}$$

Let a sphere of radius $a = R$, whose mass is equal M, expand according to the Hubble law: $v = HR$.
The equation of motion of a point located on the surface of this sphere has the form:

$$\frac{d^2R}{dt^2} = -\frac{GM}{R^2} = -\frac{4\pi}{3}G\rho R, \tag{20}$$

where $\rho$is the bulk density of the mass of the sphere, G is the Newtonian constant of gravity. If we imagine that the expanding Hubble sphere is the observable Universe, then in the general case, in equation (20) it is necessary to take into account the pressure of the equilibrium radiation of relativistic particles $P$and the cosmological constant Λ, then:

$$\frac{d^2R}{dt^2} = -\frac{4\pi}{3}GR\left(\rho + \frac{3P}{c^2}\right) + \frac{\Lambda c^2}{3},$$

or taking into account $a = R$ the equation of motion in the traditional form:

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}\left(\rho + \frac{3P}{c^2}\right) + \frac{\Lambda c^2}{3}. \tag{21}$$

We obtain a continuity equation that expresses the law of conservation of mass. To do this, consider a sphere expanding according to the Hubble law: $v = HR$, whose mass and radius are respectively equal M, R. Obviously, the mass can be represented through its bulk density in the form:

$$M = \frac{4}{3}\pi R^3 \rho,$$

then the change in the bulk density of the mass during the expansion of the sphere has the form:

$$\frac{d\rho}{dt} = -\frac{3M}{\left(\frac{4\pi}{3}\right)R^4}\frac{dR}{dt} = -3H\rho. \tag{22}$$

Formula (22) formally does not include the radius of the sphere, that is, when the sphere expands, the density of its mass does not depend on the spatial coordinates. In the general case, the pressure of equilibrium radiation of relativistic particles must be added to formula (22), then it has the form:

$$\frac{d\rho}{dt} = -3H\left(\rho + \frac{3P}{c^2}\right). \tag{23}$$

Multiplying the right and left parts of equation (20) by the rate of change of the sphere radius during expansion $\frac{dR}{dt}$, and then integrating it, we obtain the law of conservation of mechanical energy:

$$\frac{1}{2}\left(\frac{dR}{dt}\right)^2 - \frac{GM}{R} = \frac{1}{2}\left(\frac{dR}{dt}\right)^2 - \frac{4\pi G R^2 \rho}{3} = A = const. \tag{24}$$

We obtain the constant A in formula (24) from the initial conditions: at present, at the moment $t = t_0$ we have:

$$\frac{dR}{dt_{t=t_0}} = H_0 R_0,$$

where, respectively, H_0, R_0 these are the modern values of the Hubble constant and the Hubble radius, that is, the radius of the observable Universe, it is obvious that: $c = H_0 R_0$,then:

$$\left(\frac{dR}{dt}\right)^2 = \frac{8\pi G \rho R_0^3}{3R} - \frac{8\pi G R_0^2}{3}\left(\rho_0 - \frac{H_0^2}{8\pi G}\right) = \frac{8\pi G \rho R_0^3}{3R} - H_0^2 R_0^2\left(\frac{8\pi G \rho}{H_0^2} - 1\right). \tag{25}$$

Value: $\rho_{cr} = \frac{3H_0^2}{8\pi G}$ is called the critical mass density of the observable Universe at present. Obviously, the formula for the critical density of the Universe in the process of its evolution has the form: $\rho_{cr} = \frac{3H^2}{8\pi G}$.
Having expressed the constant A from formula (25), we substitute its value into formula (24) and taking into account that $a = R$, as well as taking into account the cosmological constant Λ, we finally obtain the energy conservation equation:

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G \rho}{3} - \frac{c^2}{a^2} + \frac{\Lambda c^2}{3}. \tag{26}$$

Equations (21), (23), and (26) are the basic equations of cosmology or Friedmann's equations for a homogeneous and isotropic Universe. Equations (21) and (26) can be obtained using Einstein's GR equations of the state of the gravitational field by equating to zero the spatial coordinates - equation (26) and the time coordinate - equation (21). In this case, for example, in equation (26) the parametric constant k will be taken into account:

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G\rho}{3} - \frac{kc^2}{a^2} + \frac{\Lambda c^2}{3}. \tag{27}$$

In equation (27) we denote the Hubble parameter: $H = \left(\frac{\dot{a}}{a}\right)$ and divide both its parts by H^2. Let us denote the relative energy densities of: Ω_m- matter in the Universe, Ω_c- the relative energy density, which is due to the curvature of space, Ω_Λ- the relative energy density, which is due to the cosmological constant, or the so-called dark energy:

$$\Omega_m = \frac{\rho}{\rho_{cr}} = \frac{8\pi G\rho}{3H^2}; \Omega_c = \frac{kc^2}{a^2H^2}; \Omega_\Lambda = \frac{\Lambda c^2}{3H^2}. \tag{28}$$

Then the energy balance equation of the Universe has the form:

$$\Omega_m + \Omega_c + \Omega_\Lambda = 1. \tag{29}$$

The basic equations of cosmology are presented under the assumption that the Universe is currently expanding.

2.3 The dual nature of the Hubble constant

The main parameter that characterizes the expansion of the Universe is the Hubble parameter. However, the physical nature of the Hubble parameter is of a dual nature. This parameter with equal success represents two different counterversion physical processes: 1) the expansion of the space of the Universe, and 2) the rotation of the space of the observable Universe, as a Hubble sphere: if, for example, in formula (15) we imagine that this v is the linear velocity of a given point on the radius of the sphere, l is the distance from the observer to a given point on the sphere's radius, and $H(t)$is the angular velocity of the sphere's rotation. From the point of view of the experimentally substantiated right to the existence of the above hypotheses, each of them has significant drawbacks. The first hypothesis about the expansion of the space of the Universe, or what is the same - the hypothesis about dark energy, lacks a theoretically and experimentally substantiated source of dark energy. The second hypothesis violates the basic principle of cosmology, according to which the space of the Universe is homogeneous and isotropic since with the rotation of space it becomes anisotropic. Currently, the main theoretical substantiation of the hypothesis about the source of dark energy is the vacuum pressure caused by a non-zero value of the cosmological constant Λ. However, for the pressure of a vacuum to be a source of expansion of space, a difference in this pressure is necessary. This means that at certain points in the space of the Universe, the vacuum pressure must be different, just as the value of Λ. It also means that Λ it is not a constant, but a variable, which contradicts the status Λ as a constant, Einstein's gravitational field equation, and the basic equations of cosmology. In the hypothesis of dark energy, there is one more contradiction that cannot be resolved within its framework. This contradiction arose as a result of the improvement of experiments to measure the Hubble constant. Previously measured values for the Hubble constant tended to overlap with the tolerances for those measurements. Due to the significant scatter of measurement tolerances, it seemed that the same value of the Hubble constant was measured in the course of various experiments. But in recent publications [5, 6, 7, 8, 9, 10, 11, 12, 13] it is shown that the experimentally measured values of the Hubble constant are grouped mainly in two clusters with centers near $H_0 = 67.4\,(km/s)\,/Mpc$, and near $H_0 = 74\,(km/s)\,/Mpc$. This means that the process of expansion of the space of the universe is described by two different values of the Hubble constant with non-overlapping values of measurement tolerances. The dark energy hypothesis actually ceases to exist, since it does not allow for the existence of two values of the Hubble constant, which are obtained in the course of numerous and various experiments. This is the case when practice is the criterion of truth. In the hypothesis of the rotation of the space of the observable Universe, there may be two values of the Hubble constant, if we assume that the space of the Hubble sphere and the matter in it rotate with different angular velocities. The clusters of measured values of the Hubble constant differ from each other by the working body of the experiment. The working body of the experiment is a physical environment that is used to measure the parameters under study. In the cluster of measured values of the Hubble constants with a center near $H_0 = 67.4\,(km/s)\,/Mpc$ the working body of the experiment is mainly CMB, which permeates the entire space of the Hubble sphere, and in the cluster of measured values of the Hubble constants with a center near $H_0 = 74\,(km/s)\,/Mpc$ the working body of the experiment, it is mainly matter, these are: Cepheids, Red Giants, Quasars, Masers. According to these data, it can be argued that the space of the observable Universe, like the Hubble sphere, rotates with an angular velocity proportional to the value of the Hubble constant about $H_0 = 67.4\,(km/s)\,/Mpc$, and the matter in the Hubble sphere rotates with an angular velocity proportional to the value of the Hubble constant about $H_0 = 74\,(km/s)\,/Mpc$.

It is shown [14] that the Hubble constant can be determined analytically based on the spatial and energy characteristics of the observable Universe, which means that this constant is its internal immanent attribute and therefore, by definition, cannot be a characteristic of dark energy. The value of the Hubble constant, which is determined analytically [14], is close to the value of the experimental estimates of this constant by the Planck mission, DES Collaborations, SDS - III BOSS [7, 8, 9, 10, 11, 12] and is equal to: $H_0 = 67.55770\,(km/s)\,/Mpc$.Based on observations of Cepheids, in [13], an estimate $H_0 = 74.03 \pm 1.42 (km/s)/Mpc$ of the Hubble constant is given. Based on these values of the Hubble constant, it can be argued [14] that the space of the observable Universe during the 13.88 billions of years since the Big Bang [6] has made one incomplete revolution at345degree, which corresponds to $H_0 = 67.55770\,(km/s)\,/Mpc$, the substance in it has made one complete revolution at 379 degree, which corresponds to $H_0 = 74.03 \pm 1.42 (km/s)/Mpc$.

The Schwarzschild radius $R_{US}$for the observable Universe, which defines the event horizon of a black hole:

$$R_{US} = \frac{2GM_U}{c^2}, \tag{30}$$

where $G$is the Newtonian constant of gravity, $M_U$is the mass of baryonic matter in the observable Universe, and c is the speed of light in vacuum.

It is shown in [15] that the radius of the Hubble sphere R_0, i.e. the radius of the observable Universe, is equal to:

$$R_0 = \frac{GM_U}{c^2}. \tag{31}$$

Comparing formulas (30) and (31), we conclude that the radius of the Hubble sphere is two times less than the Schwarzschild radius, which means that the observable Universe, like the Hubble sphere, is a black hole, the space of which, by definition, cannot expand with acceleration. This fact is also confirmed by the estimation of the wavelength λ_{UT} of the thermal radiation of the Hubble sphere, which is given in [14]: $\lambda_{UT} \approx 5.614 \cdot 10^{-5} m$. This is the far infrared region of the thermal radiation spectrum.

Suppose that dark energy exists, then two differently directed forces act on each point of the surface of the Hubble sphere: 1) the force F_g of gravitational compression of the Hubble sphere, which is directed towards its center, 2) the force F_{de} of dark energy, which is directed opposite to the force F_g. In [14, 15] it is shown that the modules of these forces are equal to each other and equal to the Planck force F_P:

$$F_P = \left|F_g\right| = |F_{de}| = cM_U H_0 \approx 1.210 \cdot 10^{44} kg^1 m^1 s^{-2}. \tag{32}$$

From formula (32) it follows that the centripetal force F_g of the gravitational compression of the rotating Hubble sphere is balanced by the centrifugal force F_{de} of the imaginary dark energy, that is, there is no expansion of the space of the Hubble sphere.

The rotating space of the observable Universe creates a certain inhomogeneity in the distribution of matter in it, that is, the space becomes anisotropic under the influence of rotation. Experimental data from several independent sources proved the anisotropy of the space of the observable Universe. Professor Lior Shamir from the University of Kansas (USA), having processed experimental data on spiral galaxies, proved that there is a significant asymmetry between right- and left-handed spiral galaxies [16]. This should not be observed in isotropic space. Also, based on experimental data, he pointed out the presence of a cosmological axis, that is, the axis around which the space of the observable Universe rotates [17, 18]. A group of German scientists led by Dr. K. Migkas from the University of Bonn [19] used experimental data from the XMM-Newton, Chandra, and ROSAT X-ray space orbital stations to estimate the brightness of galaxies surrounding the Earth. In an isotropic universe, galaxies of the same temperature and at the same distance from Earth should be equally bright. However, German astrophysicists experimentally showed that there is a violation of brightness. That is, the space of the observable Universe is anisotropic. Experimental data on the study of the CMB polarization also testify to the anisotropy of the space of the observable Universe [20]. The degree of space anisotropy depends on the angular velocity of its rotation. At low angular velocities of rotation of the space of the observed Universe, the inhomogeneity of the distribution of matter is insignificant; therefore, such a space can be considered conditionally isotropic, which is currently observed and confirmed experimentally. In [21] it is shown that if the angular velocity of the space of the observable Universe is less than $10^{-9} rad^1 year^{-1}$, then the principle of isotropy of its space is not violated.

In [14], an estimate is given for the angular velocity ω_U of space rotation of the observable Universe, which is equal to:

$$\omega_U = 4.3382127443 \cdot 10^{-10} rad^1 year^{-1}. \tag{33}$$

As follows from formula (33), the angular velocity ω_U of the space of the observable Universe is 2.3 times lower than the angular velocity $10^{-9} rad^1 year^{-1}$. This gives grounds to assert that the rotation of the space of the observable Universe with a very low angular velocity does not violate the basic principle of cosmology about the isotropy of its space.

2.4 Stability of constants. Why the speed of light is a stable constant

The equations of physical laws, as a rule, consist of constants and variables. Variables reflect the dynamics of physical processes, and constants reflect the structure of matter at its structural level, at which the scenario of the action of physical laws unfolds. This means that if the structure of matter changes, then the corresponding constant will also change. In other words, any constant is stable to the extent that the structure of matter, which the constant represents, is stable. It is shown [22] that the speed of light in a vacuum A can be expressed in terms of the main spatial and energy characteristics of the observable Universe:

$$E_U = M_U c^2; E_U = F_P R_0,$$

where:

$$c = \sqrt{\frac{F_P R_0}{M_U}}, \tag{34}$$

where E_U is the energy of the observable Universe, F_P is the Plank force, M_U is the mass of the baryonic matter of the observable Universe, R_0 is the radius of the observable universe, i.e. the radius of the Hubble sphere. F_P, M_U, R_0 these are constants. If we assume that the space of the observable Universe expands under the influence of dark energy, then the structure of the Hubble sphere changes, that is, the Hubble radius R_0 increases, and the speed of light in vacuum increases accordingly. However, practice confirms that this is a constant, therefore, there is no expansion of the space of the observable Universe.

2.5 Basic equations of cosmology for the rotating space of the observable Universe. The rotating space of the observable Universe is a source of imaginary dark energy. The kinetic energy of the space rotation of the observable Universe is the source of the dark mass

Based on the fact that: 1) there is no theoretically and experimentally substantiated source of dark energy in nature; 2) there are two clusters of experimentally measured values of the Hubble constant that do not intersect with measurement tolerances; 3) the force of the imaginary dark energy is balanced by the force of gravitational contraction of the Hubble sphere, respectively, the acceleration modules of the imaginary expansion of the space of the Universe and the gravity factor of the observable Universe are equal to each other; 4) the space of the observable Universe is not significantly anisotropic due to the presence of the effect of its slow rotation; 5) the cosmological axis of rotation of the space of the observable Universe was experimentally discovered; 6) the Hubble constant, as the main parameter describing dark energy, is an internal immanent property of the observable Universe and is determined on the basis of its characteristics; 7) the Hubble sphere is a black hole and, by definition, cannot expand with acceleration; 8) the main physical constants of the macrocosm, first of all, the speed of light in vacuum, do not change their value in the process of imaginary expansion of the space of the universe; 9) the spectrum of thermal radiation of the Hubble sphere into the unobservable part of the Universe lies in the far infrared region of the radiation spectrum, which is shifted towards the radiation spectrum of an absolutely black body - it can be argued that dark energy and the expansion of space in the universe do not exist, and the presence of redshift from remote objects of the observable Universe in all azimuths from the observer indicates that there is a rotation of this space. The absence in nature of the expansion of the space of the universe, that is, the absence of dark energy, requires a revision of the basic equations of cosmology, namely, the equation of motion and the energy balance equation, and also requires a refinement of the mass continuity equation. In [15] the equation of motion of the observable Universe as a rotating and expanding Hubble sphere after the Big Bang is given:

$$\frac{d^2R}{dt^2} = -\frac{GM_U}{R^2} - \omega^2 R - 2\omega^2 R \sin(\Theta), \tag{35}$$

where R is the radius of the expanding and rotating Hubble sphere, M_U is the mass of the baryonic matter of the Hubble sphere; part of the matter after the Big Bang moves at an integral angle Θ to the axis of rotation, which creates the Coriolis force, ω this is the angular velocity of rotation of the Hubble sphere, which is taken equal to the Hubble parameter: $\omega = H$. Note. Without losing the physical meaning, to simplify formula (35), it is assumed that the angular velocity ω and the integral angle Θ are constant values. Multiplying the right and left sides of equation (35) by the rate of change of the sphere radius during expansion $\frac{dR}{dt}$, and then integrating it, and taking into account that $\omega = H$, we get the energy conservation law of the observable Universe:

$$\frac{1}{2}\left(\frac{dR}{dt}\right)^2 - \frac{GM_U}{R} + \frac{1}{2}H^2R^2 + H^2R^2\sin(\Theta) = A = const. \tag{36}$$

When solving equation (35) for the case $t = t_0$, that is, for the present time, it was shown in [15] that the expansion of the observable Universe after the Big Bang ended when a radius equal to that of the Hubble sphere was reached, i.e. $R = R_0$. Wherein $H = H_0$.
An analysis of the law of conservation of energy (36) shows that if we neglect the infinitely small value of the radiation energy, then the energy of the observable Universe consists of three parts: the energy of baryon matter Ω_{BM}, the kinetic energy of the space rotation of the observable Universe Ω_{KE}, and the kinetic energy, which is due to the Coriolis force Ω_{CF}. Then, taking into account the data [15] and [5] and dividing each energy component by the total energy, we obtain the energy balance of the observable Universe:

$$\Omega_{BM}\,(73.2\%) + \Omega_{KE}\,(20\%) + \Omega_{CF}\,(6.8\%) = 1. \tag{37}$$

The integral angle Θ is [15]: $\Theta = 9.79°$.
An analysis of equation (37) shows that dark energy does not exist, and its imaginary presence in nature is associated with the dual nature of the Hubble constant: the rotation of the space of the observable Universe is perceived as its expansion. Dark mass also does not exist. The imaginary presence of a dark mass in nature is associated with the kinetic energy of the space rotation of the observable Universe. If M_U this is an estimate of the value of the baryon mass of the observable Universe, then the estimate of the value of the virtual dark mass M_{Udm} is 26.8% from the value M_U.According to [14]$M_U = 1.8442238 \cdot 10^{53} kg$, then $M_{Udm} = 0.268 M_U = 4.94252 \cdot 10^{52} kg$.
Since there is currently no expansion of the space of the observable Universe, the values of its volume
V_0, baryon mass M_U and volume density ρ_0 of the baryon mass are constants. Then the equation of the law of conservation of mass (22) takes the form:

$$M_U = V_0 \rho_0 = \frac{4}{3} \pi R_0^3 \rho_0 = const. \tag{38}$$

Any hypothesis becomes a theory when the necessary and sufficient conditions for its existence are met: necessary conditions are those under which the hypothesis adequately describes the process that it represents and makes it possible to predict its behavior in the future, sufficient conditions are those under which it can be confirmed by practical use or experiment. Without sufficient conditions, a hypothesis is a strong hypothesis, but not a theory. At present, instrumental observations and experiments are limited to the Hubble sphere. Thus, in terms of space, which is outside the Hubble sphere, only hypotheses can exist and be considered, but not theories. We observe, and theory and experiment confirm that: 1) in nature there is no empty, that is, ideal space in which there is no mass-energy, 2) any gravitating object that has mass creates a gravitational field around itself, moreover, as a rule, this object has a spherical shape and, accordingly, the curvature of space under the action of a gravitational field is also spherical. This means that the parametric coefficient $k = \{1, 0, -1\}$ in its practical use is equal to: $k = 1$.
It follows from the above that the basic equations of cosmology (21), (23), (26) must be replaced by equations (35), (37), (38).

2.6 Optimization of the choice of the metric tensor for solving the Einstein GR equation

As is known, Einstein's GR gravitational field equation, which connects the components of the metric tensor $g_{\mu\nu}$ of the curved space-time with the components of the stress-energy tensor $T_{\mu\nu}$ of matter filling the space-time, has the form:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}, \tag{39}$$

where μ, ν are the indices of the running values $0, 1, 2, 3$; $g_{\mu\nu}$ this is a metric tensor; $R_{\mu\nu}$ this is the Ricci tensor, which is expressed in terms of partial derivatives of the metric tensor and shows the degree of difference between the geometry of this metric tensor and the geometry of the Euclidean space; R this is the scalar curvature of space, which is obtained by tensor convolution, that is, the operation of lowering the valence of the tensor by 1, the metric tensor and the Ricci tensor: $R = g^{\mu\nu} R_{\mu\nu}$; $\frac{8\pi G}{c^4}$ this is the Einstein constant; Λ is the cosmological constant; $T_{\mu\nu}$ is the stress-energy tensor.
To find a solution to the Einstein equation (39) means to find the form of the metric space-time tensor $g_{\mu\nu}$. Specific solutions to the Einstein equation are determined by setting the boundary, coordinate, and initial conditions, as well as choosing and setting the stress-energy tensor of matter $T_{\mu\nu}$. Most of the solutions to equation (39) are based on the metric tensor of the FLRW metric, which has the form of a diagonal matrix whose elements are the coefficients at the coordinates (t, r, θ, φ) in formula (13). If in formula (13) we take it out of brackets $R^2$and

then transform it, then the metric tensor of the FLRW-metric has the form of a 4x4 diagonal matrix:

$$g_{\mu\nu} = diag\left(c^2, -\frac{R^2}{1-kr^2}, -R^2r^2, -R^2r^2\sin^2\theta\right); g_{\mu\nu} = 0, \forall\mu \neq \nu. \tag{40}$$

As previously stated, the observable Universe, as the Hubble sphere, is a slowly rotating black hole. An analysis of the algorithm for generating the FLRW metric and the basic equations of cosmology, which are presented in formulas (1 - 29), shows that there is no optimal solution to equation (39) based on metric (40) in this case. Currently, there are solutions to equation (39): 1) for a black hole, which was proposed by Schwarzschild [23] based on the Schwarzschild metric of a spherically symmetric space, 2) for a rotating space, which was proposed by Gödel [24, 25] based on the Gödel metric, 3) for a rotating black hole, which was proposed by Kerr [26, 27] based on the Kerr metric. The space-time interval in the Schwarzschild metric has the form [23]:

$$ds^2 = \left(1-\frac{R_S}{r}\right)c^2dt^2 - \left(1-\frac{R_S}{r}\right)^{-1}dr^2 - r^2d\theta^2 - r^2\sin^2\theta d\varphi^2, \tag{41}$$

where $R_S = \frac{2MG}{c^2}$ is the Schwarzschild radius, M is the mass of a spherically symmetric space. Then the metric tensor in the Schwarzschild metric has the form:

$$g_{\mu\nu} = diag\left(\left(1-\frac{R_S}{r}\right)c^2, -\left(1-\frac{R_S}{r}\right)^{-1}, -r^2, -r^2\sin^2\theta\right); g_{\mu\nu} = 0, \forall\mu \neq \nu. \tag{42}$$

The metric Schwarzschild tensor describes the gravitational field of a non-rotating black hole and the gravitational field outside a non-rotating symmetrical spherical massive body.
The space-time interval in local spatial rectangular coordinates in the Gödel metric has the form [24, 25]:

$$ds^2 = b^2\left[dx_0^2 - dx_1^2 + \frac{1}{2}e^{2x_1}dx_2^2 - dx_3^2 + 2e^{x_1}(dx_0dx_2)\right], \tag{43}$$

where b^2 is a constant that depends on the angular frequency of space rotation ω, it can be represented as: $b^2 = \frac{1}{2\omega^2}$.
As can be seen from formula (43), due to the presence of space rotation, non-zero elements appeared in the Gödel metric tensor that is outside the main diagonal of the matrix. These are the elements g_{03} and g_{30}. The Gödel metric tensor has the form:

$$g_{\mu\nu} = \begin{bmatrix} b^2 & 0 & 2b^2e^{x_1} & 0 \\ 0 & -b^2 & 0 & 0 \\ 2b^2e^{x_1} & 0 & \frac{1}{2}b^2e^{2x_1} & 0 \\ 0 & 0 & 0 & -b^2 \end{bmatrix}. \tag{44}$$

The Gödel metric does not take into account the mass of rotating space. The rotating mass generates angular momentum. If a part of the substance during rotation moves at an angle to the axis of rotation, then the angular momentum of rotation is equal to the sum of the angular moments caused by the rotation itself and the Coriolis force.
The Kerr metric [28] in the Boyer–Lindquist form for a rotating black hole is:

$$ds^2 = \left(1-\frac{R_Sr}{\Sigma}\right)c^2dt^2 - \frac{\Sigma}{\Delta}dr^2 - \Sigma d\theta^2 - \left(r^2+u^2+\frac{R_Sru^2\sin^2\theta}{\Sigma}\right)\sin^2\theta d\varphi^2 + \frac{2cR_Sru\sin^2\theta}{\Sigma}dtd\varphi, \tag{45}$$

where: $u = \frac{J}{Mc}; \Sigma = r^2 + u^2\cos^2\theta; \Delta = r^2 - R_Sr + u^2; J, M-$ is the angular momentum and the mass of the black hole; R_S is the Schwarzschild radius.
Let be: $W = \left(r^2+u^2+\frac{R_Sru^2\sin^2\theta}{\Sigma}\right)\sin^2\theta; V = \frac{2cR_Sru\sin^2\theta}{\Sigma}; U = \left(1-\frac{R_Sr}{\Sigma}\right)c^2.$

Then the metric tensor of the Kerr metric has the form:

$$g_{\mu\nu} = \begin{bmatrix} U & 0 & V & 0 \\ 0 & -\frac{\Sigma}{\Delta} & 0 & 0 \\ V & 0 & -\Delta & 0 \\ 0 & 0 & 0 & -W \end{bmatrix}. \tag{46}$$

The article [29] presents an algorithm for calculating the components of the Ricci tensor $R_{\mu\nu}$, of the stress-energy tensor of matter $T_{\mu\nu}$ and scalar curvature R in the Kerr metric for the Einstein equation (39). The solution of Einstein's equation (39), for the gravitational field of the observable Universe, which most fully corresponds to modern experimental observations, should be based on the Kerr metric (46).

2.7 Correct choice of reference system in cosmology

The correct solution to many problems of physics, astrophysics, and cosmology, in particular, for example, those related to the motion of matter, depends on the correct choice of a reference system, that is, a system of spatial coordinates with a time reference system specified in it. An example is the revolutionary change in the worldview of mankind during the transition from the Geocentric reference system to the Heliocentric reference system. In cosmology, depending on the type of problem being solved, for the matter that moves at a speed much lower than the speed of light, it is advisable to use four hierarchical reference systems: 1) limited local reference system, the center of spatial coordinates of which is associated with the center of mass of a particular galaxy, 2) local reference system, the center of spatial coordinates of which is connected with the center of mass of the cluster of galaxies, 3) a global reference system, the center of spatial coordinates of which is associated with the conditional center of the baryon mass of the observable Universe, as of a Hubble sphere, 4) an absolute reference system, the center of spatial coordinates of which is associated with any point of the unobserved part of the Universe, for which the observable Universe can be represented as a dimensionless material point whose mass is equal to the baryon mass of the observable Universe.

2.8 The problem of the cosmological constant

If in equation (39) we transfer the term $\Lambda g_{\mu\nu}$ from the left side to the right side, then the right side will represent the stress-energy tensor, taking into account the vacuum energy. The vacuum energy density is equal to: $\frac{\Lambda c^4}{8\pi G}$, so the cosmological constant in Einstein's equation (39) is defined as a characteristic of vacuum in the space-time of the Universe. Let us consider the region of the space-time of the Universe, in which the vacuum approaches its absolute value, that is, the region of the space-time of the Universe, in which the curvature is an infinitesimal value and is practically absent, and the elements of the geometry of the curvature of this space can be neglected, then equation (39) has the form:

$$\Lambda = \frac{8\pi G}{c^4} T_{\mu\nu}. \tag{47}$$

We set the stress-energy tensor $T_{\mu\nu}$ in equation (47) in Friedman's version, but instead of the dust density, we consider the density of the baryonic matter of the observable Universe. The Friedmann's stress-energy tensor consists of one element: $T_{\mu\nu} = T_{00}$. The remaining elements of this tensor are equal to zero. Then:

$$T_{\mu\nu} = T_{00} = \rho_0 c^2; T_{\mu\nu} = 0, \forall \mu, \nu > 0, \tag{48}$$

where the baryonic matter density of the observable Universe ρ_0 is determined from equation (38):

$$\rho_0 = \frac{M_U}{V_0} = \frac{3M_U}{4\pi R_0^3}. \tag{49}$$

It is known [14] that the Newtonian constant of gravity can be represented as:

$$G = \frac{R_0^3}{M_U T_0^2} = \frac{R_0 c^2}{M_U}. \tag{50}$$

Taking into account formulas (49) and (50), the cosmological constant Λ is equal to:

$$\Lambda = \frac{8\pi G}{c^4} T_{\mu\nu} = \frac{6}{R_0^2}. \tag{51}$$

This means that the dimension of the cosmological constant, as well as the dimension of the right and left sides of Einstein's equation (39), is inversely proportional to the surface area, that is: $[m^{-2}]$. On the other hand, $\frac{1}{R_0^2}$ this is the Gaussian curvature of the ideal Hubble sphere. Let the Hubble radius R_0, that is, the radius of the observable Universe is [14]: $R_0 = 1.3692928247 \cdot 10^{26} m$,
then:

$$\Lambda = \frac{6}{R_0^2} = 3,20006 \cdot 10^{-52} m^{-2}. \tag{52}$$

The main problem of the cosmological constant is the contradiction between the predictions of the theory, primarily Einstein's GR, and the experimental measurements of this quantity. Steven Weinberg in the late 80s of the last century in his lectures [30] identified five approaches to solving this problem, namely through: 1) supersymmetry, supergravity, and superstrings; 2) anthropic principle; 3) mechanisms for adjusting gauge fields; 4) modification theories of gravity; 5) quantum cosmology. However, none of these approaches yielded results. And I couldn't give. This is because a physical meaning is attached to the cosmological constant, which does not correspond to it. At present, the expansion of the space of the universe after the Big Bang has ended. The boundary of the observable universe is the surface of the Hubble sphere. As can be seen from equation (52), the cosmological constant has the dimension of the curvature of a spherical space. Moreover, numerically the value of the cosmological constant is close to the value of the Gaussian curvature of the ideal Hubble sphere. And since dark energy does not exist, the space of the observable Universe does not expand, then the physical meaning of the cosmological constant is a characteristic of the vacuum curvature of the Hubble sphere.

2.9 The problem of theoretical models of the origin and general structure of the Universe

The most common models of the origin and general structure of the Universe are: 1) Model of the hot Universe formed as a result of the Big Bang. This model is characterized by the presence of cosmic microwave background radiation that arose after the Big Bang. It shows how primary nucleosynthesis took place and how chemical elements were formed. The presence of the Big Bang is confirmed by experiments on relict radiation. 2) A set of models of the expanding Universe, which are based on Einstein's GR and Hubble's law. Among these models, the ΛCDM model is currently the most widely used. This is a model based on FLRW metrics with generally accepted parameters: A) matter density: a) total; b) critical; c) baryonic; d) dark; e) dark energy B) Hubble constant; C) the age of the universe since the Big Bang. A common drawback of models 1) and 2) is the problem of cosmological singularity. In cosmology and astrophysics, one of the basic, fundamental concepts is the concept of a geodesic line or a line of minimal action. A geodesic line is the trajectory of a free test particle in a gravitational field in the absence of external forces acting on it. Geodesic lines are determined from the equations of motion. Since the motion of a test particle occurs in a gravitational field, the equations of its motion can be obtained based on Einstein's equations. Under certain initial conditions and restrictions, the solutions of the Einstein equations lead to the fact that all geodesic lines extended into the "past" converge to one point, which is called the gravitational singularity point. This is a point with an infinitely large mass density

at which Einstein's equations have no solution. Extending the concept of a gravitational singularity to the Universe, we come to the concept of a cosmological singularity: there was a period in the history of the Universe when it existed as a point of singularity with infinite values of mass density, temperature, and pressure. The presence of a singularity point in the history of the Universe was proved by Stephen Hawking [31, 32, 33, 34] based on the ideas of R. Penrose [35].
3) A set of inflationary models. These models are based on a scalar field called inflanton. In a causally related region, small in terms of cosmological scales, kinetic energy is accumulated. Starting from a certain critical threshold value of energy, and under its action, an almost instantaneous expansion of the causally connected area occurs. The value of the scalar inflanton potential drops sharply at the beginning of the process, and then slowly decreases with time. This character of the inflanton change explains the uniformity of the Universe and the relatively flat space-time geometry. Since there are many ways to define a scalar field, there are correspondingly many inflationary models. As a rule, all these models have in common the behavior of the scalar field potential – this potential slowly decreases to zero. There are also models, such as Linde's chaotic inflation, which allow for the repeated accumulation of inflation due to quantum fluctuations. A common drawback of these models is large temperature drops during the inflationary expansion of space-time, as well as the problem of initial conditions at the initial moment of inflationary expansion, for example, how quantum fluctuations in the period before inflationary expansion led to those values of space-time curvature and its homogeneity, which we are watching now.

2.10 Problems of the Big Bang, singularity point, initial conditions, and restrictions. Fractal model of the Universe

Stephen Hawking [31, 32, 33, 34] showed that a strong energy condition is required for a gravitational singularity to occur:

$$T_{ab}W^aW^b > \frac{1}{2}W_aW^aT, \tag{53}$$

where T_{ab} is the stress-energy tensor, a, b these are indices that take values 0, 1, 2, 3, W this is any non-spacelike vector (that is, it is a timelike vector or a null vector), Tit is a trace of the stress-energy tensor matrix. Assuming that condition (53) is valid for the singularity point of the Universe before the Big Bang, we supplement it with the possible limiting parameters of this point. To determine such parameters, consider a model of the general structure of the Universe, which differs from models 1), 2), and 3). Postulate. Matter, its main attributes: space, mass-energy, time, and structure existed, exist, and will always exist. The logical semantic form that unites our knowledge of the main attributes of matter into one whole is the Universe. The Universe can be conditionally divided into the observable part, that is, the part that is accessible to human instrumental observations, and the unobservable part. The consequence from the postulate: the singularity point, the Big Bang, and the observable Universe formed after it is an infinitely small episode in terms of spatial dimensions, energy, and time duration in the history of the existence of matter and, accordingly, of the Universe. Observations of matter show that it has a hierarchical fractal structure [36, 37]. Accordingly, the form of representation of matter - the Universe also has a hierarchical fractal structure [38]. According to [38], the Universe consists of an infinite number of spatial and hierarchic fractal-spherical levels of matter that are nested within each other. In ascending order of spatial hierarchy, the following fractals Universe that is conventionally associated with the types of interactions of matter: nuclear, atomic, electromagnetic, and gravitational. Each fractal is characterized by finite geometrical dimensions and a finite value of its energy, consequently, by the finite value of the spatial density of energy. There are basic fractals, these are: nuclear, electromagnetic, gravitational, and transitional fractals, which are located between the main ones, such, for example, is the atomic fractal located between the nuclear and electromagnetic fractals. The transition atomic fractal has a spherically toroidal shape. The boundary of the observable Universe is the surface of the Hubble sphere. It is the boundary of the electromagnetic fractal. There is a transitional fractal between the electromagnetic fractal and the senior gravitational fractal. It is the spherically toroidal space between the surface of the Hubble sphere and the surface of the Schwarzschild sphere. Let's call it the Hubble-Schwarzschild fractal. The radius of the Schwarzschild sphere is twice the radius of the Hubble sphere, therefore the spatial volume of the Hubble-Schwarzschild fractal is seven times greater than the spatial volume of the observable Universe - the Hubble sphere. Since the surface of the Schwarzschild sphere is the event horizon of a black hole, the Hubble-Schwarzschild fractal is a powerful gravitational barrier that prevents both the expansion of the space of the observable Universe after the Big Bang and the ejection of mass-energy beyond this spherically toroidal space. If the gravitational fractal is approximately energetically homogeneous, then it contains more than 10^{37} electromagnetic fractals similar to the observable Universe. It can also be assumed that there exist fractals that are older than the gravitational ones. As the seniority of fractals grows, the spatial and energy inflation of matter grows. A huge number of chaotically moving electromagnetic fractals in the gravitational fractal of the Universe regularly leads to their mutual collisions, which creates a kind of natural collider in it, so the Big Bang was most likely caused not by quantum fluctuations at the singularity point, but by the collision of this point with the neighboring Universe. Such an outcome of events is confirmed by experimental studies on cosmic microwave background radiation [39, 40]. Four anomalous spots were found in the CMB, which could have appeared as a result of collisions of the singularity point with neighboring Universes, and one of the collisions could have led to the Big Bang. Since two clusters of non-overlapping values of the Hubble constant are observed, the singularity point was slowly rotating before the Big Bang, and the impact gave it an additional momentum of rotation. Due to the fact that the Coriolis force contributes to the kinetic energy of rotation, the direction of the impact force was at an angle to the axis of rotation. This direction of impact could also lead to a certain precession of the rotation axis of the observable Universe [16, 17, 18].

The collision energy was so strong that it did not lead to the complete destruction of the singularity point and the disappearance of its remnants in the space of the gravitational fractal of the Universe. But this energy turned out to be enough to eject mass-energy from the singularity point and expand its space to the boundary of the Hubble sphere. Since the surface of the Hubble sphere is a powerful gravitational barrier, the amount of baryonic matter that was ejected after the Big Bang into the Hubble-Schwarzschild transition fractal was not significant. Therefore, in the first approximation, taking into account the law of conservation of mass-energy, we can assume that the mass of the singularity point M_{ps} is equal to the mass of the baryonic matter of the observable Universe. It follows from the above that the first limiting parameter of the singularity point is its mass - it does not exceed the mass of the baryonic matter of the observable Universe, that is: $M_{ps} \approx M_U = 1.8442238 \cdot 10^{53} kg$. The maximum possible force in nature that corresponds to this mass is the Planck force: $F_P = m_P \frac{l_P}{t_P^2} = M_U \frac{R_0}{T_0^2} \approx 1.210 \cdot 10^{44} kg^1 m^1 s^{-2}$, where m_P, l_P, t_P is the mass, length, and Planck time, R_0, T_0 is the Hubble radius and time. The maximum possible pressure that can act in nature is the Planck pressure: $P_P = \frac{F_P}{l_P^2}$. The second limit parameter follows from the Planck pressure formula - this is the minimum size of the singularity point - it cannot be less than the Planck length l_p. Let us estimate the maximum possible size of the singularity point. We proceed from the fact that the matter of the singularity point consisted of quark-gluon plasma. The nucleus of an atom, the proton, also consists of quark-gluon plasma. According to [41, 42], the estimates of the proton radius and mass are approximately equal:
$r_{pr} \approx 0.84 \cdot 10^{-15} m; m_{pr} \approx 1.6726 \cdot 10^{-27} kg$. Then the estimate of the volume density of the proton mass is approximately equal to: $\rho_{pr} \approx 6.737 \cdot 10^{17} kg^1 m^{-3}$. This volumetric mass density with the mass of the singularity point $M_{ps} \approx M_U = 1.8442238 \cdot 10^{53} kg$ corresponds to the estimate of the maximum possible radius of the singularity point: $R_{ps} \approx 4.03 \cdot 10^{11} m$, or 403 million km,

which is more than the distance from the Sun to Mars, but less than to Jupiter. This implies a restriction on the size of the radius of the singularity point: $l_P = 1.616255 \cdot 10^{-35} m \leq R_{ps} < 4.03 \cdot 10^{11} m$.

Intermediate conclusion. Before the Big Bang, a singularity point of a spherical shape, with a mass of about $M_{ps} \approx M_U = 1.8442238 \cdot 10^{53} kg$, and a radius within: $l_P = 1.616255 \cdot 10^{-35} m \leq R_{ps} < 4.03 \cdot 10^{11} m$, slowly rotating, chaotically moved in the space of the gravitational fractal of the Universe. In the process of movement, it periodically collided with neighboring universes. Around this point, in accordance with [22] and the laws of conservation of matter and energy, there was a gravitational field in the form of a standing gravitational wave in the space of the gravitational fractal of the Universe. The structure of this gravitational field is represented as a set of hierarchical, spherical, nested equipotential surfaces centered at the singularity point, and separated from each other by a quantization step, which is equal to the length of a standing gravitational wave. The quantization step of a standing gravitational wave is equal to the radius of the Hubble sphere R_0. Thus, the first equipotential gravitational surface of the gravitational field of the singularity point is the surface of the Hubble sphere, the second is the surface of the Schwarzschild sphere, and so on, a multiple of the integer number series: $1R_0, 2R_0, 3R_0, ...NR_0, ...$

One of the collisions of the singularity point with the neighboring universe led to the Big Bang. The energy of the collision was less than the gravitational energy of the Hubble-Schwarzschild transition fractal, so the main part of the matter in the process of expanding the space of the singularity point after the Big Bang (collision) remained within the Hubble sphere. Since the experimental data indicate at least four collisions of the singularity point, its initial rotation and possible precession of the rotation axis could be caused by these collisions. In the study of the singularity point, an important aspect, including the question of epistemology, is the following: how the observable Universe with relatively deterministic laws arose from chaotic quantum fluctuations at the singularity point. If we exclude the divine principle from this aspect, then the only logical conclusion is the following: all modern laws, calibrated by the scale factors of the corresponding structural levels of matter, existed at the singularity point before the Big Bang. This statement also applies to the initial conditions of existing laws and their limitations. The basis for such a statement is the Yang-Mills equations, which are basic for quantum chromodynamics (the theory of strong interactions) and the theory of electroweak interactions. As is known, quantum chromodynamics describes the strong interactions between quarks and gluons in the atomic nucleus. The presence of deterministic Yang-Mills equations, which describe the behavior of quark-gluon plasma, makes it possible to assert by analogy the existence of proto-laws, their initial values, and limitations of the modern observable Universe at the singularity point before the Big Bang. This statement is strengthened by the fundamental law of nature on the conservation of matter, its motion, energy, and structure. The structure of matter and the laws of its development cannot arise from nowhere and they can never disappear into nowhere, but can only change.

2.11 The problem of connection between the Standard Model of physics and gravitational interaction

As is known, within the framework of the Standard Model of physics, three physical interactions are combined: electromagnetic, electroweak, and strong. The gravitational force, which is described by Einstein's equation, stands apart from the Standard Model of physics and is not unified with the other three physical forces. The gravitational field has two fundamental properties: 1) it bends space-time around the gravitating object, and 2) it creates gravitational viscosity, which prevents and resists movement and also limits the speed of this movement, which is shown in [22]. Einstein's equation is based on the first property of the gravitational field - conditionally geometric, and as mentioned earlier, the left and right sides of this equation have a geometric dimension $[m^{-2}]$. At the same time, for example,

the dimensions of the Maxwell equations, as the basic equations of electromagnetism, have nothing to do with the dimension of the equations Einstein:
1. Gauss equation for electric field:
Left side: electric field divergence. Dimension: $\left[C^1 m^{-3}\right]$,
Right side: electric charge density. Dimension: $\left[C^1 m^{-3}\right]$.
2. Gauss equation for the magnetic field:
Left side: magnetic field divergence. Dimension: $\left[Tl^1 m^{-1}\right]$,
Right side: zero (there are no magnetic charges in a vacuum).
3. Faraday's law:
Left side: electric field rotor. Dimension: $\left[V^1 m^{-1}\right]$,
Right side: change of the magnetic field with time. Dimension: $\left[Tl^1 s^{-1}\right]$.
4. Ampère's law with an additional Maxwell term:
Left side: magnetic field rotor. Dimension: $\left[A^1 m^{-1}\right]$,
Right side: the sum of two terms - the displacement current and the change in the electric field over time. Dimension: $\left[A^1 m^{-1}\right]$.
There are two options for searching for a connection between gravitational and electromagnetic interactions, which are based on the basic properties of the gravitational field. In the first variant, it is necessary to transfer the Einstein constant from the right side of the formula (39) to its left side:

$$\frac{c^4}{8\pi G} R_{\mu\nu} - \frac{c^4}{16\pi G} R g_{\mu\nu} + \frac{c^4}{8\pi G} \Lambda g_{\mu\nu} = T_{\mu\nu}. \tag{54}$$

Or, given that: $F_P G = c^4$, where F_P is the Planck force, which is the maximum possible value of the force in the observable Universe, equation (54) can be represented in a more convincing "energetic" form:

$$\frac{F_P}{8\pi} R_{\mu\nu} - \frac{F_P}{16\pi} R g_{\mu\nu} + \frac{F_P}{8\pi} \Lambda g_{\mu\nu} = T_{\mu\nu}. \tag{55}$$

Then the left and right parts of Einstein's equation (55) will have the dimension of the stress-energy tensor: $\left[kg^1 m^{-1} s^{-2}\right]$. If the tensor $T_{\mu\nu}$ in equation (55) is the stress-energy tensor of the electromagnetic field, then this option is unpromising. This is because, within the framework of his paradigm, there is a break in the logical pattern: the left side of equation (55) describes the curvature of space-time under the action of the stress-energy tensor of the electromagnetic field, which is located on the right side of this equation, which, due to insufficient energy of the electromagnetic field for the curvature of the space-time of the observable Universe, does not correspond to reality. In other words, equation (55) with the stress-energy tensor of the electromagnetic field can be a solution for the local space-time and cannot be a solution for the entire space-time of the observable Universe. If we use the stress-energy tensor $T_{\mu\nu}$, for example, the baryonic matter of the observable Universe, then in this version there are no obvious transformations of the electromagnetic field dimensions: Coulomb, Volt, Ampere, Tesla in the gravitational field dimensions: meter, kilogram, second.
A more promising option for searching for the relationship between gravitational and electromagnetic interactions is the option that is based on the second quantum-wave fundamental property of the gravitational field. Within the framework of this option, the main characteristics of the electromagnetic field - the electric field strength vector $\overrightarrow{E}$ and the magnetic induction vector of the magnetic field $\overrightarrow{B}$, based on the ideas and algorithm presented in [22, 43] can be expressed through the characteristics of the gravitational field: meter, kilogram, second. It is shown in [43] that:
1) the electric charge q is a function of the moment of mass:

$$q = \sqrt{10^7 \alpha m_P l_P} = \sqrt{10^7 \alpha m_e \lambda} = \sqrt{10^7 \alpha m_{pr} \lambda_{pr}} = \sqrt{10^7 \alpha m_n \lambda_n} = \sqrt{10^7 \alpha m_\mu \lambda_\mu} = \sqrt{10^7 \alpha m_\tau \lambda_\tau}, \tag{56}$$

where: α is the fine structure constant; $m_P, m_e, m_{pr}, m_n, m_\mu, m_\tau$ is the mass respectively – of the Planck, of the electron, of the proton, of the neutron, of the muon, of the tau; l_P is the Planck length;
λ, $\lambda_{pr}, \lambda_n, \lambda_\mu, \lambda_\tau$ this is the Compton wavelength (over 2pi) of the electron, of the proton, of the neutron, of the muon, of the tau, respectively.
Whence the dimension of electric charge is expressed in terms of gravity units: meter and kilogram:

$$[q] = [C] = \left[kg^{\frac{1}{2}}m^{\frac{1}{2}}\right]; \tag{57}$$

2) Coulomb's law can be represented in the gravitational form [42]:

$$F_C = k_e\frac{q^2}{r_{12}^2} = G\alpha\frac{m_P^2}{r_{12}^2}, \tag{58}$$

where F_C is the Coulomb force, k_e is the electric force constant, r_{12} is the distance between charges; 3) in nature, there is an experimentally and theoretically confirmed gravitational-electromagnetic resonance [15, 22, 43, 44], which shows the existence of a connection between the electromagnetic interaction and the gravitational interaction;
4) the basic units of electromagnetism: Ampere, Volt, Ohm, Tesla, Coulomb. . . , can be expressed in terms of the basic units of gravity: meter, kilogram, second [43];
5) the gravitational field, like the electromagnetic field, has a quantum-wave character. Any gravitating object forms around itself a standing gravitational wave in the form of a set of hierarchical spherical equipotential surfaces with a wavelength that is equal to the quantization step and is proportional to the mass of the gravitating object. The quantum of the gravitational field is the square of the speed of light in a vacuum, and its physical nature is the kinematic gravitational viscosity of the gravitational field of the baryonic matter of the observable Universe [22];
6) the propagation medium of electromagnetic waves in vacuum, which is determined by the vacuum magnetic permeability $\mu_0\left[H^1m^{-1}\right]$ and vacuum dielectric permittivity $\varepsilon_0\left[F^1m^{-1}\right]$, is determined and based on the kinematic gravitational viscosity $c^2\,[m^2s^{-2}]$ (c is the speed of light in vacuum) of the gravitational field of the baryonic matter of the observable Universe:

$$c^2 = \frac{1}{\varepsilon_0\mu_0}. \tag{59}$$

In [43] it is shown that the dimension of inductance in the dimension of gravity is the dimension of length: $\left[H^1\right] = \left[m^1\right]$, and the dimension of electric capacitance in the dimension of gravity is the reciprocal of acceleration, that is, this deceleration: $\left[F^1\right] = \left[m^{-1}s^2\right]$, then formula (59), expressed in terms of dimensions, has form:

$$[m^2s^{-2}] = \frac{1}{[m^{-1}s^2m^{-1}][m^1m^{-1}]} = [m^2s^{-2}].$$

It is noteworthy that the physical nature of the vacuum magnetic permeability μ_0 is the linear density of the vacuum inductance $\left[H^1m^{-1}\right]$, and the physical nature of the vacuum dielectric permittivity ε_0 is the linear density of the vacuum electric capacitance $\left[F^1m^{-1}\right]$.
Based on 1), 2), 3), 4), 5), and 6) it can be argued that the electromagnetic field is a special case of the gravitational field. Then the components of the electromagnetic field - the electric field strength vector $\overrightarrow{E}$, and the magnetic induction vector of the magnetic field $\overrightarrow{B}$, can be represented in gravitational form, that is, in the dimensions of a meter, kilogram, second:

$$\overrightarrow{E} = \overrightarrow{e}\cdot|e|\cdot\frac{\sqrt{M\cdot S}}{t^2}, \left[kg^{\frac{1}{2}}m^{\frac{1}{2}}s^{-2}\right], \tag{60}$$

$$\overrightarrow{B} = \overrightarrow{b} \cdot |b| \cdot \frac{\sqrt{M_b}}{t \cdot \sqrt{S_b}}, \left[kg^{\frac{1}{2}} m^{-\frac{1}{2}} s^{-1}\right], \tag{61}$$

where $\overrightarrow{e}$, $\overrightarrow{b}$ are the unit vectors that coincide with the direction of the vectors $\overrightarrow{E}, \overrightarrow{B}$; $|e|, |b|$ these are calibration coefficients that equalize the dimensions and absolute values of the left and right parts of formulas (60, 61); M, M_b, S, S_b some generalized values of mass and length; t this time. Vectors
$\overrightarrow{E}, \overrightarrow{B}$ in the form (60, 61) are substituted into Maxwell's equations, then their left and right parts will have the dimensions: meter, kilogram, and second. This approach makes it possible to establish a connection between the electromagnetic and gravitational interactions.

2.12 Duality of time. Traditional or mathematical time and real or physical time. Inflation of the main attributes of the Universe

The problem of time, its course (flow), as well as its relationship with two other attributes of matter - space, and mass (energy), occupies one of the central places in philosophy, cosmology, and astrophysics. Many works are devoted to the solution of this problem, and in particular, for example, [33, 44] it is noted that in the Newtonian theory and the usual quantum theory, time is the source of:
1) the ordering of events, 2) the duration measured between events, 3) simultaneity, that is, synchronization of distant events, 4) the direction of the flow from the past through the present to the future, 5) changes and transitions, that is, the fact of the flow of time, 6) the continuity of the flow of time, 7) the monotonous and progressive nature of this flow, that is, time cannot turn back or close. The Special and General Theories of Relativity have corrected the fundamental characteristics of time: the monotony of the flow of time, and the simultaneity and synchronism of distant events are not fundamental characteristics of time. That is, according to these theories: 1) for each material point of the Universe, time flows along timelike world lines, therefore proper time along world lines is a fundamentally preferred time parameter. Proper time is measured by the space-time metric, and this metric determines the length of time between events; 2) the monotonicity and progression of time in the Gödel and Kerr metrics can be broken and closed time-like lines can appear in these metrics. To solve the above problems related to the concept of time, various approaches and methods are used. For example, to search for the origins of time, researchers go to the quantum level of matter. At this level, as is known, the main equation of motion is the Schrödinger equation:

$$\widehat{H}\Psi(x, y, z, t) = i\hbar \frac{\partial \Psi(x, y, z, t)}{\partial t}, \tag{62}$$

where $\widehat{H}$ is the Hamiltonian operator, which is the sum of the kinetic and potential energy operators in a quantum system; $\Psi(x, y, z, t)$ is the wave function of the quantum particle; i is the imaginary unit
($i^2 = -1$); $\hbar$ is the reduced Planck constant. The Schrödinger equation describes how the wave function of a system changes with time under the influence of the Hamiltonian operator.
A feature of equation (62) is that the wave function has a probabilistic character. The square of the modulus of the wave function $\left|\Psi(x, y, z, t)\right|^2$ determines the probability of finding $P(x, y, z, t)$ a quantum particle in a certain state:

$$P(x, y, z, t) = \left|\Psi(x, y, z, t)\right|^2 \Delta V_a, \tag{63}$$

Where ΔV_a is the volume element around some point a, in the vicinity of which the quantum particle is located. The probabilistic nature of the wave function leads logically to the Heisenberg uncertainty principle:

$$\Delta x \Delta p \geq \frac{\hbar}{2}, \tag{64}$$

where $\Delta x, \Delta p$ are respectively the measurement uncertainty of the particle position (standard deviation) along a certain direction and the measurement uncertainty of the particle momentum (standard deviation) along the same direction. Relation (64) shows that there is an inevitable limitation on the accuracy of the simultaneous determination of the position and momentum of a particle. The more accurately we measure one of the quantities (for example, the coordinate), the less accurately we can measure the other quantity (for example, momentum) and vice versa. Another feature of the wave function is the superposition of quantum states and the quantum entanglement of quantum particles. It follows from this feature that a quantum particle can exist in uncertain states until the moment of observation (Schrödinger's cat). Only at the moment of observation (that is, actually measurement) this uncertainty is removed. The probabilistic nature of the wave function, the Heisenberg uncertainty principle, the superposition of quantum states and the quantum entanglement of quantum particles show that the initial conditions and the equation of motion of quantum particles do not give an unambiguous answer about their behavior in the future. This means that the flow of time in the microcosm differs from the flow of time in the macrocosm, where the setting of the equation of motion and initial conditions completely determine the behavior of a material particle in the future. The above confirms the ambiguous nature of time as one of the main attributes of matter. The solution to the problem of time in the macrocosm is usually based on quantum gravity and on the Wheeler-DeWitt equations, which combine General Relativity and quantum mechanics. If the Universe is considered as a quantum mechanical system, then the wave function in equation (62) is the wave function of the Universe $\Psi\left[g_{\mu\nu}\right]$, depending only on its metric space-time tensor $g_{\mu\nu}$ and independent of time. Then the Wheeler-DeWitt equation is:

$$\widehat{H}\Psi\left[g_{\mu\nu}\right] = 0. \qquad (65)$$

The role of the Hamiltonian $\widehat{H}$ in formula (65) differs from its role in formula (62). In the Wheeler-DeWitt equation, the Hamiltonian $\widehat{H}$ plays the role of a limiter; it limits the set of kinematic states of the Universe to a subset of kinematic states that follow gauge orbits. When quantized, the subsets of kinematic states on the gauge orbits become wave functions, and their restriction by the Hamiltonian leads to the equality of the right side of eq. (65) to zero. There is no time in the Wheeler-DeWitt equation. The absence of time in the Wheeler-DeWitt equation allowed some researchers to assert about timelessness on the scale of the entire Universe. For the time formula to appear on the right side, the metric space-time tensor $g_{\mu\nu}$ must be localized in some limited region of the space-time of the Universe. Then a time-dependent wave function will appear on the right side of the formula (65). In other words, time is not an absolute concept, but a local one. It follows from the above that time is a multifaceted attribute of matter. One of the possible reasons for the lack of a generally accepted and comprehensive interpretation of the multifaceted concept of time lies in a one-sided approach to this concept, an attempt to describe this attribute only within the framework of one or more theories, based on one or more properties of time, and leaving it outside the scope of research its other properties.

Of the many facets that reflect the concept of time, the most relevant are two: 1) time is traditional, or conditionally - mathematical. This is the time that is used in all mathematical formulas, reference systems, people's daily life, their research, etc. Time in the traditional sense is a continuous series of successive readings of established standards of duration; 2) the real time, or conditionally - physical. The real time is a structured space in which mass-energy is present. Let us show a possible connection between mathematical time and physical time. To do this, consider a hypothetical, speculative experiment. The purpose of the experiment is to establish whether there is a hierarchy between the main attributes of matter and what their relationship is. As an instrumental resource of the experiment, we use the concept of existence. Is it possible to imagine the existence of each of the attributes of matter: space, mass-energy, structure, and time separately from the other two? Yes, it is hypothetically possible to admit the existence of some ideal space, but it is impossible to imagine and admit, even hypothetically, the existence of mass-energy, structure, and (or) time outside of space. So, the hierarchy exists and at its top there is space. The ideal space lacks any curvature, standards, sizes, and directions. A non-material point in it moves at an infinite speed, which turns it into null space. There is no ideal space in nature. What attribute of matter is the second in the hierarchy? Of course, this is mass-energy. With the appearance of a material point in ideal space, a hierarchical spherical standing gravitational wave is formed around this point, and under its action, the ideal space will be curved and it will turn into a real structured space. The gravitational field will create gravitational viscosity, which will limit the speed of movement of material objects in real space from an infinite value to a specific value, such as the speed of light in the observable Universe. Moreover, what is very important, the maximum possible rate of transfer of physical interaction is necessarily determined by the main spatial and energy characteristics of that region of the Universe, which is limited by an energetically determined radius. For example, for the observable Universe, this is the speed of light according to formula (34), for an atom, this is the speed of an electron in the Bohr orbit, which is less than the speed of light by the fine structure constant. It will be possible to establish standards, which will entail the appearance of dimensions. So, in the second place in the hierarchy of attributes is mass-energy. With the appearance of a quantum-wave viscous gravitational field, real space will acquire structure and time. Consequently, the structure of matter and time is in the third or fourth place in the hierarchy of attributes. The presence of standards and dimensions allows you to set the standard of traditional time. Consider the interval between distant events in the 4-dimensional Minkowski space:

$$s^2 = c^2t^2 - x^2 - y^2 - z^2. \tag{66}$$

Differentiate the right and left sides of formula (66) with respect to time and then reduce them by a common factor of 2, then:

$$s\frac{ds}{dt} = c^2t - x\frac{dx}{dt} - y\frac{dy}{dt} - z\frac{dz}{dt}. \tag{67}$$

We denote the speed $V = \frac{ds}{dt}$, and its projections on the axis x, y, z: $V_x = \frac{dx}{dt}, V_y = \frac{dy}{dt}, V_z = \frac{dz}{dt}$, and then determine the time t based on the formula (67):

$$t = \frac{sV + xV_x + yV_y + zV_z}{c^2}. \tag{68}$$

It follows from formula (68) that physical time is a real space, that is, a space in which mass-energy is present. The general rate of change of physical time is given by the value of the kinematic gravitational viscosity, that is, the square of the speed of light in a vacuum c^2. Thus, physical time is not a separate self-sufficient attribute of matter. Time is a complex integral characteristic of real space. Therefore, the term space-time, while possibly being correct in form, is not correct in content, since it is translated into the term space-real space. More correct, including according to the hierarchy of attributes, is the term space-energy. Formula (68) confirms that the real time is local.

It is shown in [44] that any gravitating object, including the observable Universe, has three self-sufficient characteristics: 1) mass 2) gravitational quantization step, that is, the length of a standing gravitational wave 3) delay time for the propagation of a light signal over a distance equal to the step quantization Knowing one of the characteristics, based on Planck's Universal Proportions [44], it is possible to determine the other two. The self-sufficiency of the above characteristics is based, for example, on their ability to independently estimate the energy of a gravitating object E :

$$E = mc^2 = F_P S = E_P\frac{t_d}{t_P}, \tag{69}$$

where F_P, E_P, t_P are the Planck force, energy, and time, respectively. Since the interval is set arbitrarily, based on Planck's Universal Proportions [44] we assign a certain mass M to it and estimate the effective values of its projections on the axis $x, y, z : M_x, M_y, M_z$:

$$M = s\frac{m_P}{l_P}; M_x = x\frac{m_P}{l_P}; M_y = y\frac{m_P}{l_P}; M_z = z\frac{m_P}{l_P}, \tag{70}$$

where m_P, l_P the Planck mass, and Planck length, respectively.
Then formula (68) has the form:

$$t = \frac{MV + M_xV_x + M_yV_y + M_zV_z}{c^2}. \tag{71}$$

Formula (71) confirms the conclusions of the Special and General Theory of Relativity: the real time near large masses and with increasing speed slows down. Traditional or mathematical time is a subjective concept that depends on the will and consciousness of people. Since the keywords in the definition of traditional time are the words: the standard of duration, this concept of time can appear only in a developed social society that is able to evaluate and set the standard. Outside of social society, the concept of traditional time is absent in nature. Real or physical time is an objective concept that does not depend on the will and consciousness of people. It appears in real space, that is, the space in which mass-energy is present, and is a complex integral attribute of real space. The emergence of the real time is associated with the processes of deceleration of the movement of some parts of matter relative to its other parts. The first reason for such deceleration is the gravitational viscosity of the gravitational field of baryonic matter. The operands of the numerator in formula (71) are variables that characterize the process of mass movement, and with any change in them, the denominator of this formula, namely, the kinematic gravitational viscosity of the gravitational field of baryonic matter, as a characteristic of the deceleration of the movement of matter, is always a constant. Formula (68) shows that in all reference systems of real space, spatial coordinates must be matched with projections of the characteristics of deceleration to the movement of matter, that is, projections of the real time, for example, a reference system with Cartesian coordinates: (x, y, z)should have the form:

$$\left(x\frac{V_x}{c^2}, y\frac{V_y}{c^2}, z\frac{V_z}{c^2}\right) = \left(t_x, t_y, t_z\right), \tag{72}$$

where $t_x = x\frac{V_x}{c^2}; t_y = y\frac{V_y}{c^2}; t_z = z\frac{V_z}{c^2}$.
That is, in real physical space, the Cartesian system of spatial coordinates (x, y, z) must be replaced by space-time coordinates $\left(t_x, t_y, t_z\right)$.
Formulas (65, 68, 71, 72) show that the arrow of time does not exist in the absolute reference system. For a local and limited region of the Universe, when the right side of the formula (65) may differ from zero, the concept of Evolving Block Universe [45] can be applied. According to this concept, the block of past events is separated from the block of future events by the surface of present events. Let's modify this concept. The interval in the 4-dimensional Minkowski space between distant events according to formula (68) can be represented as the interval between an event in the past and an event in the present, which is located on the surface of present events. Then this formula can be formalized vectorially as a process of transition in the direction from an event in the past to an event in the present. Formula (68) in this case has the form:

$$\vec{t} = \frac{\vec{s}V + \vec{x}V_x + \vec{y}V_y + \vec{z}V_z}{c^2}.$$

The totality of all vectors $\vec{t}$ from the events of the past to the events of the present form an uneven, but necessarily continuous surface of the present. Further, if a normal is drawn to

each point of the surface of the present, and then all normals are summed vectorially, then the result will be an arrow of time of the local space of the Universe. It can also be argued that some limited part of the Universe has an integral arrow of time, as the sum of some number (ideally, with an increase in the volume of the local part of the Universe, as a sum tending to infinity, but never reaching the required power) of local spaces.
Consider the bad infinity problem, which is related to the Wheeler-DeWitt equation (65). Let us show that this formula in form, being the equation of state of the Universe, in content it reflects the process of inflation of space, mass-energy, time, and the structure of matter. Earlier it was said that time is an integral, complex characteristic of space itself and mass-energy, that is, it is a characteristic of the real space of the Universe, in which there is mass-energy. Let us divide the space of the Universe into $n$local, limited spaces and introduce the condition for this partition: $n \to \infty$. Given the infinity of the Universe in all senses, including its space, it can be argued that the power of the set "infinite space of the Universe" is much greater than the set of any sum of its local and limited, and even more so countable spaces. Therefore, the condition for dividing the space of the Universe of the form: $n = \infty$,
is not correct. The number of partitions is a process tending to infinity and never reaching the required capacity of this infinity. For each local space n, according to the method described above, we build normals to the surface of events of the present, and then summing these normals vectorially, we obtain the vector of the arrow of time of this local space $\vec{T}_n$. Next, vectorially sum the arrows of time of local spaces. Then, based on the logic of the Wheeler-DeWitt equation (65), where the right side is equal to zero, we obtain:

$$\sum_{n=1}^{n\to\infty} \vec{T}_n = 0. \tag{73}$$

Formula (73), as well as the Wheeler-DeWitt equation (65), reflects not only "timelessness" on the scale of the absolute Universe but also denies the main mode of existence of matter - its movement. The zero on the right side of equation (73) directly and in fact, as well as indirectly in equation (65), denies any change in matter in nature. That contradicts both practice and theory. Therefore, equations (65) and (73) require the following correction:

$$\widehat{H}\Psi\left[g_{\mu\nu}\right] = \Phi(\varepsilon); \lim_{\varepsilon\to\infty}\Phi(\varepsilon) \to 0, but \lim_{\varepsilon\to\infty}\Phi(\varepsilon) \neq 0. \tag{74}$$

$$\sum_{n=1}^{n\to\infty} \vec{T}_n = Q(n); \lim_{n\to\infty} Q(n) \to 0, but \lim_{n\to\infty} Q(n) \neq 0, \tag{75}$$

where $\Phi(\varepsilon), Q(n)$ these are some infinitesimal quantities that, with the growth of the scale factor of the Universe, constantly tend to zero, but never reach it; ε, n these are the modified scale factors of the Universe.
Equations (74) and (75) show that as the scale factor of the Universe increases, the real space asymptotically approaches the ideal space, but never reaches it. With the growth of the scale factor, the inflation of space, mass-energy, structure (transitional, boundary fractals gradually blur and disappear), and time of matter increases. The motion of matter slows down and fades, but never stops, on the other hand, the maximum rate of transmission of physical interaction tends to infinity. Formulas (68, 71-72) show that in the general case, for example, on the scale of the observable Universe and (or) at the speed of the reference system close to the speed of light, time is a dependent coordinate. In the local region of the Universe and (or) at the speed of the reference system is much lower than the speed of light, time can be conditionally taken as an independent coordinate.

2.13 Quantum-wave equations of the gravitational field. Complete and complex system of equations of the gravitational field

The idea of describing a weakly perturbed gravitational field based on Maxwell's equations belongs to Heaviside [46]. A weakly perturbed gravitational field is the field of any gravitating object that moves without acceleration, or with a slight acceleration, but without the formation of a quadrupole mass. Currently, this idea has been developed in the following publications [22, 46, 47, 48, 49, 50, 51]. Based on these publications, the Maxwell-like equations of the gravitational field have the form:

$$\nabla \cdot \vec{E}_g = -4\pi G \rho_g, \tag{76}$$

$$\nabla \cdot \vec{B}_g = 0, \tag{77}$$

$$\nabla \times \vec{E}_g = -\frac{\partial \vec{B}_g}{\partial t}, \tag{78}$$

$$\nabla \times \vec{B}_g = -\frac{4\pi G}{c^2}\vec{J}_g + \frac{1}{c^2}\frac{\partial \vec{E}_g}{\partial t}, \tag{79}$$

where: $\rho_g$is mass density, $G$is the gravitational constant, J_g is the mass current density or mass flux, in $[kg^1 m^{-2} s^{-1}]$,$\vec{B}_g$ is the flux vector of gravitomagnetic induction, $\vec{E}_g$ is the gravitoelectric strength vector.
Based on the analogy of the equations of gravity and electromagnetism, we introduce the following constants:1. Gravitoelectric constant ε_g, which is similar to an electric constant:

$$\varepsilon_g = \frac{1}{4\pi G} = 1.1923362 \cdot 10^9 kg^1 m^{-3} s^2. \tag{80}$$

2. Gravitomagnetic constant μ_g, which is similar to a magnetic constant:

$$\mu_g = \frac{4\pi G}{A^2} = 9.331680 \cdot 10^{-27} kg^{-1} m^1. \tag{81}$$

Obviously, the gravitomagnetic constant is a quantity that is inverse to the linear density of matter in the observed Universe. It is also obvious that the equation is true:

$$c = \frac{1}{\sqrt{\varepsilon_g \mu_g}}. \tag{82}$$

By analogy with electromagnetism, we introduce the vectors:
1. The vector of the gravitomagnetic field:

$$\vec{H}_g = \frac{\vec{B}_g}{\mu_g}. \tag{83}$$

2. The vector of gravitoelectric displacement:

$$\vec{D}_g = \varepsilon_g \vec{E}_g. \tag{84}$$

Given equations (80 - 84), equations (76 - 79) can be represented as:

$$\nabla \cdot \vec{E}_g = -\frac{\rho_g}{\varepsilon_g}, \tag{85}$$

$$\nabla \cdot \vec{B}_g = 0, \tag{86}$$

$$\nabla \times \vec{E}_g = -\frac{\partial \vec{B}_g}{\partial t} = -\frac{\mu_g \partial \vec{H}_g}{\partial t}, \tag{87}$$

$$\nabla \times \vec{B}_g = -\mu_g \vec{J}_g + \frac{1}{c^2}\frac{\partial \vec{E}_g}{\partial t}. \tag{88}$$

Based on the Maxwell-like equations (85 - 88) we obtain the wave equations of the gravito-electromagnetic field:

$$\nabla^2 \vec{E}_g = \frac{1}{c^2}\frac{\partial^2 \vec{E}_g}{\partial t^2} - \frac{1}{\varepsilon_g}\nabla \cdot \rho_g. \tag{89}$$

$$\nabla^2 \vec{B}_g = \frac{1}{c^2}\frac{\partial^2 \vec{B}_g}{\partial t^2} + \mu_g \,(\nabla\times \vec{J}_g). \tag{90}$$

The wave equations of the gravitational field (89, 90), taking into account the presence of a quantum of the gravitational field in them, that is, the value of the square of the speed of light in vacuum [22, 43, 44], show that this field has a quantum-wave character. Thus, a complete and complex description of the gravitational field, which takes into account both of its fundamental properties, namely, 1) conditionally geometric; And 2) conditionally quantum-wave, is a system consisting of three equations - the Einstein equation (39) and quantum-wave Maxwell-like Heaviside
equations (89, 90):

$$\begin{cases} R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}, \\ \nabla^2 \vec{E}_g = \frac{1}{c^2}\frac{\partial^2 \vec{E}_g}{\partial t^2} - \frac{1}{\varepsilon_g}\nabla \cdot \rho_g, \\ \nabla^2 \vec{B}_g = \frac{1}{c^2}\frac{\partial^2 \vec{B}_g}{\partial t^2} + \mu_g \,(\nabla\times \vec{J}_g). \end{cases} \tag{91}$$

The relationship between the components of the system of equations (91) is established through the stress–energy tensor $T_{\mu\nu}$.
Note. There are two types of gravitational waves in nature: 1) standing gravitational waves that form around any gravitating objects, including the observable Universe; 2) gravitational waves traveling in space-time, which are created by accelerating gravitating objects with the formation of a quadrupole mass. In particular, gravitational waves traveling in space are formed by colliding black holes. Prediction. A gravitational wave traveling in space will necessarily be modulated by signals whose frequencies are proportional to: 1) the mass of colliding black holes; 2) the chirp mass; and 3) the total mass of colliding black holes. For example, for the case of GW200220_061928 (GWTC, 2020) [52], the frequency ranges of the modulating signals are as follows: 1) the first black hole (1.6 – 3.17) kHz;
2) the second black hole (2.33 - 5.64) kHz; 3) chirp mass (2.39 - 4.32) kHz; 4) total mass (1.0 - 1.77) kHz.

2.14 The problem of estimating the scale factor between the microcosm and macrocosm

The hypothesis about the presence of a scale factor between the size and energy of the observable Universe and the size and energy of particles of the microcosm belongs to Dirac [53, 54]. This hypothesis is framed and implemented in the so-called Dirac Large Numbers. According to the hypothesis, the scale factor between the microcosm and the macrocosm is not a coincidence, numerology, or a mathematical game of numbers, but a strict pattern that reflects the continuity of the structure of matter and the physical relationship between the observed Universe as a whole and its structural elements. The hypothesis has been developed in numerous publications, and the Dirac Big Numbers themselves have been modified many times. One such modification was proposed by Casado in the article [55]. Among the proposed modifications of Dirac Large Numbers, two estimates of such numbers seem to be the most relevant:

$$\frac{M_U}{m_P} \approx \frac{R_0}{l_P} \approx \frac{T_0}{t_P} = 10^{61}, \tag{92}$$

$$\frac{GM_U^2}{\hbar c} \cong 4 \cdot 10^{121}, \tag{93}$$

where M_U is the baryon mass of the observable Universe; R_0, T_0 is the Hubble radius and time; m_P, l_P, t_P is the Planck's mass, length, and time.

Dirac Large Numbers according to formulas (92) and (93) are proposed to be refined and modified as follows [14]:

$$N_{De} = \frac{M_U}{m_P} = \frac{R_0}{l_P} = \frac{T_0}{t_P} = 8.47280 \cdot 10^{60}, \tag{94}$$

$$N_{De}^2 = \left(\frac{M_U}{m_P}\right)^2 = \left(\frac{R_0}{l_P}\right)^2 = \left(\frac{T_0}{t_P}\right)^2 = 7.1788 \cdot 10^{121}. \tag{95}$$

Since the transformation of formula (93) leads to formula (95):

$$\frac{GM_U^2}{\hbar c} = \frac{\frac{l_P}{m_P} c^2 M_U^2}{m_P l_P c^2} = \frac{M_U^2}{m_P^2}.$$

If the scaling factor between the macrocosm and the microcosm according to the formula (94) is obvious, then according to the formula (95) it is not quite obvious. Meanwhile, formula (94) displays the statics of the relationship between the macroworld and the microworld, and formula (95) displays the dynamics, and, in a certain sense, the energy of their relationship. Let's show it. The denominator of formula (94) is conventionally the microcosm, and its numerator is conventionally the macrocosm. We transform formula (94) as follows:

$$\frac{GM_U^2}{\hbar c} = \frac{\frac{R_0}{M_U} c^2 M_U^2}{m_P l_P c^2} = \frac{R_0 M_U}{l_P m_p} = 7.1788 \cdot 10^{121}. \tag{96}$$

The numerator of formula (96) contains the maximum possible moment of mass of the observed Universe, and its denominator contains the maximum possible moment of mass of an elementary particle since according to formula (56) the equality is true:

$$l_P m_p = m_e \lambda = m_{pr} \lambda_{pr} = m_n \lambda_n = m_\mu \lambda_\mu = m_\tau \lambda_\tau.$$

It also follows from formula (96) that:

$$N_{De}^2 = \frac{R_0 M_U}{l_P m_P} = \frac{R_0 T_0}{l_P t_P} = \frac{T_0 M_U}{t_P m_P} = 7.1788 \cdot 10^{121}. \tag{97}$$

According to the Stefan-Boltzmann law, the total radiation power of a hypothetical Planck particle J_P (that is, its total energy luminosity) is equal to:

$$J_P = \delta T_P^4 = 2,2847 \cdot 10^{121} W^1 m^{-2}, \tag{98}$$

where δ is the Stefan–Boltzmann constant, T_P is the Planck temperature.
The article [14] shows that the total energy luminosity of the observable Universe J_U, as a Hubble sphere, is equal to:

$$J_U = 0.318372270570 W^1 m^{-2}; J_U \cong \frac{1}{\pi} W^1 m^{-2}. \tag{99}$$

Then, taking into account formulas (98, 99):

$$N_{De}^2 = \frac{J_P}{J_U} = 7.1788 \cdot 10^{121}.$$

Modified Dirac Large Numbers N_{De}, N_{De}^2, as a scale factor between the macrocosm and the microcosm, most fully reflect the ratio of static, dynamic, and energy processes at these levels of matter.

2.15 The problem of estimating the mass of distant gravitating objects in the observable Universe

Currently, in cosmology, and astrophysics, there is no method for accurately estimating the mass of distant gravitating objects in the observable Universe. For this purpose, indirect estimates and approximate formulas are used. For example [3], for small gravitating objects with a mass of up to twenty solar masses, an approximate relationship can be used: luminosity - mass, of the following form:

$$\frac{L}{L_{\odot}} \approx \left(\frac{M}{M_{\odot}}\right)^{a}, \tag{100}$$

where $L_{\odot}, M_{\odot}$ is the luminosity and mass of the Sun, L, M is the luminosity and mass of the investigated gravitating object, $1 < a < 6$. Having estimated the luminosity of the object under study with the luminosity of the Sun, we can use the formula (100) to estimate its mass. If the mass of the gravitating object is more than twenty masses of the Sun, then the relation is used:

$$L \propto M. \tag{101}$$

To estimate the mass of clusters of stars and galaxies, approximate methods are used: by the distribution of hot gas, gravitational lensing, and the virial theorem. To estimate the mass of superclusters of galaxies, the model of the entire observable Universe based on Artificial Intelligence [55] is used. This machine learning based symbolic regression model selects an approximation formula that best describes the experimental data. Based on the refined formula, a new approximate estimate of the mass of superclusters of galaxies is made. In the articles [44, 57, 58], based on gravitational-electromagnetic resonance, an accurate estimate of the mass M of gravitating and emitting (or re-reflecting) objects is proposed. For an accurate estimate of the mass, M it introduces a restriction: $\sim M_{\odot} \cdot 10^{-7} \leq M \leq M_{\odot} \cdot 2.03 \cdot 10^{5}$.The method for accurately estimating the mass is as follows. A gravitating object creates a standing gravitational wave in space in the form of equipotential spherical surfaces that are nested in each other. The length of a gravitational wave is proportional to the mass of the gravitating object. The coefficient of proportionality is equal to the linear density of the Planck mass. The luminous flux of a gravitating object has a wide spectrum of electromagnetic radiation. This flow, passing through a standing gravitational wave, enters with it into a gravitational-electromagnetic resonance. As a result, the spectrum of electromagnetic radiation of a gravitating object will be modulated by the envelope of this spectrum at the frequency of the gravitational-electromagnetic resonance. The frequency of gravitational-electromagnetic resonance is equal to the frequency of a standing gravitational wave. Gravitational-electromagnetic resonance is also observed at higher harmonics of a standing gravitational wave. By selecting the envelope of the radiation spectrum with a spectrometer and measuring its frequency (wavelength), it is possible to estimate the mass of the gravitating object. For example, for the Sun, the frequency of the gravitational-electromagnetic resonance is 202.97 kHz, which corresponds to the wavelength 1477.036m, then the mass of the Sun can be determined as follows:

$$M_{\odot} = \frac{m_P}{l_P} \cdot 1477.036 = 1.989 \cdot 10^{30} kg.$$

If the mass of the gravitating object $M > M_{\odot} \cdot 2.03 \cdot 10^{5}$, then the frequency of the envelope of the radiation spectrum, which is due to gravitational-electromagnetic resonance, becomes much less than one Hertz. Then the measurements must be transferred to higher harmonics of the gravitational-electromagnetic resonance. As a result, ambiguity may arise in the estimation of the harmonic number. Then, for an accurate assessment of the mass, it is necessary to combine two methods, use some known method to make an approximate assessment of the mass, and use the proposed method as a kind of vernier.

2.16 The problem carriers of gravitational field and dark mass

As you know, the basis of the formation of an electromagnetic field is a moving electric charge. In turn, the electric charge is a function of the moment of mass according to the formula (56). The quantum of the electromagnetic field is the dynamic moment of mass:

$$h = 2\pi m_P l_P c = 2\pi m_e \lambda c = 2\pi m_{pr} \lambda_{pr} c = 2\pi m_n \lambda_n c = 2\pi m_\mu \lambda_\mu c = 2\pi m_\tau \lambda_\tau c. \quad (102)$$

Formulas (56) and (102) are based on the moment of mass, where the keyword is the word mass. From this follows the conclusion that one of the fundamental foundations of the formation of an electromagnetic field is mass. Mass is also the fundamental basis for the formation of a gravitational field. The quantum of the gravitational field h_g is the square of the speed of light in vacuum [22]:

$$h_g = c^2. \quad (103)$$

The physical nature of the gravitational field quantum is the kinematic gravitational viscosity of the gravitational field of the baryonic matter of the observable Universe. This is a physical property of the gravitational field, which is to slow down the movement, and which does not contain mass in its formula. Comparing the formulas of the quanta of the electromagnetic and gravitational fields using formulas (102) and (103), we come to the conclusion that is absent of the mass, as in formula (103), then there is no field carrier. This means that any carriers of the gravitational field in the form of individual particles with a mass, for example, gravitons, are absent in nature. Or a hypothetical massless particle, whose numerical value is equal to the square of the speed of light in a vacuum, can be conventionally called a graviton. Since the source of dark matter is the kinetic energy of the rotation of the observable Universe (taking into account the Coriolis force), there are no carriers of dark matter, for example, in the form of dark matter particles of WIMPs, in nature. Numerous experiments over the past few decades, which are aimed at searching for carriers of dark mass and the gravitational field, have not yielded any results. And will not bring them in the future. The search for gravitons and WIMPs is counterproductive from the point of view of the effectiveness of the final result.

3 Results

It is shown and/or proposed that:
1. The solution of the Einstein equation of general relativity in the Kerr metric is the most optimal solution among all known and most consistent with the set of experimental data in modern physics, astrophysics, and cosmology.
2. The Hubble constant has a dual nature. It describes two different physical processes with equal success: the expansion of the space of the observable Universe and its rotation. The Hubble constant can be expressed through the main characteristics of the observable Universe. This means that this constant is an internal immanent property of the Hubble sphere (i.e. the observable Universe), and therefore it cannot be a characteristic of dark energy.
3. All physical constants are a reflection of the structure of matter at that structural level at which the scenario of the action of a physical law unfolds. The constants are stable to the extent that the structure of matter is stable. The speed of light in a vacuum can be expressed through the main spatial-energy characteristics of the observable Universe. The fact that the speed of light does not change and is a constant indicates that the structure of the Hubble sphere does not change. That is, there is no expansion of the space of the Hubble sphere, which means there is no dark energy.
4. Observations, experimental data, and calculations show that the Hubble sphere is a slowly rotating black hole. This means that dark energy does not exist, and the kinetic energy of rotation and the Coriolis force create the effect of the presence of a dark mass in nature. This means that there are no carriers of dark mass in nature and their search is counterproductive.

5. Taking into account the rotation of the Hubble sphere, a new model and, accordingly, new basic equations of cosmology are considered.
6. The cosmological constant cannot be a source of dark energy.
7. The structure of matter, accordingly, the structure of the Universe has a hierarchical fractal character. The Hubble sphere is one of its infinitely small structural fractals. With an increase in the number of the fractal hierarchy, the spatial and energy inflation of the Universe increases.
8. Before the Big Bang, the Hubble sphere existed as a slowly rotating singularity point in the space of a senior hierarchical fractal, let's call it gravitational. The source of the Big Bang could have been a collision with a neighboring fractal, which is similar to the Hubble sphere. After the Big Bang, the space of the singularity point expanded to the boundary of the Hubble sphere, after which the expansion process ended. The space of the Hubble sphere and the matter in it rotate with different angular velocities. This is why experiments yield two non-intersecting sets of values of the Hubble constant. Depending on the working fluid of the experiment, one of the sets is grouped around the angular velocity of rotation of the space of the Hubble sphere, and the other set is grouped around the angular velocity of rotation of the matter.
9. Electromagnetic interaction is a special case of gravitational interaction. This is because the electric charge is a function of the moment of mass, Coulomb's law can be expressed in gravitational form, and the units of measurement of electromagnetism can be expressed through the units of measurement of gravity.
10. Time has a dual nature. Traditional or mathematical time, and real or physical time. Real time is real space, that is, space in which mass-energy is present.
11. The gravitational field has a quantum-wave nature. The quantum of the gravitational field is the square of the speed of light in a vacuum. The physical nature of the quantum of the gravitational field is the kinematic gravitational viscosity of the gravitational field of baryonic matter of the observable Universe. A feature of the gravitational wave is its standing nature. If the gravitating object is imagined as a material point, then its gravitational field can be imagined as a set of hierarchical spherical surfaces that are nested inside each other and spaced apart by a quantization step, the value of which depends on the mass of the gravitating object. The quantum-wave nature of the gravitational field is evidenced by the presence of gravitational-electromagnetic resonance in nature.
12. Based on gravitational-electromagnetic resonance, it is possible to create new sources of electrical energy, as well as determine with high accuracy the mass of remote objects in the observable Universe. 13. The structure of the microworld and macroworld is inseparable and interconnected. One of the physical and mathematical factors confirming this inseparability and interconnection is modified large Dirac numbers.
14. The signals of gravitational waves traveling in space, which are formed as a result of the collision of black holes, contain information about their mass. This is because gravitational waves traveling in space are modulated by standing gravitational waves of these black holes.

4 Discussion

Gravity, being one of the fundamental concepts of cosmology and related sciences, has two fundamental properties: 1) it bends the space around any gravitating object; this property is described by Einstein's GR equation; 2) creates gravitational viscosity, which slows down the movement of some parts of matter relative to its other parts; this property is described by the Maxwell-like Heaviside equations. The gravitational field has a quantum wave structure. The quantum of the gravitational field is the square of the speed of light in a vacuum. The physical nature of the gravitational field quantum is the kinematic gravitational viscosity. A feature of the quantum-wave structure of the gravitational field is that if any gravitating object (including the observable Universe) is represented as a material point, then a standing gravitational wave is formed around this point. The structure of a standing gravitational wave is represented in the form of hierarchical equipotential spherical surfaces that are nested in each other, centered at a given material point, and separated from one another by a quantization step (the length of a standing gravitational wave). The quantization step is proportional to the mass of the gravitating object. The coefficient of proportionality is the Universal Planck Proportion - the linear rarefaction of the Planck mass, that is, the ratio of the Planck length to the Planck mass. The proof of the quantum-wave structure of the gravitational field is the presence in the nature of gravitational-electromagnetic resonance, which is experimentally confirmed in a ground-based laboratory and space missions, for example, Cassini, Interball 2.

Since electric charge is a function of the moment of mass, Coulomb's law can be represented in gravitational form, and the basic units of electromagnetism can be expressed in terms of gravity units, the electromagnetic field is a special case of the gravitational field. Taking into account that the gravitational field and the electromagnetic field have a quantum-wave character, there is a gravitational-electromagnetic resonance in nature, and the electromagnetic field is a special case of the gravitational field, it is advisable to establish the connection between the Standard Model of physics and the gravitational interaction not on the first basic property of gravity (conditionally - geometric), and on its second property (conditionally - quantum wave). A scientific project becomes a theory only when the necessary and sufficient conditions for its implementation are met: the necessary conditions confirm that the scientific project explains the existing scientific facts of its subject area and gives predictions of their behavior in the future, and sufficient conditions confirm that the scientific project has been tested in practice, in the experiment. In terms of cosmology, since only the Hubble sphere is available for instrumental observations of the Universe, scientific projects related to the unobservable part of the Universe are not theories but hypotheses. This statement is true, first of all, when considering the issues of the general structure of the Universe, the equation of Einstein's General Theory of Relativity, the source of the so-called dark energy. Our knowledge about the surrounding world is based on the laws of nature, constants, restrictions, and thresholds for changing variables in-laws. Variables reflect the dynamics of changes in physical processes in nature, and constants reflect the structure of matter at the level at which the scenario of the laws is unfolding. The study of the constants shows that their structure has a fractal character. Accordingly, the structure of matter and the Universe also has a hierarchical fractal character. Observations show that the main structural levels of matter are associated with known types of physical interaction. They are, as a rule, spherical, fractally, and hierarchically nested in each other: nuclei are nested in atoms, atoms are nested in the Hubble sphere, that is, the observable part of the Universe, and so on. It is convenient to name the structural levels of matter according to the main type of physical interaction in them: nuclear, atomic, and electromagnetic. Given that the Universe is infinite, there is reason to believe that the Hubble sphere is also included in a hierarchically older fractal of the Universe, conditionally gravitational. There are also fractals older than gravity. The scale factor of the physical interaction of these fractals is so great that it cannot be fixed by the existing instrumental technologies of mankind. There are basic and transitional fractals of matter and, accordingly, the Universe. Transitional fractals are on the border between the main fractals. Basic fractals: nuclear, electromagnetic, gravitational. Transition fractals: 1) atomic, it is between nuclear and electromagnetic fractals; 2) Hubble-Schwarzschild, it is located between the electromagnetic fractal, that is, the Hubble sphere, and the gravitational fractal. Given the hierarchy, it is convenient to number the main fractals of the Universe: nuclear -1, electromagnetic -2, gravitational - 3, and so on ad infinitum. The fractal number can be used as one of the variants of the modified scale factor of the Universe. Analysis of the physical nature of time according to formulas (68 - 72) shows that time is a real space, therefore it is an attribute of matter, which depends on space and mass-energy in it. This means that in the general case, in all physical formulas, time is a dependent coordinate. In local and limited spaces of the Universe, such dependence can be neglected. In other words, time in this case is the independent variable. On a scale commensurate with the observable

Universe, and also (or) at the speed of the reference system close to the speed of light, time becomes a dependent variable. Analysis of the algorithm for the formation of the FLRW metric and the basic equations of cosmology by formulas (1 - 29), taking into account the fact that time is a dependent coordinate on the scale of the Universe, suggests that the Einstein equation by formula (39) is information redundant.

5 Conclusions

Since the observable Universe is a slowly rotating black hole, the most optimal solution to the equation of Einstein's General Theory of Relativity is a solution based on the Kerr metric. Taking into account the fact that there is currently no expansion of the space of the observable Universe after the Big Bang and this space rotates, it is advisable to change the basic equations of cosmology to equations that take into account the above facts. The correct solution to the cosmological problem is largely connected with the correct choice of the frame of reference. Depending on the scale factor of the cosmological problem, it is expedient to consider it in absolute, global, local, and limited local reference systems. Time has a dual character. Traditional time, or mathematical time, is a subjective category that depends on the will and consciousness of people. Outside of social society, traditional time is absent. Real time, or physical time, is a complex integral and objective characteristic of a real structured space, in which there is mass-energy. Real time does not depend on the will and consciousness of people. Dark energy does not exist. Its imaginary presence in nature is caused by the effect of the rotation of the space of the observable Universe. The kinetic energy of the rotation of space and the baryon mass of the observable Universe creates the effect of the presence of a dark mass in it. Matter has structure. A feature of this structure is its fractal character. With the growth of the scale factor of the Universe, a fractal inflation of all its main attributes is observed. The real space asymptotically tends to approach the ideal space. The movement of matter is slowed down, but the characteristics of the resistance to movement are reduced. Since dark energy does not exist, the cosmological constant cannot be its source. The gravitational field has two fundamental properties: 1) it bends the space around any gravitating object (the conditional name of the property is geometric), and 2) it creates gravitational viscosity, which slows down the movement of material objects and resists the movement of some parts of matter relative to its other parts (the conditional name properties - quantum wave). It is due to gravitational viscosity that there is no infinite rate of transfer of physical interaction in nature. The maximum possible rate of transfer of physical interaction in the observable Universe - the speed of light in a vacuum, is determined by its main spatial and energy characteristics and the gravitational viscosity of the gravitational field of its baryonic matter. A complete description of the gravitational field, which takes into account both of its fundamental properties, is given by a complex system consisting of three equations: 1) Einstein's GR equation, and 2) two quantum-wave Maxwell-like Heaviside equations. It is expedient to establish the connection between the Standard Model of physics and gravitational interaction based on the scientific facts that the electromagnetic field is a special case of the gravitational field, both fields have a quantum wave structure, which manifests itself in the presence of gravitational-electromagnetic resonance in nature. Before the Big Bang, the observable universe existed as a slowly rotating singularity. The radius of this point was no less than the Planck length, and the baryon mass was approximately equal to the baryon mass of the observable universe. The Big Bang did not occur as a result of quantum fluctuations of the quark-gluon plasma at the singularity point but as a result of its collision with neighboring universes. The singularity of the observable Universe before the Big Bang was relative and had a structure. This structure included "packaged" all the existing laws of nature, their initial conditions, and limitations. Since otherwise it is not possible to rationally explain how modern relatively deterministic laws of nature arose from quantum chaos. It is expedient to set the scale factor between the microcosm and the macrocosm in the form of modified Big Dirac Numbers. These numbers are based on the ratio of the main space-energy parameters of the observable Universe and the length, mass, and Planck time. Gravitational-electromagnetic resonance allows you to accurately determine the mass of distant gravitating objects in the observable Universe. Gravitons and WIMPs do not exist in nature. What is perceived as the above particles is a physical property of the gravitational field (kinematic gravitational viscosity) in the case of gravitons or a side effect of the actual physical process (rotation) in the case of WIMPs.

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