Chapter 2

THE OBSERVED UNIVERSE — A FRAGMENT OF THE FRACTAL "INFINITY"

> Probably the connection of time with a very deep, and changing the physical properties of time can lead to a change in the forces of the bodies.
>
> *Kozyrev N.*

§1. The modern picture of the observable Universe

In this section we will discuss the structure of the observable Universe, obtained on the basis of the ideas currently existing in science. The capital letter at the beginning of the word "universe" is written in the case when it is a question of "our" (observable) Universe, the upper one is applied to all other models. Here the situation is similar to the use of capital and capital letters in the word "galaxy": the capital letter is used only when it comes to the Milky Way. The construction of cosmological models is one of the applications of the methods of general relativity to the description of the material world. At the present time, cosmology deals exclusively with the material body of the Universe as a whole object, and also with the problem of the evolution of the universe, including the process of its inception and the supposed end. According to one scenario, the universe exists for a certain period, according to others — the time of her life is not limited. Scientists working in other areas of astronomy, from different angles study the planets, the sun, stars, galaxies and their clusters and superclusters. In each section, there are different directions, using their own methods of investigation. Thus, celestial mechanics studies exclusively the motions of celestial bodies, mainly the planets of the solar system. Star astronomy studies the dynamics of stars and calculates them using statistical methods (a section called *stellar statistics*). In the last century there was an astrophysics, especially rapidly developing at the present time. Possessing a good instrumental base, deduced into outer space, astronomers receive a lot of information about the material structure of planets, stars and their clusters, the Milky Way and other galaxies, as well as their clusters and superclusters. The youngest areas of astronomy are relativistic astrophysics and relativistic cosmology, where calculations are conducted by methods of General Relativity.

The Universe is the place that we settled, our common home. The inevitable question arises: who built this house for us? There are two basic answers: 1) it was created by an external force, the knowledge of which at this stage of evolution is impossible within the framework of human consciousness; 2) the Universe arose by itself and reached the modern state through self-development (evolution). The first answer has existed from time immemorial, only the external forces that created our world have different names depending on which peoples transmit from generation to generation information about the beginning of the universe and the subsequent stages of its development. This information is contained in myths, fairy tales, legends of different peoples, in religious literature. The second response appeared relatively recently, if we compare the period of the emergence of the philosophy of materialism with the duration of the evolution of mankind. Especially lush color this answer blossomed in the first third of the twentieth century: then the General Theory of Relativity (GTR) appeared, whose role in cosmology (the science of the origin and development of the universe) should be specially noted. GTR is not just another theory, it is a leap of consciousness of a modern person to a fundamentally new level, implying a way out of a three-dimensional space in space-time. In this Time is not just an additional coordinate, but an active participant in the universe. Time can be compared to the ocean in which we are all immersed. Einstein created his theory not from scratch. Time itself ordered that people were found, each of which contributed to the construction of a new foundation of the building, consisting of a set of ideas about the surrounding world, including the structure of the Universe. In science, this set is called *a cosmological model*. Models of the universe have existed since time immemorial, for example, a flat earth, surrounded by a crystal sky with stars fixed on it, the Sun and the Moon. After the creation of general relativity, the scientists applied this theory as the mathematical basis of *relativistic cosmology*. At present, nonrelativistic models based, in particular, on the Newtonian theory of gravitation, are practically absent. The construction of relativistic models of the Universe is carried out with the help of the mathematical apparatus of general relativity-Riemannian geometry, developed by the German mathematician Riemann on the basis of the theory of curved surfaces. To use the Riemannian geometry of four-dimensional space as a description of the space-time continuum, Einstein proposed Marcel Grossman, one of the participants in the discussions that the creators of fundamentally new ideas conducted at the beginning of the last century. Subsequently, Grossman withdrew from participation in scientific discussions and became a school teacher. However, for several decades scientists met at a conference on the Theory of Relativity named after Marcel Grossman.

In modern cosmology, the Universe is a single material object that once arose (is born), develops (lives) according to its laws and in the future will come to its natural end. Within the framework of this concept, nothing is said about the space surrounding it - a lonely universe lives in Time from the moment of origin to the end of its existence as a whole object. The mathematical base of general relativity admits the existence of many different models of universes. They can be either stationary (independent of time) or dynamic. In the latter case, the three-dimensional space can theoretically expand, contract, pulsate. Of the many models at present, the homogeneous isotropic Universe, which arose as a result of the Big Bang of a clot of pra-matter, possessing monstrous density. The huge (infinitely large!) Value of the density of the bunch is due to the fact that, according to calculations, the entire mass of the modern universe at the time of creation was concentrated in one "point" — *the primary singularity*. As a result of the explosion, the universe began to expand rapidly at first, then its expansion slowed and continues inertially until now. For the sake of simplicity of calculations, it was assumed that the space of the Universe is homogeneous and isotropic. Homogeneity — the equality of all points of space, isotropy — the equality of all directions in it. The rationale for accepting such conditions is the idea that the space of the Universe is huge, therefore galaxies, their clusters and superclusters are tiny dust particles and lumps scattered in it. The rationale for accepting such conditions is the idea that the space of the Universe is huge, therefore galaxies, their clusters and superclusters are tiny dust particles and lumps scattered in it. In homogeneous isotropic models, time flows evenly from the past to the future, in which the universe is likely to die from the cold — its "heat death" will occur. The hypothesis of the thermal death of the universe was put forward by R. Clausius in 1865. He extended to the whole Universe the second law of thermodynamics, according to which any physical system that does not exchange energy with others tends to the most probable equilibrium state when all movements, including molecular ones, stop. And this movement is associated with thermal energy: after all, according to modern science, heat is the energy of the "chaotic" movement of molecules. In the framework of the notion of the universe as a solitary object, this hypothesis is quite logical. A homogeneous isotropic universe expands in space, losing energy and not being able to fill it. The time of existence of the universe as a single object, as well as its extent, are calculated by scientists within the framework of the model of a nonstationary homogeneous isotropic model. It is important to note that in this approach it is believed that time in the universe flows evenly, and it has always been so, except for the first few minutes from the "creation of the world" as a result of the Big Bang of the primary singularity. In fact, scientists calculate the dynamics of the universe within the framework of the idea of Time as a uniformly current process, which, as is known, is a reflection of the motion of heavenly bodies, and not an independent creative energy that manifests itself literally in everything.

In fact, scientists calculate the dynamics of the universe within the framework of the idea of Time as a uniformly current process, which, as is known, is a reflection of the motion of heavenly bodies, and not an independent creative energy that manifests itself literally in everything. Obviously, such a complex system has many different solutions in principle, so to obtain the required class of solutions it is necessary to set the initial conditions and formulate mathematical constraints on the behavior of the model under given conditions. These limitations should be based on experimental (observable) data on the Universe. The result of solving equations under given conditions is a four-dimensional metric that describes the geometry of the space-time under study. With the initial conditions, the matter is more complicated, because when they are assigned, the problem of determining ***the initial moment***, more precisely, the driving force that created our world, inevitably arises. Beginning in the 1920s, to this day, the official theory of the origin of the universe is the theory of the Big Bang of the initial pra-matter, which has a monstrous density and is called the original singularity. In other words, all the matter of the future Universe was concentrated in an extremely small volume, which led to its super-dense state. From then on, the space of the universe expands due to inertia caused by the initial explosion. This model is called ***inflationary***. Expansion of the space of the universe is associated with its deformation, hence inflation in this case is due to deformation of space. The Big Bang theory rests on three whales: 1) the theory of the non-stationary universe of Alexander Friedman; 2) the theory of the hot universe of George Gamov; 3) the shift of the spectral lines in the spectra of distant galaxies to the red site, measured by Edwin Hubble. Briefly about each of the whales.

A significant role in the development of relativistic cosmology was played by the Soviet mathematician Alexander Friedman, the creator of the first whale and the third one directly associated with it. He was keenly interested in problems of the theory of relativity, corresponded with Einstein on some issues. In particular, a dispute arose between Einstein and Friedman about the possibility of the existence of a non-stationary model of the universe. Einstein argued that nonstationary solutions of field equations that are suitable for describing the universe do not exist. In response to this in 1922 and 1924, Friedman published a whole class of nonstationary solutions of field equations obtained under the assumption that the universe space is homogeneous and isotropic. From the point of view of formal mathematical calculations Friedman was right, and Einstein subsequently recognized this. Moreover, Friedman himself has repeatedly stated that his business is to get mathematical equations, and physicists are free to do with them what they want. At present, this class of solutions is called *Friedmann models*. They describe monotonically expanding, monotonically contracting and oscillating universes. Models are considered both filled with matter and empty. The three-dimensional space in them has a constant curvature, which can be: 1) positive; 2) negative: 3) zero. In the first case, the space has a finite volume like a three-dimensional sphere: such a model is called *closed*. Its space can expand indefinitely, or the expansion continues to a certain limit, and then the space again shrinks into the original singularity (oscillating model). In the second case, the three-dimensional space is like a hyperboloid: its volume is infinite, and the expansion continues indefinitely. In the third case, the space is flat (Euclidean). It is infinite in all directions, and will also expand indefinitely. The curvature of a flat space C is equal to zero, hence the radius of its curvature $a = 1/\sqrt{C}$ is infinitely large. For clarity, a three-dimensional flat space can be represented as a three-dimensional sphere of infinitely large radius. The second and third models are *open*. General form of the metric of a homogeneous isotropic model [11]:

$$ds^2 = c^2dt^2 - [R^2(d\zeta^2 + d\eta^2 + d\xi^2)]/[1 + (k/4)(\zeta^2 + \eta^2 + \xi^2)],\ k = 0; \pm 1 \qquad (1.1)$$

where $\zeta,\ \eta,\ \xi$ — homogeneous coordinates, $R = R(t)$ — радиальная функция ("радиус Вселенной"). Einstein recognized the mathematical correctness of these solutions. The non-stationary nature of Friedman's solutions provides a theoretical opportunity to investigate the question of the beginning and end of the universe. Indeed, if we extrapolate in the past an expanding model, then we can calculate the time of the existence of the universe. If you extrapolate the contracting model into the future, you can find out the date of the "end of the universe". Accordingly, the oscillating model optimistically indicates that after the end of the universe there will be a new cycle of its development. However, all these calculations are carried out under the condition that time always and everywhere flows evenly, which is embedded in the very structure of the model: the component of metrical tensor $g_{00} = 1$.

The question of which of the Friedmann models to use to describe the observable universe was solved thanks to observational data first obtained by the Belgian scientist Georges Lemaitre in 1927, and then by the American astronomer Edwin Hubble in 1929. Exploring the movements of galaxies, both scientists came to the conclusion that galaxies "run away" from us with a speed directly proportional to the distance from the observer (from the Earth). The Hubble law has the form: $v = H_0r$, where v — speed of removal of galaxies, H_0 — proportionality coefficient, named Nabble constant, r — distance to the galaxy. Currently, the value $1/H_0$ is used to approximate the age of the Universe. The result, up to a numerical factor of the order of unity, coincides with the age calculated in the framework of the Friedmann model. The conclusion was based on data showing that the lines in the spectra of distant galaxies were shifted toward lower frequencies. At the same time, the farther away from us the galaxy, the stronger *the red shift*. Cosmology theorists immediately explained this phenomenon with the Doppler effect. If the source approaches the observer, then, accordingly, the lines in the spectrum are shifted towards higher frequencies, so the source looks more violet than the fixed one.Cosmology theorists immediately explained this phenomenon with the Doppler effect. It turned out that the further the galaxy, the faster it is removed from us. Scientists immediately concluded: the universe expands at a rate directly proportional to the distance from the Earth (as from the "center of the Universe"), and they explained the red shift in the spectra of galaxies solely by stretching (deforming) the space of the Universe. If the redshift for individual objects is greater than that which follows from the Hubble law, it is immediately explained either by an accelerated expansion or by the presence of a hypothetical "dark matter". Other explanations (gravitational displacement, aging of photons) proved to be untenable, since these effects could not cause such large displacements that were obtained for some objects. And the explanation of the redshift effect by the expansion of space is extremely convenient, since it allows us to use as a starting point the Friedmann model of the expanding universe: it is easy to calculate within its framework, since time flows evenly, and gravitation and rotation, which significantly complicate the calculations, are absent here. Now the most universal non-stationary model, called the Friedman-Lemaitre-Robertson-Walker universe, is a priority in cosmology. In this case, cosmologists refer to the law of Hubble as an irrefutable proof of the expansion of the Universe. Note that Hubble himself did not claim that the dispersal of galaxies is a direct proof of the expansion of the universe. Thus, shortly before his death, Hubble said that other ways of explaining his law should be sought.

So, almost a century in cosmology is dominated by the Friedmann model of the expanding universe as the most simple and convenient for calculations. However, behind this simplicity there are serious problems. It is common knowledge that the gravitational interaction is universal in the Universe, therefore, it must exist in all its space. But in all Friedmann models (expanding, contracting, oscillating) the 3-space only deforms, but does not rotate and there is no gravitational field in it. Therefore, the observed time in these models flows evenly.The interval of the observed time in the nonrotating reference frame is $d\tau = (1 - w/c^2)dt$, where $w = c^2[1 - (g_{00})^{1/2}]$ is the three-dimensional gravitational potential, dt is the interval of ideal (uniformly current) time [11, 12]. If $w = 0$, then $d\tau = dt$ (the observed time flows evenly). Friedmann models can be used to describe the early universe at a time when gravity as a universal force providing order in the world of cosmic bodies was not yet formed, and the bodies themselves did not yet have a structure called the physical body. But at this stage of the evolution of the Universe, when gravity exists as a real force that controls the movements of cosmic structures of different scale, it is necessary to use models that take into account the effect of the gravitational field of the Universe.

Now about the second whale. The theory of the expanding universe is closely related to the theory of the hot universe of George Gamow, put forward by him in 1947. According to Gamow's theory, our Universe (at least, its observable part) arose as a result of the primary clot of pra-matter, which has a monstrous density called *the singularity*. In fact, it is believed that all future space-time along with the future matter was compressed in a tiny volume, which for some reason exploded. The fragments of the initial clot were transformed, forming in interaction various structures that eventually led to the creation of modern matter, and the observed redshift (the third whale) is a consequence of the expansion of space due to the initial explosion caused by the initial explosion. In the 1950s, Gamow's theory was combined with the mathematical foundation laid by Friedman, which gave a powerful impetus to development for relativistic cosmology. In other words, from the whole class of models of Friedmann preference was given to the Universe, born as a result of the Big Bang of the original singular structure, and since then expanding by inertia.

The third whale emerged as a by-product of the problem of determining the extent of the space based on the measurement results of distances to galaxies started by the astronomer Hubble in the 10s–20s of the last century and continuing at the present time. Hubble estimated distances to distant galaxies by their brightness. He assumed that the brightness of galaxies decreases with distance from the observer. Since this rule was applied to a huge number of galaxies, then, according to the laws of statistics, the results obtained can be considered quite satisfactory. A limiting distance of about 10^{28} cm was established, which was taken as the radius of the Universe. Thus, the observational data of Hubble can be fully interpreted in favor of the existence of a spherical model of the universe. Staff working under Hubble's leadership examined the spectra of stars in galaxies when possible. (Obviously, it is impossible to study individual stars in very distant galaxies). They found that the spectral lines of the stars are shifted toward lower frequencies (redshift). Recall, the effect of redshift occurs when the light source is removed from the observer. As a result, it was established that, from a certain distance, the galaxies are “removed” from the observer at a rate proportional to the distance from it. The word *is removed* in quotation marks because in principle the redshift effect may have another explanation, as will be discussed below. It should also be noted that the result of Hubble measurements is the empirical formula $H = c/a$, where H is the Hubble constant, c is the speed of light, and a is the limiting radius of the observable part of the Universe. According to modern data, $H = (2.3 \pm 0.3)\times10^{-18}$ sec^{-1}, from which it is easy to find the value $a = 1.3\times10^{28}$ cm. The Hubble formula defines the maximum possible distance (the horizon of the Universe), at which the rate of “removal” of galaxies becomes equal to the speed of light. An additional argument in favor of this concept was the interpretation of the Hubble formula $c = Ha$. Since H has a frequency dimension of sec^{-1}, its inverse $T = 1/H$ has a time dimension. It was called the time of existence of the observable part of the Universe. Then the Hubble formula takes the form $a = cT$. This formula is interpreted by cosmologists as an expression for the limiting radius of the observable universe: the value of a is equal to the distance that light passes during a time T, equal to the duration of the existence of the universe from the moment of the Big Bang. It is easy to calculate that $T = 17{,}6\times10^{17}$ сек. Given that the astronomical year contains 365.25 astronomical days, and in the days of 86400 seconds, we easily find that the time $T = 14$ billion years has passed since the birth of the Universe (Big Bang). Since velocities greater than c are currently unknown, the distance a has been termed the *cosmic horizon* or *horizon of events*.

In 1931, F. Zwicky proposed an explanation for the reddening of the emitted light by the effect of photon aging. He believed that photons emitted by remote objects lose energy along the way from the object to the observer due to their interaction with the intergalactic medium. The loss of energy is manifested as a decrease in the frequency of light, since the photon energy is directly proportional to its frequency. In 1934, the Soviet scientist Matvey Bronstein proved that in this case the stars would not look like dots, but as fuzzy blotches. Since then, Zwicky's explanation has figured as simply a fact in the history of the emergence of relativistic cosmology. The decrease in the frequency of photons was also explained by the interaction of light with intergalactic gravitational fields, which could lead to the loss of its energy, hence, to reddening (gravitational displacement). However, this explanation also lasted for a short time, since it seemed to the scientists the most convenient explanation of the red shift by the Doppler effect. This variant subsequently entered into all textbooks as the only true, despite the fact that Hubble objected to such an explanation until the last years of his life. He wrote: “I believe that the theory of space-time in the future will find another explanation for the redshift, different from the Doppler effect arising in the expanding universe.”

The Big Bang Theory with the subsequent expansion of space allows us to find the time the existence of the universe and its limiting radius. However, this concept does not allow us to calculate the mass of the universe, which makes it impossible to give a theoretical estimate of the density. In addition, all the Friedmann solutions contain an unknown time function $R(t)$, the change of which in time characterizes the deformation of the Universe space. The absence of a specific expression for this function does not allow in turn to determine the geometry of the universe, in particular, to find out what is the sign of the curvature of the space of the Universe: positive or negative? Or its 3-space is generally flat, which is also permissible in the class of these models. In other words, for some cosmologists the theory of the expanding universe ceases to be an immutable truth, if only because, first, it does not solve the problem of the origin of the initial singularity; secondly, considers the universe as a unique phenomenon, incomprehensible as related to the space surrounding the singularity that has taken from nowhere; Thirdly, it is unclear why our planet turned out to be the “center of the Universe”.

Recently, a new trend has appeared in cosmology: scientists have become seriously interested in the question: “What was before the beginning of the universe?”, i.e. before the Big Bang. These include the well-known theoretical physicist, professor of Oxford, Roger Penrose. He drew attention to the results of research by a scientist from Armenia Vahe Gurzadyan (Yerevan Institute of Physics). Gurzadyan studied the maps of temperature oscillations of microwave background radiation (MFI) discovered by Penzias and Wilson in 1965. The maps are based on data obtained for 7 years using a WMAP space probe launched by NASA. This radiation, which exists everywhere in the universe, is caused by photons of the microwave range. Supporters of the Big Bang theory, relying on the theory of the hot Gamow Universe, argue that it arose shortly after the Big Bang, which is why they call it *relic*. It is believed that the MFI stores information about the physical state of the universe, starting from the early period of its existence to the present. By virtue of this assumption, the evolution maps of the Universe from the most ancient times to the present stage should be reflected in the maps of the temperature fluctuations of the MFI. Penrose and Gurzadyan posted their results on the site of free applications ArXiv.org in the form of an article in which they outlined their views on the evolution of the Universe. And this process can last indefinitely. One of the stages of this cycle is our Universe. The reason for the change in the universes is the formation of black holes (according to modern science — these are objects with monstrous density, formed as a result of compression of massive bodies).

Well-known cosmologists Andrew Linde (Stanford University, USA) and Alexander Vilenkin (Tufts University, Boston, USA) expressed the idea of a branching universe: in this approach, one universe grows out of another like a soap bubble. (It looks very much like a fractal structure!) In general, there are many ideas, including such exotic ones: according to one of them, the presence of a stream of distant galaxies of about 1400 units at a speed of 1000 km/sec is explained by the fact that they are attracted by a black hole existing in a parallel universe. All of the above facts indicate the approach of a new stage in the study of the universe, which will inevitably lead to a change in existing paradigms. This change is due to the constant inflow of new observational data supplied by instruments installed on space vehicles that are far from the Earth. However, the new is not built from scratch, but taking into account earlier ideas about the subject being studied. New knowledge should not categorically deny everything that has been said about the subject before: after all, scientists had reason to create a definite scientific picture of the world, dictated by their Time (the part of the span of the planet in the Galaxy). In the next section, Time will reveal new factors that will serve as the basis for a new view of the World. Therefore, it is necessary to look at the established scientific picture of the World with a new look, but not denying everything done before. In new hypotheses there are such concepts as *black hole*, *dark energy*, *dark matter*. And in order for these concepts to enter into a new, not yet created cosmological concept, it is necessary to consider them in detail within the framework of the classical theory of space-time — General Relativity. After all, it is this theory at this stage is the mathematical basis for constructing cosmological models. But first you should pay close attention to a very large “fragment” of past ideas about the structure of the observed Universe — the stationary de Sitter model.

But first you should pay close attention to a very large "fragment" of past ideas about the structure of the observed universe — the stationary de Sitter model.

§2. Gravitational repulsion as a cause of redshift

Einstein suggested that the universe is initially static (independent of time), not focusing on how it originated. As a concrete model, he chose the space of constant curvature de Sitter, obtained in 1917 by the Dutch astronomer Willem de Sitter, who specifically studied the mathematical apparatus of the then modern theory of space-time-Riemannian geometry. In the general case, the de Sitter space is a maximally symmetric simply connected n-dimensional Riemannian space of constant curvature that can be either positive or negative. The simplest example of a space with positive curvature is the surface of a sphere, with a negative surface the surface of a hyperboloid. In application to GTR, the de Sitter space-time with positive curvature can be conditionally represented as a sequence of three-dimensional spheres located along the time axis: each sphere has its own sphere (static three-dimensional space). Accordingly, de Sitter space-time with negative curvature is a sequence of three-dimensional hyperboloids located along the time axis. The geometric structure of the de Sitter space-time satisfies the equations of the general relativity field, which includes the cosmological constant λ, also called *the Einstein constant.* According to Einstein, the λ-field characterizes the presence of non-Newtonian gravitational forces of cosmological scale related to the deep properties of the Universe itself. If λ is positive, then in the universe there is a repulsive force, and the four-dimensional space (space-time) has a positive curvature. If λ is negative, then the non-Newtonian force is the force of attraction, and space-time has a negative curvature. The cosmological constant has the dimension of curvature $1/\text{cm}^2$, therefore the quantity $1/\sqrt{\lambda}$ has the dimension of length and is characterized as the radius of curvature of de Sitter space-time. Einstein believed that the value of λ should be of the order of $10^{-56}/\text{cm}^2$. When $\lambda > 0$, the radius of curvature is real, and space-time is elliptic (closed model). For $\lambda < 0$, the radius of curvature is imaginary, and space-time is hyperbolic (open model). Theoretically, both signs are equal. But practically the choice of the sign of λ should be related to the results of astronomical observations concerning the investigation of the spatial distribution of galaxies, for example, by triangulation. Measurements of galaxies formed by triangles in different directions would make it possible to clarify the question of the sign of four-dimensional curvature, hence, the sign of the non-Newtonian force: in the Euclidean space the sum of the angles of the triangle is 180°, in elliptic it is larger, and in the hyperbolic it is less than this value. However, the question of the sign of curvature remains to this day open. However, the question of the sign of curvature remains open until now. Some modern cosmologists associate the λ-field with the presence of a physical vacuum filling the space of the Universe. A physical vacuum is an inviscid (ideal) medium in which the energy flux is absent, and the density and pressure are constant. For $\lambda > 0$, the vacuum density ρ_0 is positive, and its pressure p is negative; for $\lambda < 0$, respectively, the vacuum density is negative, and the pressure is positive. The vacuum density ρ and its pressure p are related by the relation $p = -\rho_0 c^2$, which describes matter in *the state of inflation* [19, 20]. At $\lambda = 0$ there is no physical vacuum.

Since the density of matter is generally assumed to be positive, we will further consider the de Sitter elliptic model with $\lambda > 0$. We investigate the physical properties of its de Sitter spacetime, whose metric has the form:

$$ds^2 = (1 - \lambda r^2/3)c^2dt^2 - dr^2/(1 - \lambda r^2/3) - r^2(d\theta^2 + sin^2\theta d\varphi^2), \qquad (2.1)$$

where r, θ, φ are the spherical coordinates.

The three-dimensional de Sitter space does not rotate, since all the quantities $g_{0i} = 0$, and does not deform, since the three-dimensional observable metric $h_{ik} = -g_{ik}$ does not depend on time. But space has a gravitational field, since the quantity $g_{00} = (1 - \lambda r^2/3) \neq 1$, therefore the time of the universe for the observer flows unevenly. Three-dimensional gravitational potential $w = c^2[1 - (1 - \lambda r^2/3)^{1/2}]$. The interval of the observed time in this model has the form: $d\tau = (1 - \lambda r^2/3)^{1/2}dt$, where t is the ideal (ephemeris) time, r is the distance from the observer to the observed object. From this we see that the rate of time slows down with the growth of the radial coordinate r, that is, with observations of increasingly remote sources. For $r = (3/\lambda)^{1/2}$, the value of $d\tau = 0$: the time for the observer stops [11, 23]. The vector of gravitational-inertial force $F^1 = [c^2(c^2 - w)](\partial w/\partial x^1)h^{11} = c^2\lambda r/3 > 0$ [11, 23], i. e. the gravitational-inertial force in the de Sitter space is the *repulsive* force that inflates the sphere. The de Sitter space (bubble) is filled with matter of a special type: it satisfies the equation of state $p = -\rho c^2$, describing matter in a state of inflation, therefore it is called the *inflation equation*. At a constant positive density ρ_0, the pressure p is negative and is also constant. The de

Sitter space-time satisfies the field equations, the right-hand side of which describes a homogeneous matter with the energy-momentum tensor $T_{\alpha\beta} = \lambda g_{\alpha\beta}$, the observed components of which are the density $\rho = T_{00}/(g_{00})^{1/2} = \lambda$, the pressure $p = c^2T^{ik} = -\lambda c^2$ and energy flow $q^i = c^3T_0^i/(g_{00})^{1/2} = 0$. This homogeneous isotropic matter, which fills the de Sitter space, is the physical vacuum in the state of inflation, or the λ-vacuum. Obviously, the presence of such a medium affects the phenomena occurring in the universe, which inevitably should appear in the results of observations of remote objects. Thus, the de Sitter world is a four-dimensional sphere of a real radius equal to the limiting observable distance (cosmic horizon), the numerical value of which will be obtained in the next section. The sphere does not expand, despite the presence of negative pressure, and does not contract, despite the presence of a positive density, but is in equilibrium. The gravitational force existing in it is a purely inertial non-Newtonian repulsive force, directly proportional to the distance from the observer. The three-dimensional space has a constant positive curvature $C = 2\lambda$.

Thus, in cosmology, there are two basic approaches to describing the observable universe: 1) the stationary de Sitter model, proposed by Einstein; 2) the model, expanding as a result of the Big Bang, based on the works of Friedman, Hubble and Gamow. Obviously, when choosing a model, one should rely on the results of astronomical measurements of distances to galaxies, which for greater accuracy should be measured by different methods. The most common are the determination of distances to galaxies by measuring redshifts in their spectra (the Hubble method), as well as the method of "standard candles", whose role is played by objects whose luminosity is known. Such are supernovae of type *Ia* — stars exploding at a certain stage of their evolution. Their luminosity strictly depends on the distance from the observer, which allows you to determine the distances to them. The fact is that these stars have a very dense homogeneous mass, since they arose as a result of explosions of white dwarfs — stars with a mass of the order of the solar, contracting at a certain stage of their evolution to the size of the Earth. Their apparent stellar magnitudes depend primarily on the distance to the observer. Such stars are present in all galaxies, therefore it is possible to compare the distances measured by the "standard candle" method with the results of redshift measurements. During the observation of supernovae of the type Ia in the 1990s, it was found that the brightness of the Ia stars in remote galaxies, measured by the "standard candle" method, turned out to be less than the Hubble (measured by the redshift detection method), that is, the distances to galaxies turned out to be greater than in accordance with the Hubble law.

Scientists concluded: the Universe expands with acceleration, and the reason for this phenomenon is the presence in the Universe of a hypothetical *dark energy*. It is known that it is very evenly distributed, has an extremely low density and does not interact with ordinary matter through known fundamental interactions. Thus, the concept of dark energy in modern cosmology emerged as an explanation of the experimental fact, which manifests itself in breaking the Hubble law for the most remote objects located near the event horizon. In modern cosmology, two explanations of the dark energy are accepted: 1) dark energy is due to the presence of a vacuum density (non-zero energy of the vacuum), whose source is the λ-field; 2) dark energy is a dynamic field whose energy density varies in space-time. From the foregoing it follows that in the de Sitter space both explanations are valid, since they are interrelated. Indeed, the λ-vacuum has a non-zero density, and the dynamic field (force F^1) depends on the distance from the observer. Thus, the "dark force" of repulsion, responsible for inflation, is simply a physically observable quantity — a gravitational-inertial force of a non-Newtonian character. Although the dynamic theory of the expanding universe still dominates, the non-stationary de Sitter universe with the repulsive force acting in it, filled with an inflationary physical vacuum with positive density and negative pressure, may well serve as a modern cosmological model. It is precisely the nonuniformity of the flow of time for objects that are far from the observer that can be explained by the effect observed by astronomers, called the "*dispersal of galaxies*".

It was said above that the stationary model of the de Sitter universe was rejected in favor of the expanding Friedman model, in which Hubble's law is interpreted as a consequence of the expansion of the universe space. At the same time, a strict calculation of the change in wavelength (frequency) of light was not performed, and only qualitative estimates were made under the assumption that the Hubble law is due to the Doppler effect caused by the expansion of space. In fact, in GRT there is a strict theory that allows us to calculate the change in the frequency of light sources, determined by the physical and geometric properties of space-time — its acceleration, rotation, deformation of the 3-space and the curvilinear character of the trajectories of the light rays. It is known that free (not bound by any forces, except gravitational) particles move along geodetic lines, which are the shortest paths connecting two points. In flat space-time — these are straight lines, in curved they have a form that is the shortest space-time distance between two events — four-dimensional points in the space-time under study. The geodesic lines of particles of matter that have a nonzero rest mass are called non-isotropic: for them, the four-dimensional distances between neighboring points are real and the particles themselves move along them with sub-light velocities inside the light cone.

Light-like particles propagate at the speed of light along the generatrix of the cone (isotropic geodesics). The four-dimensional distances between two points on isotropic trajectories are equal to 0. The problem of changing the frequency of light in the stationary de Sitter model, as in any other space-time of general relativity, can be solved exactly with the help of the equations of isotropic geodesics that describe the behavior of photons in this model. For this purpose, it is convenient to use the equations of motion, expressed in terms of physical observables (chronometric invariants), that is, in the observer's reference frame [11]. The fact is that the general covariant equations of geodesics, written with respect to the kinematic vector of four-dimensional velocity $dx^{\alpha}/d\sigma$, are applicable in any frame of reference, but this form does not allow to determine the dynamic (physical) characteristics of photons — the frequency and 3-dimensional momentum. General covariant equations are the equations of parallel transfer of an isotropic vector and have the form:

$$d^2x^{\alpha}/d\sigma^2 + \Gamma^{\alpha}_{\mu\nu}\, dx^{\mu}/d\sigma\, dx^{\nu}/d\sigma = 0,\ \alpha = 0, 1, 2, 3, \qquad (2.2)$$

where $\Gamma^{\alpha}_{\mu\nu}$ — the Christoffel symbols of the second kind (connectivity coefficients), $d\sigma = cd\tau$ is an element of three-dimensional length along the ray, $dx^{\alpha}/d\sigma$ — the 4-velocity vector of the particle, tangent to its trajectory. Zelmanov obtained a system of dynamic equations of light-like (isotropic) geodesics that allow finding not only the shape of trajectories, but also the dependence of the observed photon frequency on the physical characteristics of the space under study: deformation, rotation, and gravitational-inertial force [11, 12].These equations describe the behavior of the four-dimensional wave vector $K^{\alpha} = \omega(dx^{\alpha}/d\sigma)$, the observed components of which are the observed cyclic emission frequency ω and the spatial momentum vector $\omega(dx^i/d\sigma)$. Equations of isotropic geodesics in terms of physical observables have the form:

$$(1/\omega)(d\omega/d\sigma) + (1/c^2)D_{ik}\alpha^i\alpha^k - (1/c^2)F_i\alpha^i = 0, \qquad (2.3)$$

$$(1/\omega)d(\omega\alpha^k)/d\sigma) + \Delta_{ij}^{k}\alpha^j\alpha^k + (2/c)(D_i^k + A_{i\cdot}^{\cdot k})\alpha^i = 0, \qquad (2.4)$$

where ω — observed cyclic frequency, D_{ik} — the tensor of velocities of deformation, $\alpha^i = dx^i/d\sigma$ — the observed wave 3-vector, F_i — вектор гравитационно-инерциальной силы, Δ_{ij}^{k} — chronometrically invariant symbols of Christoffel, A_{ik} — angular velocity tensor of space rotation [11, 12]. The observed frequency ω in the general case depends on both of these characteristics and remains constant in a non-deforming non-gravitating space. In the stationary gravitating de Sitter space, the frequency of the photon at the radiation point ω_{em} is related to the frequency of the photon at the observation point ω_{obs} by the formula $\omega_{em} = \omega_{obs}/(1 - \lambda r^2/3)^{1/2}$ [24]. This means that at the observation point $\omega_{obs} < \omega_{em}$, that is, the object looks more "red" than it should be according to calculations. Then the relative frequency difference at the radiation site and the place of reception $z = (\omega_{obs} - \omega_{em})/\omega_{em} < 0$, i. e., there is a red shift of the spectral lines of the remote objects.

The value of z, which characterizes the magnitude of the change in the frequency emitted by the source relative to the observed frequency, plays an important role in modern cosmology. The condition $z < 0$ means that the frequency of light emitted by the source is greater than the observed frequency: as the light propagates in space, the light "reddens" (red shift); if $z > 0$, then the frequency of light shifts to the violet side (violet displacement). In the de Sitter space-time, $z < 0$, that is, there is a redshift. Only it is not a consequence of the expansion of the universe, which in this case is stationary: the redshift here is due to the impact on photons of the gravitational-inertial repulsive force existing in the de Sitter space caused by the uneven progress of the universal time from the point of view of the internal observer located on Earth. From the exact solutions of the equations of motion of photons (the equations of isotropic geodesics) in the de Sitter space-time, it follows that the observed value of the photon frequency $\omega_{obs} \to \infty$ with an unlimited increase in r [24]. In the next section, it will be shown under what condition the exact distance to the event horizon can be obtained. In this case, the observed "accelerated expansion" of the space of the universe is nothing more than a distortion of the wave front, manifested in this case as an unlimited increase in the photon frequency in the spectra of distant galaxies: the farther away from us the observed galaxy, the stronger the effect of the reddening of photons. Within the framework of the ideas of Friedmann cosmology, the space of the Universe expands with acceleration. However, the redshift effect is easily explained in the framework of the stationary de Sitter model by the presence of repulsive forces. For the terrestrial observer, this looks like an amplification of the effect of red shift in the degree of removal of the source from the Earth.

Thus, within the framework of the de Sitter stationary universe theory, the effect of the red shift of the frequencies of the observed photons, the magnitude of which asymptotically increases near its event horizon, can be explained, which allows one to explain the imaginary "acceleration of the expansion" for distant sources. However, the de Sitter model is simply a mathematical construction whose geometric structure in space-time satisfies the equations of the general relativity field, which includes the cosmological constant. Because of the static nature of the model, we can learn nothing about its origin and further evolution, since we do not have information about it, unlike Friedmann's cosmology, based on the Big Bang theory as a consequence of the decay of the initial singularity, the "point" cluster of superdense matter. (True, nothing is known about the origin of the singularity itself, nor about the cause of its "explosion", as a result of which a modern universe filled with a physical vacuum, different fields and matter collected in clumps of different sizes was formed by multiple transformations). But so far we have only a model of a secluded universe that has not changed since the beginning of its creation and has no connections with the external "environment". Is it possible to simulate the situation in such a way as to find out how the de Sitter space-time appeared, filled with a physical vacuum? After all, it was built by de Sitter purely formally for reasons of symmetry. And while we have only a model of a secluded universe that has not changed since the beginning of its creation and has no connections with the external "environment". And what was this "beginning"? And what kind of environment surrounds our Universe? This will be discussed in detail in the following paragraphs.

§3. What could precede the de Sitter Universe?

What could have preceded the de Sitter Universe? The knowledge of our distant ancestors, which has come down to us in the form of fragments belonging to different civilizations, contains information that the Universe originated from the original matter called "water". Then all objects of the Universe (its parts) consist of the same matter, which is at different stages of evolution. As you know, ordinary water in a state of weightlessness takes the form of a sphere. Stars, galaxies are in a state of weightlessness relative to their centers of attraction. Many cosmic bodies (planets, stars) are spheroids. Perhaps the same form has the physical body of the Universe. Thus, the problem arose: to construct a space-time (field of aggression) created by a liquid incompressible sphere. A similar model was previously obtained by the German astronomer Karl Schwarzschild [25] by solving field GRT equations (Einstein equations), however, he initially excluded the presence of singular states in this field — singular points or surfaces with discontinuities, limiting the solution to regular functions only. The fact is that Schwarzschild built his model to describe, within the framework of GR, the behavior of the Sun as a regular star. But in astrophysics and cosmology, the problem of singularities has recently become very relevant, since astronomers are exploring such objects of the Universe as irregular (exploding) stars, "black holes" and their interaction with the environment, neutron stars and pulsars with a very interesting structure, etc. In this connection, the question arises of the need to expand the possibilities of the mathematical description of the structure of a homogeneous liquid sphere, in particular, it is of interest to find a more general solution (metric) that allows singularities (time stop and space break). Modern physicists associate the time stop with the collapse of the studied gravitating mass. The rupture of space in any direction can be viewed as an infinite increase in the value of the metric component in a spatial direction. Singularities should be discussed separately, since if we follow the path of using only regular metrics, this will mean a restriction on research related to special (singular) states of space-time-matter. Fortunately, modern astrophysics and cosmologists are free to use such concepts as "black holes", "event horizon", etc. But in order to gain a deeper understanding of such unusual terms for ordinary perception, one must first clearly formulate them within the framework of GR.

And here is a concrete example: in connection with the growing interest in black holes, physicists admit the possibility of stopping time on the surface of a black hole, determined by the condition $g_{00} = 0$. It is one of the four signature conditions [12, 22] that must be satisfied by any reference system that can be implemented using real (physical) bodies. In [22], these conditions are presented in a simplified form for diagonal metrics, which will be discussed later. They have the form: $g_{00} > 0$, $g_{11} < 0$, $g_{22} > 0$, $g_{33} <0$. In addition to them, there is a strong condition $g = \det\|g_{\alpha\beta}\| < 0$, which is still an inviolable "sacred cow": after all, it was once accepted that it is Riemannian geometry that has the mathematical basis of GR, and the determinant of the metric tensor is strictly negative in it. It turns out that our World is built according to the laws invented by the scientists themselves for reasons of "obviousness" and simplicity in handling. Therefore, everything that contradicts the customary canons is banished from explanations. The metric in Riemannian geometry is nondegenerate ($g \neq 0$), and since GTR stands on this foundation, to leave it means to remain without a reliable mathematical base. In fact, a way is possible not to abandon the base, but, on the contrary, to expand it. If we assume the possibility of the existence of a non-degenerate (Riemannian) space as a special case of a generalized space for which g ≤ 0, then such a problem as the impossibility of instantaneous transmission of information (energy) in the GRT space-time will disappear. In the previous chapter, an explanation of the results of Kozyrev's experiments on observations of the true positions of stars was explained precisely within the framework of the extended Riemannian space, whose metric tensor satisfies the condition $g = \det\|g_{\alpha\beta}\|$. Therefore, if the results of observations (measurements) are in contradiction with theories invented at a certain stage in the development of science, the results should not be immediately denied: it is better to try to find a theoretical explanation that does not deny the old explanations, but indicates a path that later allows us to see new horizons. The world is infinitely large, and all our instructions for studying it are simply a tribute to the time period in which they were created. Otherwise, the outdated rules will prevent us from further exploration of the World.

We investigate the gravitational field created by a fluid ideal (non-viscous) homogeneous sphere: indeed, many natural objects have this form, in particular, stars of different types. The shape of the ball takes water in a state of weightlessness. In modern science, water in such a state is classified as *condensed matter*. Note that the planets, stars, globular clusters, quasars ... also have a spherical shape. It is possible that all these bodies once consisted of condensed matter, and their spherical forms were preserved in the process of evolution, although the chemical composition and density of matter at the present time vary greatly among themselves. Since cosmic bodies are integral parts of space-time, they must inevitably affect both the surrounding space and time. When considering the gravitational field of a liquid homogeneous sphere, we will not exclude the possibility of the existence of singular states.

Calculations of the gravitational field of a liquid homogeneous sphere have long been given in textbooks, but the fact is that they were obtained in a flat three-dimensional (Euclidean) space, where the time as the coordinate direction is absent. In the space-time of GR, time plays an equal role along with the spatial directions, therefore, the resulting solutions for bodies of different shapes and consisting of different substances can differ greatly from similar solutions in a flat 3-space. Indeed, in the curved space-time of GR, in contrast to the flat Minkowski space, for each direction there is a coefficient $g_{\alpha\beta}$, which depends in general on all coordinates. So, the time direction $x^0 = ct$ in the general case is accompanied by the coefficient g_{00}, so that the time direction (tempo of time) depends not only on the coordinate (uniformly current) time t, but also on the coefficient $g_{00} = (1 - w/c^2)^2$, directly related to the 3-dimensional gravitational potential w [11]. The magnitude of the gravitational field is manifested in its effect on the pace of time. It is maximal in the case of $w = c^2$, since in this case $g_{00} = 0$, which can be considered as a stop of time for an external observer. In particular, this condition is fulfilled during the collapse of the object, so it can be called the collapse condition. The value of w is the gravitational potential per unit mass. Multiplying both parts of the collapse condition by the mass M of the collapsing body, we obtain the expression $Mw = Mc^2$. Thus, the well-known expression for the energy $E = Mc^2$ can be considered, in particular, as the amount of energy required for the collapse of the body. Where does it come from? Since the collapse of time for a collapsing object stops, one may think that the collapse is due to the energy of Time: the passage of time under the condition w = c2 stops instantly and the object leaves our spacetime.It turns out that having your own time is a necessary and sufficient condition for the existence of an object in our world: there is no time — the object becomes a part of another world. It should be noted here that we are talking only about the proper time, and not about the coordinate (ephemeris): it always flows evenly.

Obviously, the gravitational field is the weaker, the smaller the magnitude of the gravitational potential w. Therefore, a weak gravitational field is considered such where the component g_{00} differs from unity only by a small correction. Modern scientists believe that, in the main, the GTR apparatus is applicable in the region of low velocities and weak gravitational fields. This is due to the fact that the magnitude of the gravitational potential of the planet U is very small compared to c^2. On the Earth's surface, $U/c^2 = 10^{-9}$, but even such a “weak” field of the planet holds us so tightly that it can only be left when it reaches a speed of 11.2 km / s, called the second cosmic velocity. In this case, we will fall into the “weak” gravitational field of the Sun (at a distance of 1 AU. From the Sun, U/c^2 = 9.9×10–7), which can be left only by gaining speed above 16 km/s. What is the nature of gravity, if it binds so strongly to its source everything that is in its field? Maybe this is just one of the manifestations of the energy of Time itself, in whose power we are? The answers to these questions do not lie on the surface, but in order to try to solve them, first of all, you should abandon the many prohibitions on the development of some areas of research. After all, the purpose of these restrictions is to remain in the familiar cozy world, but what will we do if this world “suddenly” begins to change rapidly? And in order to prepare for the coming changes, which we are already beginning to notice, we will not be afraid of the emerging shoots of the “new”, but rather try to understand what is happening with our world. Science is one of the ways of knowing the world, only you don’t have to interfere with yourself on the path of knowledge, putting different restrictions and prohibitions. All these TABUs for the development of the new are based on the reluctance to go beyond the "obvious" and step onto paths that no one can enter. But it is impossible to think that the entire Universe is built in the image and likeness of our ideas about it, which have developed in its tiny corner — the Local Group of Stars of the Milky Way. Therefore, let us turn to the study of strong gravitational fields in order to understand how their manifestation differs from the effect of the "weak" fields that we are used to.

The exact expression for the metric of a homogeneous liquid sphere is obtained by solving field equations for a spherically symmetric distribution of a homogeneous liquid medium, on the right side of which there is an energy-momentum tensor of an ideal (nonviscous) liquid:

$$T^{\alpha\beta} = (\rho_0 + p/c^2)U^\alpha U^\beta - (p/c^2)g^{\alpha\beta}, \qquad (3.1)$$

where ρ_0 = const is medium density, p is her pressure , $U^\alpha = dx^\alpha/ds$ is four-dimensional unit velocity vector. As a result of the exact solution of the field equations with the right-hand side, described by the above energy-momentum tensor of an ideal incompressible fluid, an expression for the metric was obtained in [23]:

$$ds^2 = \{3[1 - (\kappa\rho_0 a^2)/3]^{½} - [1 - (\kappa\rho_0 r^2)/3)]^{½}\}^2 c^2dt^2 - dr^2/[1 - (\kappa\rho_0 r^2)/3] - r^2(d\theta^2 + sin^2\theta d\varphi^2), \quad (3.2)$$

where $\kappa = 8\pi G)/c^2$=18,6×10^{-28} см/г is Einstein constant , a is radius of sphere , ρ_0 is fluid density, r, θ, φ are spherical coordinates. In the future, this solution will be applied in the study of both the Universe and its parts — planets, stars, galaxies,... Unlike the Schwarzschild solution [25], constructed in the framework of GR, provided that all the space-time characteristics of the gravitational field are regular functions, the solution [23] admits singular states:

1) collapse provided: $3[1 - (\kappa\rho_0 a^2)/3)]^{½} = [1 - (\kappa\rho_0 r^2)/3)]^{½}$;
2) space break provided: $g_{11} = [1 - (\kappa\rho_0 r^2)/3] \to \infty$, i.e. $r = r_{br} = (3/\kappa\rho_0)^{½}$.

Thus, a homogeneous liquid sphere collapses under certain conditions, with others it creates breaks in the surrounding space, and sometimes both of these processes occur simultaneously [23]. The collapse condition of a homogeneous liquid sphere can be rewritten as $r_c = [9a^2 - 24/(\kappa\rho_0)]^{½} = (9a^2 - 8r^2_{br})^{½}$, where r_c is the radius of the liquid sphere in a state of collapse. Its execution means that for an external observer the time on the surface of the observed object stops: $d\tau = 0$ [11]. In other words, the observer and the surface of the observed collapsar at the moment of observation are in the same moment of time, that is, they are connected by instantly propagating information (energy). The collapse of the sphere is possible under the condition that the radius of the collapsar is real, that is, for $a > (8/3\kappa\rho_0)^{½}$. Thus, material structures, with a certain ratio between their size and density, are capable of "stopping time", that is, creating surfaces from which instantly spread information about this object comes to the observer. And the distance that this surface is removed from the center of the sphere is determined by the ratio between its radius and the radius of the gap. Investigate in more detail the singular states of the liquid sphere: 1) a gap in space occurs at a distance r = $r_{br} = (3/\kappa\rho_0)^{½}$; 2) the time stop occurs at a distance $r_c = (9a^2 - 8r^2_{br})^{½}$. Below it will be shown in which case the value of rc coincides with the value of the gravitational radius $r_g = 2GM/c^2$. It is easyly to see that the distance = r_{br} is determined solely by the density of the sphere (mass concentration), and the radius of the liquid collapsar depends both on its size a and on the value of ρ_0. From what has been said, it is clear that a homogeneous liquid sphere collapses if the radius of its surface a is close in magnitude to the rupture radius of the space r_{br}. This means that the collapse of the liquid sphere is possible: 1) for huge bodies of low density; 2) for small bodies with enormous density.

It is a little about the ruptures of space created by different bodies. For the Sun, whose average density is ρ_0 = 1.4 g/cm^3, the value of r_{br} = 2.2 A.U. = 3.3×10^{13} cm, for neutron stars whose density is assumed to be intranuclear ($\rho_0 \sim 10^{14}$ g/cm^3), the value of $r_{br} \sim$ 10 km. Note that this corresponds to the radii of neutron stars ($r \sim$ 10–20 km). From the expression for r_{br}, it follows that the body "pulls" the fabric of space onto itself, creating tension in it that reaches the rupture. In this case, the greater the density of the body, the closer to itself it breaks the space. The space of the Sun has a gap in the region between Mars and Jupiter, where the central part of the Asteroid Belt is located — a ring-shaped region lying at a distance of 2.1–4.3 A.U. The distance at which the gap occurred coincides with the location of the hypothetical planet Phaeton. The gap of space created by Jupiter (ρ_0 = 0.94 g/cm^3) also lies in this area: r_{br} = 2.8 A.U. is from the surface of Jupiter. For the Universe, the density of which, according to modern estimates, is 10−29 g/cm^3, the rupture radius is 1.3 равен 10^{28} cm, which also corresponds to scientific data. It should be noted that the size of the Sun (a = 7×10^{10} cm) is much smaller than the break radius, therefore the Sun cannot collapse in this way. But the

Universe and neutron stars, for which the rbr value is commensurate with their size, may well be in a state of collapse. It is important to note that the concept of collapse here is not related to the monstrous density of a collapsed object: both a neutron star having a density of the order of an intranuclear one, and the Universe with its negligibly small density can be equally of this type.

We investigate this issue in more detail. If the surface of the discontinuity coincides with the surface of the sphere, then it is also the surface of the collapsar: $r_{br} = a = (3/\kappa\rho_0)^{½}$.This case is of particular interest, since for a = rbr = (3 / κρ0) ½, the expression for the metric takes the form:

$$ds^2 = (1 - r^2/a^2)c^2dt^2 - dr^2/(1 - r^2/a^2) - r^2(d\theta^2 + sin^2\theta d\varphi^2), \qquad (3.3)$$

that is, we obtain the de Sitter space (2.1), for which the cosmological constant has a specific value $\lambda = 3/a^2$. From the expression for the energy-momentum tensor $T_{\alpha\beta}$ (3.1), it is easy to see that an ideal incompressible fluid transforms into a physical vacuum if its density and pressure are related by the condition: $\rho_0 c^2 = \lambda c^2/\kappa = - p$, describing matter in a state of inflation. Metric (3.3) satisfies the field equations $R_{\alpha\beta} = (\lambda/\kappa)g_{\alpha\beta}$, where $R_{\alpha\beta}$ is Ricci tensor (convolution of the four-dimensional curvature tensor $R_{\alpha\beta\gamma\delta}$), $\lambda = 3/a^2$. The sphere breaks the space at a distance from its center $r_{br} = (3/\kappa\rho_0)^{1/2} = (3/\lambda)^{1/2} = a$. By $a = 1{,}3\times10^{28}$ cm we find $\lambda = \kappa\rho_0 = 1{,}8\times10^{-56}$ см$^{-2}$. The order of magnitude of the cosmological constant $\lambda \sim 10^{-56}$ см$^{-2}$ corresponds to the evaluation made by Einstein. Thus, the value of $a = 1{,}3\times10^{28}$ cm is close in magnitude to the event horizon — a conditional boundary dividing sets of events of the past and the future. In fact, the event horizon is the limiting distance at which objects are observed, that is, the radius of the observed Universe. It is quite possible to assume that our Universe is an inflationary collapsar, whose geometry is described by metric (3.3). In this case, it represents the de Sitter constant curvature space, originally proposed by Einstein as a model of the stationary Universe, and its gravitational radius $r_g = 2GM/c^2$ coincides with the discontinuity radius and with the radius of the sphere a. This is easy to show by substituting in the expression for $r_{br} = (3/\kappa\rho_0)^{1/2} = a$ the Einstein constant $\kappa = 8\pi G/c^2$ and expressing ρ_0 through mass M: $\rho_0 = 3M/4\pi a^3$. From here it is easy to find $a = r_{br} = r_g$. Thus, the inflationary collapse is simultaneously an object called "black hole" by physicists. It is believed that such objects are formed as a result of the gravitational contraction of the space they occupy. We investigate this issue in more detail.

In order to understand what black holes are from the standpoint of modern science, let us turn to the history of the issue. The term "black hole" was proposed by J. Wheeler in 1967. However, the first predictions about the possible existence of such objects belong to the 18th century and are associated with the work of John Mitchell, written by him in 1783, as well as with similar results from Paul Laplace, which he obtained independently of Mitchell. The English astronomer Mitchell became interested in the following question: what should be the radius of the sphere so that the speed of escape of matter from it (in modern terminology — the second cosmic speed) would be equal to the speed of light. Their calculations were based on the theory of Newton and the corpuscular theory of light. Mitchell sought the distance r from the center of the sphere of mass M, at which the escape velocity of a particle is equal to the speed of light. He equated the value of the potential energy of a particle of mass m located on the surface of the sphere of mass M at a distance r from its center, its kinetic energy: $GmM/r = mc^2/2$, where he found the corresponding value $r = r_g = 2GM/c^2$, $G = 6{,}\ 67\times10^{-8}$ cm^3/g×sec^2 is the constant of Newton. With $r < r_g$, the light will not be able to leave the sphere, therefore such an object was called a black hole, or a gravitational collapsar. Mitchell calculated that the Sun could become a "black hole" under the condition $r = r_g < 3$ km.

The problem of the collapse of stars, which leads to the appearance of "black holes," has been studied for a long time in relativistic astrophysics. The initial theoretical material in the study of this problem was the famous work of astronomer Karl Schwarzschild, in which he investigated the gravitational field of a distant object located in empty space-time. This object was quite rightly considered by him as a "point mass" [26]. The solution of this problem is still used in celestial mechanics in those cases when it is necessary to take into account relativistic corrections to the motion of bodies. In particular, the Schwarzschild solution allowed us to calculate the magnitude of the displacement of the perihelion of Mercury in the gravitational field of the Sun, and also to calculate the correction to the movement of the light beam in the field of the Sun. Radio interferometric observations of quasars confirmed the effect of deflection of radio waves with an accuracy of 1%. In the case of a weak gravitational field (away from the gravitating "point"), the movement of bodies in this field is described with a sufficient degree of accuracy by the Newtonian theory of aggression.

The famous German mathematician David Hilbert became keenly interested in this problem, therefore the gravitational radius rg is also called the Gilbert radius. Unfortunately, Schwarzschild's solution was applied by him to study such a phenomenon as the collapse of stars. Hilbert began to solve the same problem as Mitchell and Laplace, but not within the framework of the classical theory of Newton, but using the

Schwarzschild relativistic model, the metric of which has the form [26]:

$$ds^2 = (1 - r_g/r)c^2dt^2 - dr^2/(1 - r_g/r) - r^2(d\theta^2 + sin^2\theta d\varphi^2) \qquad (3.4)$$

where $r_g = 2GM/c^2$. Hilbert suggested that at a distance $r = r_g$ the star turns into a black hole, from which light cannot escape, because the matter inside the star is compressed to a superdense state. The space-time (3.4) obtained by Schwarzschild is currently the main (actually the only) model for describing non-rotating black holes in relativistic astrophysics. At the same time, it is forgotten that Schwarzschild built his model for calculating the motion of bodies in the gravitational field of a point mass, and not to study the physical properties of this "point". Mitchell also considered a gravitating body of a certain radius, and not a dimensionless point. Comparing the de Sitter solution (3.3) with the Schwarzschild metric (3.4), it is easy to see that in both cases, under the condition $r = rg$, the space-time: 1) collapses; 2) has a gap; 3) the surface of the gap coincides with the surface of the collapsar. In the de Sitter space, these conditions are fulfilled by $\lambda = 3/a^2$. It was shown above that for $\lambda = \kappa\rho_0 = 3/a^2$ the radii of gravitational and inflational collapse coincide : $r_g = r_c$. This means that with a certain ratio of the density of a body and its size it stops time and breaks space at a distance equal to its radius, that is, it is a self-closed object both in space and in time. The r_g value is also called the event horizon. For the external observer, the time on the event horizon stops. It should be noted that Mitchell posed the problem of the condition under which the gravitational pull of the mass can accelerate the body falling on her to light speed, transformed with the Hilbert feed into the collapse problem as a result of compression of the body to a state from which there is no way out even for light. It should be noted that Mitchell posed the problem of the condition under which the gravitational pull of the mass can accelerate the body falling on her to light speed, transformed with the Hilbert feed into the collapse problem as a result of compression of the body to a state from which there is no way out even for light. Now a bit of history.

It is obvious that the stars, like the Universe, are forms filled with matter and having a length in space. It is most natural to consider stars as spheroids. In modern astronomy, they are considered as gas balls in which thermonuclear reactions take place, as a result of which the matter of stars burns out and its compression occurs. But have stars always been seen as gas balls? And can gas form spheres with a clearly defined (not vague) surface? In fact, the models of stars as gas balls began to be considered only from the 20s of the last century through the efforts of the well-known supporter and propagandist of the UTO ideas Arthur Eddington [27]. The calculations of models in the framework of general relativity are very laborious: it is necessary to solve a system of 10 field equations (Einstein's equations), the left parts of which contain the geometric characteristics of the gravitational field, and the right parts describe the matter of which the gravitating source consists. Considering stars as gas balls is a more straightforward task than calculating models of liquid stars, since gas is described by the equation of state that relates the pressure of a gas to its density. After Hans Bethe discovered the thermonuclear cycle of proton-proton reactions in 1938, the idea of representing stars as gas balls, in the depths of which thermonuclear reactions of converting hydrogen to helium take place, became generally accepted [28]. The theory of liquid stars, which was actively promoted by the British physicist and astronomer, a member of the English Royal Society, James Jeans, temporarily faded into the background, as the theory of the gas structure of stars became more popular at that time.

Jeans built his theory of liquid stars [29, 30], using the method of analogies. He suggested that the behavior of rapidly rotating liquid stars is similar to the behavior of a heavy rotating incompressible fluid, which was previously studied by Henri Poincaré and Alexander Lyapunov. Investigating the problem of shapes that form liquid rotating masses in 1914–1916, Jeans showed that, as a result of evolution, a rapidly rotating fluid body either divides into two parts or takes a very flattened lenticular shape, the matter of which breaks down from its sharp equatorial edges. The last process Jeans associated with the formation of planetary nebulae. Since the 90s of the last century and to the present, the idea of treating stars in the form of liquid spheroids has begun to materialize in the minds of astrophysicists. The American biophysicist Pierre Robital proposed a model of the Sun consisting of liquid metallic hydrogen [31–33]. tar plasma is modeled using magnetohydrodynamics, i.e. the movement of a magnetic fluid. Magnetohydrodynamics is also used in the simulation of liquid metals [34, 35]. In the gas environment magnetohydrodynamics is not applicable. Therefore, the theory of liquid stars is used in our time to explain the observational data relating to the Sun and the stars. In the light of the above, the consideration of the model of the Sun in the form of a liquid sphere is not anything out of the ordinary. The liquid model of the Sun, proposed by Schwarzschild, is pioneering in the sense that for the first time the structure of a space object was described within the framework of the recently appeared General Theory of Relativity [25]. The structure of stars as relativistic objects will be discussed in §5 of this chapter, but for now let us return to the de Sitter Universe.

At a distance $r = a = (3/\kappa\rho_0)^{1/2} = r_g$, the time for an observer stops at a distance of about 1.3×10^{28} cm from him. We can say that the Universe "pulled" the surrounding space towards itself and "stopped" time. The rupture of space at the level of the border of one's own body and stopping at this time boundary is a jump (catastrophe) that instantly translates the body that made it into a different nature than the stars known to us with their planetary systems. The substance filling the collapsar, with a positive density, has a negative pressure. In the theory of a nonstationary Universe, the quantity a is also the maximum distance at which observable objects are detected, i.e., the "edge of the Universe". Scientists are not allowed to see further, beyond the horizon, the technical capabilities of the instruments (telescopes) through which observations are made. It should be noted that here we are talking exclusively about the ranges of electromagnetic radiation emitted by objects, i.e., photons emitted by extremely distant objects. Information about objects located beyond the "edge of the universe" is missing. It is easy to see that the numerical value of the Hubble constant $H_0 = c/a$ corresponds in order of magnitude to that adopted in modern cosmology: $H_0 = 2.3\times10^{-18}\ s^{-1}$ [19, 20]. Thus, the nonstationary (swelling due to deformation of 3-space) Friedmann model and the stationary gravitating model of de Sitter give the same numerical value for H_0. Thus, the nonstationary (swelling due to deformation of 3-space) Friedmann model and the stationary gravitating model of de Sitter give the same numerical value for H_0. About the future of the expanding spheroid is unknown, and the time of the "beginning of the Universe" is determined from the condition $T = 1/H_0 = 13{,}9\times10^9$ years. A detailed discussion of this will be in the next paragraph.

In de Sitter's Universe, a is the event horizon — a conditional boundary separating the totality of events of the past and the future, and being the limiting distance at which objects of the Universe are observed. However, in this model, in contrast to the Friedmann time with a uniformly current (ideal) time, the observed time on the surface $r = a$ stops. We encountered a similar situation in §4 of Chapter 1 in a theoretical explanation of Kozyrev's astronomical observations. There, the observed time stopped at a three-dimensional degenerate hypersurface separating the past and the future, that is, being present. In other words, observing the objects farthest from it, the observer instantly receives information about them. From a formal point of view, its carriers are hypothetical zero-particles. In fact, the human consciousness perceives information about events from such a hypersurface instantly, but if it comes to realization, it will come much later: after all, in the modern system of perception of information this process is regulated by the brain. And brain activity is determined by the energy state of the span of the planet in the galaxy. So far the brain dictates to us the "absolute" (at the moment) truth that there are no influences in the world that propagate with speeds exceeding the light one. This is also confirmed by the most common definitions: "the event horizon is an imaginary boundary in space-time separating those events that can be connected with events at light-like infinity by light-like geodesic lines (trajectories of light rays), and those events that cannot be so connected. In modern science, it is believed that there are two light-like infinities (past and future), therefore there can be two horizons of events — past and future. The horizon of past events divides events into changeable ones from infinity and unchangeable ones, and the horizon of the future separates events that you can learn about, at least in the infinitely remote future, from those events that you don't know anything about. These infinities are the generators of the Minkowski cone, starting in the infinitely distant past and ending in the infinitely distant future. Recall that a vertex of a cone is a degenerate three-dimensional hypersurface, on which the future is instantly transformed into the past. Since in the minds of scientists there was a firm conviction that nothing in the Universe spreads faster than the speed of light, the formation of events begins in that region of space-time, which is connected with the "thin" worlds from the point of view of the observer Since in the minds of scientists there was a firm conviction that nothing in the Universe spreads faster than the speed of light, the formation of events begins in that region of space-time, which is connected with the "thin" worlds from the point of view of the observer — the areas of existence of electromagnetic fields. These fields are also material, but with a lesser degree of condensation of matter: in modern science they are called radiation fields. Then, some events "germinate" (materialize) in our "gross" world of material bodies moving at sublight speeds. In fact, this means that the information (energy) of a photon located on the horizon line of events, comes to the observer instantly. Here there is a clear analogy between the information that instantly connects the observer with the observed objects, and information about the most recent events occurring on the edge of the Universe: they both instantly connect the observer with remote places of the Universe, right up to its edge. It turned out that "at the edge of the Universe" a sharp increase in the red shift effect is observed. The edge of the Universe is otherwise called the event horizon and is defined as: 1) a conditional boundary separating the totality of events of the past and future; 2) the limiting distance at which objects of the Universe are observed. In the future, it will mainly focus on the first definition.

§4. Life of the Universe — Transformation of the Energy of the Future into the Past

In this section, we discuss a comparison of the physical and geometrical characteristics of an ideal liquid sphere (3.2) and the de Sitter inflation bubble (3.3) and the mechanism of their interaction. The fact is that the liquid sphere transforms into an inflation bubble with a strictly defined ratio between its density and radius, i.e. by $\rho_0 a^2 = 3/\kappa = 1{,}6\times10^{27}$ cm/g. From this it is clearly seen that such a transformation is possible only: 1) for huge bodies with extremely low density; 2) for small super dense bodies. It turns out that the transformation occurs at the moment when a definite relationship is established between the density of the sphere and its size. If the density of the sphere increases, then its radius should decrease, and vice versa: a decrease in the density of the sphere leads to an increase in its radius. Without guessing the reasons for this situation, we investigate the physical and geometric properties of the spaces of the liquid sphere and the vacuum bubble, and then compare them. To do this, we calculate the observed physical characteristics (the vector of gravitational-inertial force, the tensor of strain rates, the tensor of the angular velocity of rotation) and the geometric — three-dimensional curvature [11]. The four-dimensional curvature of the de Sitter vacuum bubble (3.3) is constant and negative: $K = -1/a^2$ [23, 24].]. The space-time of the liquid sphere does not have a constant curvature, since the four-dimensional Riemann curvature tensor $R_{\alpha\beta\gamma\delta}$ does not satisfy the conditions : $R_{\alpha\beta\gamma\delta} = k(g_{\alpha\gamma}\, g_{\beta\delta} - g_{\beta\gamma}\, g_{\alpha\delta})$, k = const.

The study of the physical characteristics of the spaces of the liquid sphere and the vacuum bubble of the results led to the following conclusions [23, 24]: the three-dimensional spaces of the liquid sphere and the vacuum bubble do not rotate and do not deform, but non-Newtonian gravitational-inertial forces of opposite direction act in them. In the space of the liquid sphere (3.2), the vector of gravitational-inertial force has the form:

$$F^1 = -(\kappa\rho_0 c^2/3)\times(1-(\kappa\rho_0 r^2/3)r/\{3[1-(\kappa\rho_0 a^2/3)]^{½} - [1-(\kappa\rho_0 r^2/3)]^{½}\} < 0, \qquad (4.1)$$

that is, it is a non-Newtonian force of attraction. In the space of a vacuum bubble (3.3), it is transformed into a non-Newtonian repulsive force

$$F^1 = c^2 r/a^2 > 0. \qquad (4.2)$$

The pressures inside the liquid sphere and the vacuum bubble have the form, respectively:

$$p = \rho_0 c^2\times[(1-r^2/r_{br}{}^2)^{1/2} - (1-a^2/r_{br}{}^2)^{1/2}]/[3(1-a^2/r_{br}{}^2)^{1/2} - (1-r^2/r_{br}{}^2)^{1/2}] > 0;\ p = -\rho_0 c^2 < 0 \quad (4.3)$$

Thus, if the condition $a = [3/(\kappa\rho_0)]^{½} = (3/\lambda)^{½}$ is fulfilled, the force of attraction acting inside the liquid sphere is transformed by the repulsion force inside the vacuum bubble; positive pressure inside the liquid sphere goes into negative pressure inside the inflation collapsar. The transformation takes place under the condition that the liquid sphere breaks the space and stops time at a distance from the center equal to its radius a, i.e. on the surface of the inflationary collapsar, where the interval of the observed time is $d\tau = 0$.This process can be represented more clearly with the help of an elementary curvilinear light cone, conditionally existing at every point of the Riemannian space (see Chapter 1, §7). Since the integration problem in a curved space is not trivial, the light cone is local: it is introduced in a neighborhood of dx^α of any arbitrary point. This cone is described by the equation $cd\tau = \pm\, d\sigma$, where dσ is observed spatial interval. Between the cones of the past and the future, there is a membrane, described by the equation $cd\tau = \pm\, d\sigma = 0$, which in the non-rotating frame of reference takes the form:

$$d\tau = (g_{00})^{1/2}dt = (1 - w/c^2)dt = 0,\ d\sigma^2 = h_{ik}\,dx^i dx^k = 0,\ u^i = dx^i/dt. \qquad (4.3)$$

где w = — collapsar gravitational potential. This shows that the interval of the observed time is dτ > 0 for $w < c^2$; accordingly, dτ < 0 for $w > c^2$. In the area of space-time, where the physical observer is located, we have taken the countdown from past to future, therefore the gravitational potential $w < c^2$. Let's call this area the space of the past. Then the region of space-time, where w > c2, is the space of the future, where formally time flows in the opposite direction — from the future to the past. This mathematical result should not be taken literally: it merely means that the future is in a certain virtual space, where our physical body does not have a turn, but there are no such boundaries for consciousness.The metric quadratic form $d\sigma^2$ in a Riemannian space-time is positive definite, but in this case, due to the condition $d\sigma = 0$, it degenerates: $h = det|h_{ik}| = 0$. Since the determinants of the $g_{\alpha\beta}$ and h_{ik} metrics are related by $(-g)^{½} = h(g_{00})^{½}$, then from the condition $h = 0$ it follows $g = 0$, therefore, the metric $g_{\alpha\beta}$ in the region of the transition of the past into the future is degenerate, therefore non-Riemannian. So, the observable region of space-time, perceived by the observer as a present, is a non-Riemannian hypersurface, called null space. From the point of view of mathematics, the singular surface $d\tau = 0$ has a different geometric structure, different from the Riemannian one. For an observer with a physical body, it is still an insurmountable barrier that does not allow penetrating into the events of the future. In fact, this surface is a membrane: after all, there are people who can look into the future. In other words, the space of the present, which we mostly perceive as the only "reality", is only one of the layers of Time, called *the material world*. Details about this will be discussed in subsequent chapters.

The membrane between the past and the future $d\tau = 0$ can also be viewed as a mirror in which the past and the future are viewed from different directions. We illustrate this with a concrete example. Since the liquid sphere instantly transforms into a vacuum bubble, we consider their spaces as mirror images of each other with respect to time. Calculating $d\tau = \pm (g_{00})^{½}dt$ for metrics (3.2) and (3.3), we find, respectively:

$$d\tau_1=\pm(½)\{3[1 - (\kappa\rho_0 a^2)/3)]^{½}- [1 - (\kappa\rho_0 r^2)/3)]^{½}\}dt;\ d\tau_2 = \pm (1 - r^2/a^2)^{½}dt. \quad (4.4)$$

It is easy to see that when $a = (3/\kappa\rho_0)^{½}$, the interval dτ1 goes into $d\tau_2$, provided that their signs are opposite: if $d\tau_1 > 0$, we get $d\tau_2 < 0$. Which of these spaces should be identified with the observable universe, and which one with its mirror image? Obviously the choice should be based on observational data. Studies of the spectra of distant galaxies showed that the spectral lines are shifted towards lower frequencies (redshift). Therefore, a world with a direct course of time is one where the frequency of radiation from a remote source at the point of observation ωobs is less than the frequency at the point of emission ωem ($\omega_{obs} < \omega_{em}$), and the looking glass is the world where $\omega_{obs} > \omega_{em}$ The exact expressions for the observed frequency are obtained by solving the equations of isotropic geodesics (trajectories of light propagation), written in terms of physical observables [12]. Solving them for metrics (3.2) and (3.3), we find, respectively [23, 24]

$$\omega_{1\,obs} = \omega_{1\,em}/\{3[1 - (\kappa\rho_0 a^2)/3)]^{½}- [1 - (\kappa\rho_0 r^2)/3)]^{½}\},\ \omega_{2\,obs} = \omega_{2\,em}/(1 - r^2/a^2)^{½}. \quad (4.5)$$

In modern cosmology, a large role is played by the value $z = (\omega_{em} - \omega_{obs})/\omega_{obs}$, which characterizes the change in the radiated frequency of the source relative to the observed one. Recall that the condition $z > 0$ means that the frequency of the light emitted by the source is greater than the observed one: as it propagates in space, the light "turns red" (red shift). If $z < 0$, then the frequency of the emitted light is shifted to the violet side (violet offset). It is easy to see from (4.5) that in the space of the liquid sphere (3.2) the frequencies are shifted to the violet side, and in the vacuum inflation bubble (3.3) to the red one. Since it is the redshift that is observed, de Sitter space filled with a positive-density physical vacuum should be chosen as the world with the direct course of time (space of the past), then the future space is a liquid incompressible sphere, therefore, $d\tau_2 > 0$, $d\tau_1 < 0$. Transformation of the future into the past is realized through the present: time from the upper part of the elementary light cone (the future), built at each point of space-time, flows into its lower part through this point (the present) and becomes the past. In this case, the vector tangent to the time line in each of the halves of the cone has opposite signs, and at the apex of the cone becomes zero (isotropic). Thus, stopping the flow of future time is caused by the collapse, therefore, the future is transformed into the past through the state of collapse.

In fact, a four-dimensional homogeneous liquid sphere "turns" in time inside out, where the "wrong side" is an inflationary vacuum. This inversion is equivalent to the transition from one side of the three-dimensional Möbius surface to the other, provided that the passage of time on one side is opposite to the passage of time on the other. At transition, it stops "for a moment", which is the moment of the present. At this moment the present (turning out) becomes the present, passing into the past. The next moment begins the transformation into the past of another part of the future. If our Universe to some extent corresponds to this model, it means that there are repulsive forces in it. It is possible that it is precisely the presence of these forces that can explain some discrepancies in the motions of stars in the galaxies of the Newtonian theory of attraction. Thus, physically observable time is like Möbius strip. As is known, the usual Möbius strip is a three-dimensional non-orientable surface in Euclidean space. A surface is orientable if its normal vector retains its direction, otherwise it is called non-orientable (Klein bottle, Möbius sheet). It can be said by analogy that the observed time is three-dimensional, and its measurements are the past, present, and future. At this stage of evolution, time is perceived by consciousness as one-dimensional and directed from the past to the future.At this stage of evolution, time is perceived by consciousness as one-dimensional and directed from the past to the future. However, there are no absolutely identical events, since the space of the future, which we associated with the ideal liquid sphere, is not homogeneous, despite the fact that the density of the sphere's substance was considered homogeneous: ρ_0 = const. Recall that a homogeneous space is called, where all points are equal. One of the conditions of homogeneity is the absence of gravitational-inertial force: $F^i = 0$ [11]. However, the force is present both in the space of a liquid homogeneous sphere, and in the space of an inflationary vacuum bubble, which makes them heterogeneous. Therefore, the chain of events of the past will never be exactly reproduced in the future. ***We can say: the spaces of the past and the future for us are woven from different fabrics, the material of which corresponds to the energy of the time of their "manufacture".***

The results obtained are of fundamental importance, since they allow us to introduce a new concept - "reverse course of time". It is considered that time flows in one (forward) direction — from the past to the future, although the mathematical capabilities of the GR apparatus do not prohibit the reverse direction (from the future into the past). However, in modern science, the reverse course of time is not considered, since it was accepted that Reichenbach's "time arrow", always directed from the past to the future, does not allow it. The unidirectionality of the course of time seems quite obvious, as people, by habit, view time as a starting point for a sequence of events. The reason is that despite the nearly 100-year existence of GR, time is basically considered as evenly flowing from the past to the future, as is the case in the Minkowski space in the Special Theory of Relativity. But calculations in the framework of the GTR indicate the possibility of an instantaneous transformation of a liquid bubble (3.2) into a vacuum bubble (3.3) that occurs under the condition $r_{br} = r_g = a$. This jump is a clear illustration of the statement: the flow of observable time, falling on the surface of a gap in space, $r_{br} = r_g = a$, changes its direction to the opposite. Thus, on this surface, the observed time stops. Let the direct course of time mean the flow directed from the past to the future ($d\tau > 0$), then the reverse flow of time ($d\tau < 0$) is associated with the flow of time directed from the future to the past. Obviously, the present is due to the condition $d\tau = 0$. In other words, the future and the past interact instantly with each other through the present. The surface $r_{br} = r_g = a$ is simultaneously a surface: 1) a homogeneous liquid sphere in the state of gravitational collapse; 2) a bubble filled with a physical vacuum in the state of inflation collapse. It can be said that from the point of view of a real observer, time has three states - the present, the past, the future, each of which is associated with the corresponding space. At the same time, the moment of the present is an instantaneous transition from the future to the past, associated with the inversion of time like a Mobius strip. The interval of the observed time of a non-rotating space is $d\tau = (1 - w/c^2)dt,$ hence in the space of the past $d\tau > 0$ ($w < c^2$), in the space of the future $d\tau < 0$ ($w > c^2$), in the space of the present $d\tau = 0$ ($w = c^2$). The coordinate (independent of the observation conditions) time in this approach is considered as current in the forward direction ($dt > 0$). Thus, the space of the present is connected with the surface of the collapsar, and the spaces of the past and the future are located inside and outside the collapsar. Consequently, the surface of the collapsar is at the same time: 1) a mirror into which the past and the future look at each other; 2) a membrane between the future and the past. Since the spaces of the past and the future are woven from different materials (matter filling the bubbles), they are not just mirror reflections of each other, therefore similar events of the past and future (four-dimensional points, i.e. three-dimensional points stretched in time in a thread) never. It should also be noted that the present is an instantaneous state of transition through collapse — a moment between the past and the future. This instantaneous state is perceived by the human consciousness as a "reality". In this case, the past and the future can be considered as virtual states.

The key point in the future materialization is the condition $a = (3/(\kappa\rho_0)^{1/2}$, which describes the bridge between the present and the future. Obviously, the "length" of the bridge depends on the density of matter that fills the space of the future. The length of the bridge is the distance from the observer to the event horizon, or the conditional boundary separating the totality of events of the past and the future. This boundary is also considered as the limiting distance at which objects of the Universe are observed. It was shown above that at $\rho_0 \sim 10^{-29}$ g/cm^3 the length of the bridge is commensurate with the observed radius of the Universe $a = 1.3\times10^{28}$ cm. This means that the events of the Universe are formed at a distance a, called the "event horizon". Since distances in the Universe are measured by means of light, for which the concepts "length" and "duration" are identical, the distance to the event is equal to the time of propagation of a signal from it. In de Sitter space, the interval of the observed time is $d\tau = dr/c(1 - r^2/a^2)^{1/2}$. Putting the initial values at the observation point $\tau = 0$, $r = 0$, we find as a result of integration: $r = a\times sin(H_0\tau)$, where $H_0 = c/a = 2{,}3\times10^{-18}$ сек$^{-1}$ — Hubble constant. минимальное $r = 0$ при $\tau = \pm\, \pi/H_0$. It is easy to see that r takes the maximum value of a at $\tau = \pi/(2H)$, the minimum $r = 0$ at $\tau = \pm\, \pi/H_0$. It can be said that light is a sinusoidal wave (harmonic oscillation), propagating in a physical vacuum with a speed of $dr/d\tau = c\times\cos(H_0\tau)$ and a cyclic frequency H_0. A photon emitted at a certain point will reach the event horizon over a period of time $\tau = 21.6\times10^9$ years. From (4.5) it follows that the observed cyclic frequency of a photon emitted from a distance

$r = a$ is infinitely large, therefore, such a "photon" reaches the observer instantly, that is, in fact, is a zero-particle (see Chapter 1, §7). Massless particles that propagate instantaneously are called null particles. They are carriers of long-range (instantaneous transmission of information). Thus, information from the event horizon r = a materializes instantaneously, but in the form of zero-particles — matter more subtle than light. And information from distances $r < a$ comes to the observer (materializes) by means of photons propagating with speed c. In the modern theory of the expanding Universe, an increase in the frequency of a photon as it approaches the event horizon is interpreted as "accelerating galactic runaway" as they move away from the observer to the "event horizon". By definition, the event horizon is the surface that separates the events of the past and the future. In the proposed model (3.3), which is a special case of de Sitter space with positive curvature and cosmological constant $\lambda = 3/a^2$, surface a is simultaneously a surface: 1) space rupture, 2) an inflationary collapsar, 3) a gravitational collapsar (Schwarzschild surface). The last point should be considered in more detail, as it leads to the problem of the existence of black and white holes.

The black hole in modern science is called space-time, described by metric (3.4), when the condition r = r_g is fulfilled. In non-rotating and non-deformable three-dimensional spaces (3.3) and (3.4), gravitational-inertial forces act: 1) attraction $F^1 = -c^2r_g/2r^2 = -GM/r^2$ in Schwarzschild space; 2) the repulsion $F^1 = c^2r/a^2$ in the de Sitter space. It is easy to see that in the first case, F^1 is the Newtonian force of attraction. At the distance $r = r_g$ from the center of the gravitating mass $F^1 = -c^2/2r_g = -c^4/4GM$. Suppose that inside each physical body there exists a surface of radius r_g, inside of which we have not yet been given a look: from the point of view of our ideas, there is a world with completely different physical and geometric characteristics under the Schwarzschild surface. Suppose that inside each physical body there exists a surface of radius rg, inside which we can't see yet. From the point of view of modern scientific ideas, a world with completely different properties is hidden under the surface of Schwarzschild. In particular, it is assumed that the space inside the Schwarzschild black hole is one-dimensional space, and time is three-dimensional, that is, space and time change places there [22]. We cannot imagine our existence in such a world, but nevertheless we constantly feel its impact in the form of a gravitational force attracting us to the planet.

The expression for the gravitational repulsive force can be rewritten in the form: $F^1 = c^2r/a^2 = H_0^2r,$ where H_0 is Hubble constant. Thus, inside the vacuum bubble, a repulsive force acts directly proportional to the distance from the observer, where the proportionality factor is the square of the Hubble constant H_0^2 = 5,3×10^{-36} сек$^{-2}$. Since H_0 has the dimension of angular velocity of rotation, it can be said that the repulsive force is a centrifugal force. But this does not mean that the space of the universe rotates at a linear speed. $v = H_0r$: In this case the components of g_{0i}, characterizing the rotation of space with respect to time, would certainly be present in the space-time metric [11]. Here, in the form of centrifugal force, the effect of the gravitational force of repulsion manifests itself, proportional to the distance from the observer. The action of this force is just manifested as the effect of "scattering of galaxies". In this case, the further away from the observer the observed object is, the stronger the centrifugal force acting on it. This means that the Hubble constant is a cosmological scale, since it is directly related to the cosmological constant: $F^1 = H_0^2r = \lambda c^2r/3$, where it comes from $H_0 = c(\lambda/3)^{1/2}$. And the very force $F^1 = [h^{11}/(2g_{00})](\partial g_{00}/\partial x^1$ is the result of the unevenness of the course of proper time, the elementary interval of which is $d\tau = (g_{00})^{1/2}dt = (1 - r^2/a^2)^{1/2}$. From here it is easy to see that time for the observer slows down as it approaches the event horizon and stops at the very horizon. This is a slowdown, asymptotically striving for a full stop on the surface of the passage of time on the surface of the collapsar, which is explained in cosmology as "accelerated expansion of the Universe". It is possible that the non-Newtonian repulsive force is a manifestation of dark energy due to the unevenness of the course of time. When $r = a$, the gravitational repulsion force takes the form: $F^1 = c^2/a$. As part of our ideas, the surface of a sphere rotates at the speed of light. It can be figuratively said that the event horizon transforms the continuously incoming streams of the future into the world, in which events that will take place in the future are already laid. This will be said in subsequent chapters in quite different words, since not everything can be explained in the language of science. In general, the use of formulas that relate exclusively to the material world, to the border worlds can be compared with the use of "crutches": they cannot go far along the paths of the unknown, but you can at least intuitively penetrate into the unknown worlds.

If the Schwarzschild space [26] at $r = r_g$ under the action of gravitational compression turns into a black hole, which has a gravitational field of attraction, then the de Sitter space at $r = a = (3/\lambda)^{1/2}$ under the action of the gravitational repulsion force turns into an inflationary collapsar which can be called a "white hole", since it radiates a non-Newtonian gravitational energy. Thus, the physical nature of black and white holes is different. Обычно возникновение чёрных дыр связывают с коллапсом сверхплотных звёзд на последней стадии эволюции. However, it follows from the obtained results that an object with an extremely low density, but an enormous size, commensurate with the space of the observable Universe can be a collapsar. Consider the value of a as the radius of the sphere of mass M filled with a medium with a constant density ρ_0. The total mass of the sphere is expressed in terms of the energy-momentum tensor of the medium using the formula $M = 4\pi\int T_0^0 r^2 dr = 4\pi\int \rho_0 r^2 dr = 4\pi\rho_0 a^3/3$. Assuming the maximum radius of the Universe is a = 1.3×10^28 cm, and a density of about $\rho_0 = 10^{-30}$ g/ cm^3, we find its mass $M = 9.2\times10^{55}$ *g*. These values are consistent with those adopted in modern cosmology.

In relativistic cosmology, the concept of a collapsed object as a model of the observable Universe was first proposed by Kirill Stanyukovich [36]. However, they did not consider the initial body, the collapse of which gave rise to the Universe. Nevertheless, if we assume that the limiting radius of the observable Universe, $a = 1{,}3\times10^{28}$ cm, is equal to the Hilbert radius $r_g = 2GM/c^2$ and calculate the mass of the Universe using the formula $M = 8{,}7\times10^{55}$ *g*. The result corresponds to the estimate of the mass of the Universe, obtained from the results of the spatial distribution of galaxies and the assessment of their total mass. В этом случае величина плотности Вселенной $\rho_0 = M/V$, where the volume $V = 4\pi a^3/3$, is $\rho_0 = 9{,}4\times10^{-30}$ г/см^3. Thus, if a collapsar is such an extended object as the observable Universe, then its density is not at all enormous, like neutron stars in a state of collapse, but on the contrary, it is extremely small. In the following, we will call a large-scale collapsed object *collapsar*. Using the collapsar as a model for the universe theoretically allows us to calculate its mass and density. However, the concept of gravitational radius was originally formulated for an object whose mass is concentrated in the center. Meanwhile, from the observations of galaxies it does not at all follow that they are concentrated in a certain center: they are evenly distributed throughout the whole space, but at distances close to the horizon of the Universe, their number decreases sharply. In addition, from observations it follows that the space of the Universe is filled with a rarefied gas. Therefore, a model of the Universe filled with matter was considered, and the conditions under which it becomes a collapsar were investigated.

So, the past, the present, the future are three dimensions of the amount of time allotted to us for evolution. Our Universe recycles the time of the future into the space of the past through a singular surface — the space of the present. This surface, which rotates at the speed of light, in turn is the arena of struggle between two opposing forces — compression and expansion. The Universe will exist until it processes (turns into the past) the entire resource of its future time. When the time resource released to us runs out, the white hole will inevitably turn into a black one — the gravitational singularity that existed before the beginning of time, i.e. the balance between the forces of attraction and repulsion will be broken in the direction of the forces of attraction. The mass of this singularity is a material manifestation of energy, which manifests itself in the material world as a force of attraction, leading to the compression of space. And while the Universe exists, its life is supported by energy, manifested in the form of repulsive force, manifested, in particular, as the effect of "scattering of galaxies". It can be called "Living Water of the Universe". This energy is the result of the processing of matter in the space of the future by a singular surface, which is the shell of the Universe. This shell separates the space of our Universe from the surrounding infinite space as a material object that exists for a certain period of time.

In the conclusion of this section, it is necessary to once again pay attention to the gravitational force of repulsion $F^1 = c^2r/a^2 = H_0^2 r = \lambda c^2 r/3$. It looks like a centripetal force in Newton's theory, but in fact it is generated by the cosmological forces of repulsion, which are manifestations of the energy of creation. In opposition to them, there is Dead Water associated with the gravitational forces of attraction, which tend to eventually lead living bodies away from the world of living life into spaces where they cannot exist in their previous form. But their energies (in other forms) will exist forever, so these energies are fragments of the energy of Time, which exists forever. The infinite space of Time is the fractal "Infinity"*, of which the Universe is a fragment, and all of its structures, including humans, are fragments of the "Infinity" fractal. A detailed discussion of this will go from Chapter 3.

§5. The evolution of a star is predetermined by the type of its gravitational energy

A special role in the expansion of human consciousness is played by stars - mediators between Heaven and people. Stars emit light, which is perceived as information that propagates in three-dimensional space with a "speed limit" of c = 300,000 km/s. In reality, the speed of light is the speed of materialization (manifestation) in our three-dimensional space of energy perceived by the human consciousness as electromagnetic radiation, one of the ranges of which (optical) is the light perceived by the human eye. In the previous paragraphs, a model of a liquid homogeneous sphere was constructed, which was applied to the Universe as a whole. It was also shown there that this model is equally applicable to stars. As a single building material for stars, the original "water" was used, considered for simplicity as an ideal (non-viscous) incompressible fluid, and the model was a sphere consisting of this fluid. In this section, the original model (3.2) will be applied to stars at different stages of evolution, including the transformation of ordinary stars into neutron ones, as well as their transition to a state of collapse. It turned out that the most important stellar characteristics are its mass and a certain ratio between density and radius: $\rho_0 a^2 = 3/\kappa$. ***The destinies of the stars are determined by these parameters.***

Since stars are objects of four-dimensional space, their three-dimensional bodies are instantaneous projections of four-dimensional spheres onto three-dimensional space. Modeling is the establishment of analogies between a real physical object and its simplified image, in this case, between a star and a four-dimensional liquid sphere. Stars can be compared with each other according to different characteristics: size, mass, color, density, etc. Considering stars as a population of four-dimensional space, one should pay special attention to their properties, which can manifest themselves only when considering them in space-time. A rigorous mathematical study of a liquid non-rotating sphere from an incompressible fluid in space-time showed that the objects described by it can be divided into two classes depending on the magnitude of the ratio r_g/a: 1) $r_g/a \ll 1$; 2) $r_g/a = 1$ [37]. All regular stars, except neutron stars, belong to the first type; to the second - neutron stars and the observable Universe. Intermediate variants of objects were not found. For the vast majority, the magnitude of r_g (the radius of the Schwarzschild sphere) is hundreds of thousands (and even millions) times smaller than the size of the stars themselves. So, for the Sun, $r_g = 3$ km, and the value of r_g/a is of the order of 10^{-6}. Let's call stars for which $r_g/a \ll 1$ regular. Then the stars for which $r_g = a$ can be called singular, since their surfaces are the Schwarzschild sphere. The radius of the Schwarzschild sphere is determined only by the mass of the star, and the sphere itself is a singular surface on which the time for the observer stops. For regular stars, this surface is deep under the liquid shell. Regular stars vary greatly in size, mass, and density, but they all have the same structure — these are tiny Schwarzschild spheres surrounded by a liquid medium. Thus, the largest stars, supergiants, are 100–250 times larger than the Sun, and their masses are 10–70 solar masses. The masses of the smallest stars, cold brown dwarfs, make up 0.01–0.07 mass of the Sun, and in size they are similar to Jupiter. White dwarfs belong to a special group of stars. Their masses are of the order of the sun, and their size is hundreds of times smaller than the size of the sun. Accordingly, the densities of white dwarfs lie in the range of 10^5–10^9 g/cm^3, i.e., they are millions or more times higher than the density of water. This means that the densities of ordinary stars range from 10^{-6} g/cm^3 for supergiants and giants to 10^9 g/cm^3 for white dwarfs: see Table 1. Nevertheless, all this variety of stars fits into the framework of one model — a liquid incompressible sphere, which has a tiny core, the surface of which is singular. The minority of stars, called neutron stars, are actually themselves singularities, whose radius is 10–20 km, and their masses are commensurate with the mass of the Sun.

In this section, the models of the liquid sphere (3.2) and the inflation bubble (3.3) will be used to describe the structure of stars of different types, that is, the stars will be considered as objects of the space-time continuum. In the previous paragraphs it was shown that a homogeneous liquid sphere, provided that its density and radius are related by $\rho_0 a^2 = 3/\kappa$, transforms into a vacuum bubble — a substance with completely exotic properties: it has a constant positive density and a constant negative pressure. In this case, the surface of the sphere is at the same time both the surface of a gap in space and the surface of the collapsar. It rotates at a speed of light, whereby matter cannot penetrate through it. Therefore, the sphere is in a steady steady state, despite the inflation caused by negative pressure, and the presence of non-Newtonian gravitational repulsive force. All of the above applies to neutron stars in a state of collapse. The mathematical apparatus of a theory is a tool for the theoretical analysis of a problem, just as a physical device is an instrument used in an experimental study of the world. In this case, the theory confirmed the point of view of astronomers on neutron stars as the results of catastrophes that befell regular stars. In this case, ordinary stars can turn into neutron stars only if their mass is large enough to form a gravitational sphere with a radius of 10–20 km. By the way, the Sun's mass is enough only to turn into a white dwarf with a density of about 10^5 g/cm^3, which is fully consistent with the modern theory of the evolution of stars. By the way, the Sun's mass is enough only to turn into a white dwarf with a density of about 10^5 g/cm^3, which is fully consistent with the modern theory of the evolution of stars ($\sim 10^{-5}$–10^{-6}) either close to 1. Since no intermediate types of stars have been found, it can be concluded that some massive regular stars can become neutron stars only as a result of a catastrophe — the rapid transformation of one form into another (metamorphosis).

According to modern astrophysics, neutron stars are formed as a result of a supernova explosion, that is, as a result of a catastrophe. At a certain stage of the evolution of massive stars, they explode, throwing off the shell, which is subsequently observed in the space around the stars. In the course of the explosion, the stars lose most of their mass, and the rest of the mass is compacted into a small, supercompact object - a miniature copy of the Universe. ake a look at this process from the four-dimensional space. If the density of the liquid and the radius of the sphere an incompressible satisfy the relation $a^2 = 3/\kappa\rho_0$, then it transforms into a vacuum bubble filled with a homogeneous medium in the state of inflation (de Sitter space). When the density is $\rho_0 \sim 10^{14}$ g/ cm^3, we find $a \sim 10$ km, which corresponds to the average size of neutron stars. From here it is easy to see that the model of the vacuum sphere (bubble) is applicable: 1) to very long objects with extremely low density (Universe); 2) to compact objects with nuclear density (neutron stars). In other words, the process of transformation of a liquid sphere into a vacuum bubble is realized according to one scenario both for a neutron star and for the Universe itself. It was previously shown that the transformation of a sphere is realized under the condition that it breaks space and stops the observed time at the same distance from its center, thereby closing the space and time on itself. This distance is equal to its gravitational radius, that is, the star becomes a collapsar. In this case: 1) the gravitational-inertial non-Newtonian force of attraction that occurred before the catastrophe turns into a non-Newtonian force of repulsion; 2) the positive pressure of the fluid is transformed into a constant negative pressure of the inflationary vacuum medium; 3) the course of the observed time on the surface of the collapsar stops. What is the main reason for the significant difference between neutron stars and regular ones?

It turns out that the whole thing is in the value of the radius of Hilbert in relation to the size of the stars. In modern relativistic astrophysics, the r_g value determines the event horizon of a collapsed point mass. However, the expression r_g/a can be easily represented as: $r_g/a = v_{II}^2/c^2$, where $v_{II} = (2GM/a)^{1/2}$ is the escape velocity of a substance from the surface of a gravitating body (second cosmic velocity). The expression for v_{II} is easy to obtain by equating the expressions for the Newtonian potential energy GmM/a acting on a particle of mass m and the kinetic energy of the particle $mv^2/2$. If the velocity of a star's particle exceeds v_{II}, then it will be freed from the gravitational star captivity. For example, for the Sun, v_{II} = 618 km/sec. Particles of solar matter, whose speed on the surface of the Sun, exceeds this value, form the solar wind, creating a bubble in the solar space, called the heliosphere. Thus, within the framework of the proposed model, all stars are divided into two types, for which: 1) $v_{II} \ll c$; 2) $v_{II} = c$. Thus, within the framework of the proposed model, all stars are divided into two types, for which:

$$p = \rho_0 c^2 \times [(1 - r^2/r_{br}^2)^{1/2} - (1 - a^2/r_{br}^2)^{1/2}]/[3(1 - a^2/r_{br}^2)^{1/2} - (1 - r^2/r_{br}^2)^{1/2}] > 0. \quad (5.1)$$

The values of p and ρ_0 satisfy the relation: $p \ll \rho_0 c^2$ [23]. W hen a particle reaches the star's velocity of $v > v_{II}$, it leaves the star. In the second case, the star's substance has rather exotic properties, since its density and pressure are related by the relation $p = -\rho_0 c^2$, which describes a substance in the state of inflation. Stars of the second type do not lose matter (they do not have stellar wind): they can only emit light-like particles, in particular, photons of different frequencies. It is possible that the loss of mass (or its transfer from one star to a more massive one) is possible with a strong approach or collision of neutron stars.

Because $r_g/a = v_{II}^2/c^2$, then the escape velocity is the greater, the closer the value of r_g/a to unity. In other words, the greater the mass of the star and the smaller its radius, the greater its second cosmic velocity, the overcoming of which by individual particles leads to the mass loss of the star. Astronomers explain the outflow of matter (stellar wind) by convective processes in the atmosphere, which, of course, takes place. However, in hot stars of early spectral classes, as well as in cold stars of late spectral classes, plasma outflow occurs at speeds of the order of hundreds or even thousands of km/s! It is entirely possible that this outflow is due to the nonstationarity of the Schwarzschild sphere inside each star. Then particles of the liquid medium surrounding the dense core of a star can experience acceleration directed from the surface of the Schwarzschild sphere to the surface of the star. In this case, the larger the Schwarzschild radius, the higher the velocity of the particle. It can be assumed that, in exploding stars of the Wolf-Rayet type, the nucleus is compressed from time to time, which leads to periodic ejections of the star's matter. And in stars turning into supernovae, the compression of the nucleus occurs so quickly and strongly that the star drops the envelope, and its inner core is released from the liquid atmosphere, turning it into a circumstellar nebula.

Consider the process of transforming an ordinary star into a neutron star, considered in modern astrophysics as a supernova explosion [37]. From the condition of transformation of a liquid sphere into a superdense sphere with a radius of 10 km, filled with a neutron medium, it is easy to find the value of the critical density of the transformation of a liquid. The condition for the transition of a liquid medium to an inflationary vacuum has the form: $\kappa\rho_0 a^2 = 3$, whence the expression for the critical density $\rho_{cr} = 3c^2/8\pi G a^2$ follows. With a radius of a = 10 km value $\rho_{кр}$ = 1,6×10^{15} g/cm^3. Calculating the critical value of the angular velocity of rotation $\omega_{cr} = c/a$ for a neutron star with a radius of 10 km at which its surface would rotate at the speed of light, we find $\omega_{cr} = 3.0\times10^4$ s^{-1}. Currently, only millisecond pulsars are found, for which $\omega \sim 3.0\times10^3$ s^{-1}, $\rho_0 = 1.6\times10^{15}$ g/cm^3. Probably, some neutron stars are in a state close to collapse, and collapsed neutron stars have not yet been discovered. In order for an ordinary massive star to transform into a sphere with a radius of 10 km and with a density equal to the critical one, it must have a mass $M = 6.7\times10^{33}$ g = 3.35

$M_{\copyright}$. Since the observed neutron stars have a smaller mass, then in all likelihood, part of the mass of the exploded star transforms into radiation, and part of it turns into a circumstellar nebula. It is quite possible that the Schwarzschild spheres, whose radius is equal to rg, actually exist inside all stars, and the sizes of the spheres are determined only by the mass values of the stars. Therefore, the "explosion" of a supernova can be considered as the inversion of a four-dimensional liquid sphere in time. At the same time, the inner (Schwarzschild sphere) becomes the outer — a neutron star, and the former outer turns into a flash of light and a nebula. In the framework of the model under consideration, the observed time inside a neutron star flows in the direction opposite to the time course in the surrounding space, and time stops on the star's surface. We can say that neutron stars are miniature machines that produce (emit) "time". Here it will be appropriate to quote the outstanding time researcher Nikolai Kozyrev. "A star is a machine that generates energy through its arrival from outside. If time is a physical phenomenon, then it can bring energy that supports the glow of stars" [6].

It is possible that the emission of regular stars is caused by processes in their liquid atmospheres, and the processes themselves are due to the effect of the Schwarzschild internal gravitational sphere on the star's envelope. In neutron stars, energy exchange with the environment occurs differently, since they themselves are Schwarzschild spheres. Neutron stars in a state of collapse are spheres filled with a superdense substance in a state of inflation, i.e. they are miniature copies of the Universe with a radius of ~ 10 km, a mass on the order of the mass of the Sun and a density of ~ 10^{14} g/cm^3. Thus, the inflation sphere model is equally applicable: 1) to very long objects with vanishingly low density (Universe); 2) to compact objects with nuclear density (neutron stars). Conclusion: the process of transformation of the liquid sphere into the inflationary one is realized according to one scenario both for the neutron star and for the Universe itself. This process can be thought of as turning the four-dimensional liquid sphere inside out, including a mirror reflection in time. It is known that most neutron stars have a radius of ~ 10–20 km, therefore their masses must be greater than 1.2×10^{33}–9.6×10^{33} g, which is 0.6–4.8 masses of the Sun. (Mass of the Sun M© = 2.0×10^{33} g). However, most of the known neutron stars have masses ~ 1.44 $M_{\copyright}$ = 2.88×10^{33} g. It is theoretically possible the existence of neutron stars with a mass of about two solar, but there are very few such stars. One of the most massive neutron stars with a mass of ~ 1.88 M© is in the constellation Sail.

For neutron stars, the ratios r_g/a and r_{br}/a are close to unity. This means that they are not far from the state of inflation collapse, which will translate them into objects of a different nature, which the vast majority of stars cannot be. Thus, the collapse of a neutron star is favored by its rotational speed: the higher it is, the closer the star is to the collapse state [37]. Thus, the fate of stars and other objects of the Universe is predetermined initially by the ratio between the values of their masses and sizes. Depending on the prevailing conditions, the star may explode, become white, red, brown dwarf, a planet, ... With a sufficiently large initial mass, stars in the process of evolution can shrink and become neutron stars, if they have not previously lost their mass, exploding or bleeding with stellar wind. An increase in the speed of rotation of a neutron star for some reason will in some cases turn it into a rotating collapsar [37]. If the star's mass is initially small, and she herself could not increase it, for example, by ruining her neighbor, then she will follow the evolutionary cycle characteristic of dwarfs. Thus, the mass of a star is the determining factor of its further fate. By the way, for quasars, the values of r_g/a and r_{br}/a are also close to unity.

The Schwarzschild Sphere is otherwise called the event horizon, from where information comes to the observer instantly. The Schwarzschild Sphere is otherwise called the event horizon, from where information comes to the observer instantly. Registration of this particular non-electromagnetic type radiation made it possible for Kozyrev to establish the true positions of a number of stars, star clusters, and another galaxy. The study of this information in the future will allow analyzing the state of the space surrounding the neutron stars.In 2007, astronomers from the state of Pennsylvania (USA) and McGill University (Canada) found the single neutron star 1RXS J141256.0 + 792204, called the Culver star, closest to Earth in the constellation Ursa Minor. Supposedly it is single and "radio-noise": it radiates only in the X-ray range. Isolated X-ray neutron stars that have no twin and no supernova remnants are a rarity. So far, they have been discovered seven. Astronomers have paid attention to it, comparing the catalog, which contains 18,000 X-ray cosmic sources, with a catalog of objects emitting in the visible, infrared and radio bands. Object 1RXS J141256.0 + 792204 was noted only in the X-ray range and was absent in the rest. The estimated distance to the Sun is 625 light years. Assumptions about the nature of this star do not fit into existing theories. It may be a new subtype of isolated radio-neutron stars. The presence of an X-ray neutron star in relative proximity to the Sun can have a strong influence on the life of the Earth.

Now let's talk about the rapidly rotating objects of the Universe, to which we can certainly include rotating neutron stars, called pulsars. These stars are sources of radio, optical, X-ray and gamma radiation, which come to Earth in the form of strictly periodic pulses. According to the modern scientific concept, pulsars are neutron stars with a strong magnetic field. In this case, the magnetic axis is inclined to the axis of rotation, which causes modulation of the signal. Pulse periods range from 640 pulses per second (millisecond pulsars) to a single pulse in 5 seconds. The periods of most known pulsars are in the range from 0.5 to 1 second (second pulsars). The strict periodicity of the pulses is due to the rotation of the pulsars. Pulsars continuously emit energy, part of which is radiation recorded by astronomers emitted by small areas located in the region of the poles. The source of radiation is the rotation of the star: this conclusion follows from the fact that the intervals between the pulses slowly increase in all pulsars, that is, the rotation of the pulsar slows down due to the loss of its radiation energy. The rotation of a pulsar can be viewed as a consequence of the rapid compression of an ordinary rotating star to a state in which its density is close to nuclear. In this case, the rotational speed increases sharply due to the law of conservation of momentum. The behavior of pulsars in the framework of general relativity was studied in detail in [37], where the pulsar is modeled by a strongly magnetized rotating sphere filled with a substance of nuclear density in the inflation (inflation) state.

The study was conducted by the standard method adopted in the framework of GR: a self-consistent system of stationary Einstein-Maxwell equations was written, written in terms of physical observable quantities [37]. In this representation, the four-dimensional electromagnetic potential A^{α} has one temporal (scalar) component φ and three vector q^i. The electric and magnetic components of the field are expressed in terms of the derivatives of φ and q^i and the physical characteristics of the gravitational field ита gravitational-inertial force and angular velocity of rotation [37]. Moreover, for simplicity, it was assumed that the scalar electromagnetic potential φ of the pulsar is constant. In this case, the electric field strength was determined only by the product of φ and the gravitational-inertial force acting in the pulsar, and the magnetic field strength was determined by the vortex nature of the vector field and the product of φ by the angular velocity of rotation of the pulsar. The vortex of the vector potential qi is determined by the condition $\partial q_i/\partial x^k - \partial q_k/dx^i \neq 0$. The system solution was obtained for the cases when the vector electromagnetic field is: 1) irrotational; 2) vortex. In the first case, the axis of rotation of the pulsar coincides with the magnetic axis, and there is no electromagnetic radiation in the pole region. In the second case, the magnetic axis of the pulsar has a slope to its axis of rotation, and the pulsar radiates in the region of the poles. Thus, it is shown that the deviation of the magnetic axis of the pulsar from the axis of rotation is due exclusively to the vortex nature of the magnetic field.This deviation makes it possible to observe pulsars due to their radiation in the region of the poles. If the magnetic field is irrotational, then the pulsar is a closed system for a real observer (not perceived as a radiating object). In other words, if the magnetic axis coincides with the axis of rotation, the pulsar) is not observed in our world. The latter case is worth considering in more detail. In particular, the irrotational electromagnetic field can be realized in the case when the vector potential is equal to 0. In ordinary electrodynamics, based on a flat space-time (Minkowski space), in the case of constancy of the scalar potential and in the absence of vectorial intensity of the electric and magnetic fields would simply be equal to 0. However, in a curved space-time, the GTR strengths of the electric and magnetic fields are determined, respectively, by the products of the scalar φ and the gravitational-inertial force and angular velocity. The strengths of the electric and magnetic fields in the case of $\varphi = const$ and $q^i = 0$ have the form: $E^i = -(\varphi/c^2)F^i$ and $H^{*i} = -(2\varphi/c)\Omega^{*i}$, where Ω^{*i} is pseudovector of angular velocity of rotation of a star. In this case, the gravitational force is the repulsive force $F^1 = c^2r/a^2 > 0$ [37]. Thus, the gravitating and rotating permanent magnet, considered as a model of a pulsar, has electric and magnetic fields due to the interaction of the scalar electromagnetic potential with the physical characteristics of the pulsar — the gravitational-inertial repulsive force and angular velocity. Of course, even in this simplified model, radiation goes in all directions, except for the pole region. But the fact is that the extremely strong magnetic field of the pulsar does not transmit radiation anywhere except in the pole region, where this field is weakened. Namely, in the field of poles, the Poynting vector, which characterizes electromagnetic radiation, is zero [37]. In the case of a vortex vector electromagnetic field, the pulsar radiates everywhere, including at the poles. In this case, the radiation is the sum of the radiation of the vortex-free field and the radiation, due exclusively to the vortex nature of the magnetic component of the electromagnetic field. And observers register just the result of the impact of the vortices of the magnetic field, since it is this radiation that passes through the magnetic field, where possible, that is, in the region of the poles. Thus, it is the deviation of the magnetic axis from the axis of rotation, caused by the vortex of the magnetic field, which allows the radiation of the pulsar to be registered.

It now remains to solve the question of the horizon of the events of the pulsar. As is known, the event horizon is the surface of a collapsed object (collapsar). Since the observer stops on the surface of the collapsar, such an object is unobservable in principle (there is no progress of time — there are no processes that can be observed). Therefore, the collapsar is called the “black hole”. The event horizon of a non-rotating neutron star coincides with its surface, so there is no reliable data on the existence of non-rotating neutron stars. However, it is possible to calculate the radius of the event horizon of a rotating neutron star using the stopping condition of the observed time $d\tau = 0$, which in the rotating reference frame has the form: $w + v_i u^i = c^2$, where w — three-dimensional gravitational potential, v_i — linear rotational velocity of space, u^i — coordinate speed. In [37] an expression for the radius of a rotating collapsar is obtained $r_c = a/(1 + \omega^2 a^2/c^2)^{1/2}$, where ω — neutron star rotation speed. This shows that the event horizon of a rotating neutron star is inside it. In this case, the greater the ω, the deeper the collapsar is located under the surface of the star. Thus, for millisecond pulsars ($\omega \sim 10^3$ s^{-1}, $a = 10$ km), the event horizon is located at a depth of 5.5 meters. Thus, pulsars are available for observation due to the fact that their event horizon is below the surface of the star.

In addition to the horizon of events, such a thing as a light cylinder appears in astrophysics. The radius of a light cylinder is defined as the distance at which the linear speed of rotation of space is equal to the speed of light. In this case it is tacitly assumed that not only the pulsar rotates, but it also carries away the surrounding space with its rotation. In fact, this means recognizing the reality of the existence of the field of rotation. For a millisecond pulsar, the radius of the light cylinder $r = c/\omega = 300$ km. All magnetic field lines are closed, with the exception of the lines of force located near the poles. All magnetic field lines are closed, with the exception of the lines of force located near the poles. The observed effect of the pulsar, as was shown above, occurs only in the case of a vortex magnetic field: then the magnetic axis is tilted to the axis of rotation. For the fastest millisecond pulsars, $\omega \sim 10^3$ s^{-1}, hence $r \sim 300$ km. Astronomers assume that the space inside the cylinder is filled with a secondary plasma, and all the magnetic field lines are closed inside the light cylinder, only the lines of force near the poles remain open, from where the radiation comes.

To summarize the above. In fact, all stars are divided into two groups depending on the ratio of their densities and radii (or masses and radii). In the first group are the stars, the density of which is much less critical: $\rho_0 \ll \rho_{кр} = 3c^2/8\pi G a^2$. They are small superdense nuclei surrounded by a liquid atmosphere. Depending on the size of the nucleus, these stars lose their substance (stellar wind), which expires at a speed depending on their size and mass. This group includes the Wolf-Rayet type stars, the outflow of matter from which occurs at speeds of 1000–2000 km/s. Stars of the first group can neither become neutron stars nor collapsors. Their evolutionary path they end up as dwarfs, white or brown, depending on the values of their masses and temperatures at the final stage. The second group includes stars whose density reaches a critical, and the mass forms a core with a radius of about 10 km. n this case, two development paths are possible for them: a) as a result of compression, the density of the liquid medium becomes equal critical, the star explodes, getting rid of the liquid atmosphere, and the inner core becomes a neutron star — an inflationary collapsar emitting "time", i.e. white hole "; b) as a result of compression, the density is $\rho < \rho_{cr}$, and the star after the explosion turns into a "black hole" absorbing "time" [37]. In the latter case, it becomes invisible to the real observer. Such are the evolutionary paths of stars, if we consider them as objects of a four-dimensional curved spatio-temporal continuum, simulating a four-dimensional projection of multidimensionality.

The spheroid of the Galaxy consists of 5 subsystems: 1) spherical (halo); 2) intermediate spherical ("bulge"); 3) a disk; 4) old flat; 5) young flat. In the atmospheres of stars, the spherical component of heavy chemical elements (in particular, metals) contains about 100 times less than that of stars of the flat young subsystem. The order of star formation in the galaxy is "drawn", first in the entire spherical volume. The most massive of the stars quickly consume their "fuel" stocks and flare up as supernovae, replenishing the interstellar medium with heavy chemical elements. It, meanwhile, turning around the Center of the Galaxy, "settles" to its plane, and the formation of a "second generation of stars" takes place in it, etc.

For clarity, the research results are presented in the form of a table, which presents the physical characteristics of different objects — from the Universe to the giant planet. Calculations were made as in accordance with the specific data of objects, but in some cases, some averaged characteristics were used. From it follows that there are two classes of objects: 1) Universe, quasars, neutron stars; 2) galaxies, regular stars, giant planets.It is possible that quasars play the same role in the Universe as neutron stars. The resulting picture indirectly confirms the work of those scientists who are inclined to believe that the Universe has a fractal structure [16, 17]. In accordance with the theory of fractals applied to the multi-scale structures of our world — from the Universe to plants, microbes, etc., combinations of different structures are repeated at all levels of an infinite hierarchical structure called the Infinite Space of Time, or simply Infinity.

Table 1.
Comparative characteristics of objects of the universe

Object	Density ρ_0	Radius a	Mass M	Gilbert radius	Space break radius	r_g/a	r_{br}/a

	(g/cm³)	(cm)	(g)	r_g (cm)	r_{br} (cm)		
Universe	$9,5\times10^{-30}$	$1,3\times10^{28}$	$8,8\times10^{55}$	$1,3\times10^{28}$	$1,3\times10^{28}$	1	1
Milky Way	$1,2\times10^{-20}$	$4,8\times10^{21}$	$6,0\times10^{45}$	$8,9\times10^{17}$	$3,7\times10^{23}$	$1,8\times10^{-4}$	77,1
Quasar	$3,5\times10^{-2}$	3×10^{14}	$4,0\times10^{42}$	3×10^{14}	$2,1\times10^{14}$	1	0,7
Red supergiant (Betelgeuse)	$2,8\times10^{-8}$	7×10^{13}	4×10^{34}	$5,9\times10^{6}$	$2,4\times10^{17}$	$4,3\times10^{-7}$	$5,1\times10^{6}$
White supergiant (Rigel)	$7,4\times10^{-7}$	$4,8\times10^{12}$	$3,4\times10^{34}$	5×10^{6}	$4,6\times10^{16}$	$5,0\times10^{-6}$	$9,6\times10^{3}$
Sun	1,41	7×10^{10}	2×10^{33}	$2,9\times10^{5}$	$3,4\times10^{13}$	$4,1\times10^{-6}$	486
Yupiter	1,38	$7,1\times10^{9}$	$1,9\times10^{30}$	281,2	$3,4\times10^{13}$	$4,0\times10^{-8}$	$4,8\times10^{3}$
White dwarf	$2,0\times10^{6}$	7×10^{8}	$2,9\times10^{33}$	$4,0\times10^{5}$	$2,8\times10^{10}$	$5,7\times10^{-4}$	40
Red dwarf	13,1	$2,3\times10^{10}$	$6,7\times10^{32}$	$9,9\times10^{4}$	$1,1\times10^{13}$	$4,3\times10^{-6}$	478
brown dwarf	0,1	7×10^{9}	$1,5\times10^{32}$	$2,2\times10^{4}$	$1,3\times10^{14}$	$3,1\times10^{-6}$	$1,9\times10^{4}$
Neutron star	$7,6\times10^{14}$	10^{6}	$3,2\times10^{33}$	$4,7\times10^{5}$	$1,4\times10^{6}$	0,5	1,4

§6. Breaks in the space of the solar system

So far, the main attention has been paid to space objects, which, by virtue of their structure, have the ability to stop time and tear space at distances equal to their radii. This section is devoted entirely to the solar system, the center of which is a yellow dwarf named the Sun, которое относится к регулярным звёздам. In this paper, they are considered as liquid incompressible spheres, for which $r_g \ll a$, in contrast to neutron spheres, for which $r_g = a$. It was previously shown that the Sun is a three-kilometer-long Schwarzschild sphere, surrounded by a liquid atmosphere. It is quite possible that the Schwarzschild spheres, located in the depths of ordinary stars, have the same structure as neutron stars. For example, for the Sun, the radius of the Schwarzschild sphere is 3 km. Putting the mass of this sphere equal to $M_{\copyright}$, we find the density value inside it $\rho_0 = 1.8\times10^{16}$ g/cm³, which is slightly higher than the currently accepted density values of neutron stars. It is possible that the core is in a state that is not yet considered by modern science. The Sun can be considered as a superdense sphere (core) with a radius of 3 km, surrounded by an "atmosphere of an incompressible fluid". Probably, superdense nuclei inside regular stars also "emit time" like neutron stars. According to Kozyrev, time carries energy that supports (and, possibly, causes) the glow of stars. The Sun itself cannot become a neutron star, since its critical density is $\rho_{cr} = 3.3\times10^5$ g/cm³, which is in the range of white dwarf density values. This conclusion is consistent with the modern theory of the evolution of stars. However, the Sun, like many other cosmic bodies, creates a gap in space, the distance to which is determined by the density of its substance. The radius of discontinuity of the space $r_{br} = (3/\kappa\rho_0)^{1/2}$ for the Sun is 2.3 A. U. = 3.45×10^{13} cm, radius of the Sun $a = 7\times10^{10}$ cm, therefore, $r_{br}/a = 214.3$, ratio $r_g/a = 4.2\times10^{-6}$. A similar situation exists for all regular stars, but due to their remoteness, we cannot examine in detail the structure of their planetary systems, if any. It was shown above that the magnitude of the gravitational radius of the physical is determined solely by its mass, and the radius of rupture depends only on the density of the body. The body mass slows down the course of the observed time until it stops completely, and the density creates a gap in space. It can be said that the physical body is a condensation of matter, and the gap of space created by it is its discharge. Perhaps the alternation of condensations and discharges of space is a manifestation of the law of conservation of energy, which is universal.

Does this gap somehow affect the structure of the Solar system? The sun is the source of a gravitational field that holds planets with their satellites around them, asteroids, comets, large and small meteoric matter, interstellar dust and gas. The large bodies of the Solar System — the planets are divided into 2 groups: 1) terrestrial planets (Mercury, Venus, Earth, Mars); 2) giant planets (Jupiter, Saturn, Uranus, Neptune). The ninth planet Pluto by the decision of the International Astronomical Union (IAU) of 2006 was transferred to the category of minor planets. This term was introduced in 2006 by the decision of the XXVI General Assembly of the International Astronomical Union (IAU). An object related to dwarf planets must satisfy the following criteria:

1) revolves around the Sun;

2) is large enough and massive to take a spherical shape;

3) does not cleans the surroundings of its orbit so that there are no other bodies of comparable size;

4) is not a satellite of another planet.

In addition to the planets, in the solar system there are belts formed by smaller bodies. The asteroid belt is the closest to the Sun, the region of the Solar System located between the orbits of Mars and Jupiter, occupying an area from 2.1 to 4.3 A. U. This area is the site of the accumulation of many objects of mostly irregular shape.The total mass is 4% of the mass of the Moon, and more than half of it is concentrated in four asteroids: Ceres, Pallas, Vesta, Hygea. Their average diameter is 400 km, and the diameter of Pallas (the only dwarf planet) is more than 950 km, and its mass is twice the total mass of Ceres and Vesta and makes up 32% of the total mass of the asteroid belt. Ceres, discovered by Italian astronomer Giuseppe Piazzi on January 1, 1801, has a shape close to spherical. According to the assumptions, it has a stone core and an ice mantle. Its surface consists of a mixture of ice, clay, carbonates ... Perhaps under it there is water in the form of oceans. The mantle thickness is 100 km (23–28 % of the total mass and 50% of the volume). Ceres is the closest dwarf planet to us. Its distance from the Sun 2.77 is equal to A. U.

Another cluster of small bodies is the Kuiper belt — the region of the solar system, starting from the orbit of Neptune (30 A. U) and extending to a distance of 44 A. U. It is 20 times wider and 20–200 times more massive than the asteroid belt. Like the asteroid belt, the Kuiper belt consists of small bodies. But if the objects of the asteroid belt mainly contain rocks and metals, then the objects of the Kuiper belt mainly consist of volatile bodies (ices): methane, ammonia, and water. This belt is close to the composition of comets, but is not their source. In this region of near space there are three dwarf planets — Pluto, Haumea, Makemake. The Kuiper belt is dynamically stable, and its largest known object is — Pluto, translated into the category of minor planets by the decision of the International Astronomical Union. In addition to the Kuiper belt, there is a scattered disk — a remote region of the solar system, sparsely populated by small bodies, mostly composed of ice. Scattered disk objects belong to a subset of a large family of trans-Neptunian objects.The inner region of the disk is partially overlapped by the Kuiper belt, and the outer one lies far from the Sun much higher and lower than the plane of the ecliptic. In contrast to the dynamically stable Kuiper belt (a bagel located at a distance of 30–44 A. U.), the dispersed disk is a more unstable medium. Its objects can move both horizontally and vertically at equal distances.

Now look at the Solar system as part of the space-time. It was previously shown that the surface of the Schwarzschild, where time stops, is located deep beneath the surface of the Sun. The motion of the planets in the solar system is fairly accurately described in the Newtonian theory of gravity. The exception is Mercury, the perihelion mixing of which is slightly different from that calculated in the framework of Newton's theory. This effect is purely relativistic, therefore it is successfully explained in the framework of the theory of relativity. It can be thought that the Schwarzschild spheres, whose radius is $r_g << a$, are sources of the Newton-type gravitational field. Thus, it is regular stars that are sources of gravitational fields of attraction, which are parts of the gravitational fields of larger objects. For example, for the Milky Way, the ratio is rg / a = 1.8×10–4, therefore, the Schwarzschild inner sphere is the source of Newtonian gravity. True, in our Galaxy, in addition to regular ones, there are also neutron stars that have non-Newtonian gravitational energy, which manifests itself as repulsive forces. However, being parts of the galactic body, they can only contribute to the motion of the surrounding stars, causing small deviations from the trajectories calculated in the framework of Newton's theory. These deviations can be perceived by astronomers as a manifestation of “dark energy”. But back to the Solar system.

It was shown above that each body having a mass affects the course of the observed time, since the mass determines the radius of the Schwarzschild sphere, at which time for the observer stops. But every material body also has a density, so it can be considered as a condensation of matter. For example, a homogeneous liquid sphere breaks the surrounding space, and the gap radius $r_{br} = (3/\kappa\rho_0)^{1/2}$ is smaller for it, the higher its density.The Sun, whose density is $\rho_0 = 1.4$ g/cm^3, breaks the space at a distance of $r_{br} = 2.2$ A. U., therefore, the discontinuity surface is located inside the asteroid belt. The same method of calculation can be applied to the giant planets, similar in structure to the stars, dwarfs. The results of the calculations are shown in Table 2.It turned out that the Solar System is torn in half by a wide strip (Asteroid Belt), on one side of which there are the terrestrial planets, and on the other are the giant planets headed by Jupiter. The densities of the Sun and Jupiter are almost the same, so their rupture radii are close in meaning: the Sun and Jupiter equally stretch the fabric of space until it breaks. But the Sun reigns in our system, since its mass is almost 1000 times the mass of Jupiter. Therefore, all the planets with their satellites rotate around the Sun - it is the mass that determines the force of Newtonian gravitational attraction: $F = GmM/r^2$, where M is the attracting (central) mass, r is the distance to the center of the attracting mass, m is the mass of the attracting body.It can be assumed that at one time the Sun and Jupiter tore apart the space, trying to pull it each towards itself (see table 2). As a result of this battle, in which the Sun defeated, possessing a larger mass than Jupiter, we live inside a region of discontinuity in which there are earthly planets — burned or dying out. And beyond the Asteroid Belt lies an area of giant planets, more similar to stars than the terrestrial planets, surrounded by very interesting satellites, the study of which is becoming more intense.

About Earth-like planets, we reliably know that they are covered with hard crust. But for us the inner structure of the Earth is still hidden. We do not know reliably what is at a great depth under its bark. To describe the current state of the Earth, it would be incorrect to immediately apply the model of the liquid sphere, but it is possible to make estimates of the values of r_g/a and r_{br}/a, equal, respectively, 1.4×10^{-9} and 2.6×10^{4}. It turns out that the Earth, like the stars of the Main Sequence, could not pull space over itself and stop time. What is the result? "The earth is covered with ashes and consists of ashes ... And the water of the oceans itself ... there is only the product of the giant burning of hydrogen in oxygen. Everywhere ash: stones - ash, water — ash, mountains — ash ... The remains of the unburned are negligible: (gold, silver, iron, aluminum ...)" [2]. The body of the planet simply burned down, but this ashes became a place for the life of various biological species — plants, animals, people. Hydrogen burned to the surface, but there is no information about its fate deep in the bowels of the planet in official science. Note that Mercury, Venus and the planet Earth are inside the region of the gap, but Mars has an area of intersection with the asteroid belt. Calculations show that of the giant planets, only the orbits of Jupiter and Saturn intersect with the Belt of asteroids, and the orbit of Neptune intersects with the Kuiper Belt. But where are the boundaries of the Solar system as a fragment of the Universe)?

Modern research based on data from the Voyager-1 and Voyager-2 spacecraft suggests that the solar system is a bubble filled, in addition to the above-mentioned objects, by the stellar wind consisting of charged particles emitted by the sun every second. The bubble is called *the heliosphere.* Solar matter can leave the body of the Sun as a result of its blowing, due to the influence of *the solar core*. It is believed that the boundary of the heliosphere is where the solar wind is completely inhibited by the influence of the interstellar gas surrounding the solar system. According to estimates, the border should lie at a distance of about 100–150 A. U. On February 22, 2014 Voyager-1 is at a distance of 127 A. U. from the Sun, but has not yet reached the boundaries of the heliosphere, since it still registers the stellar wind, although it is very slow. Meanwhile, if we assume that the body of the Solar system as an object of the Universe has a bubble filled with plasma, then it should have a border. By virtue of the laws of mechanics, the heaviest objects in a bubble should be approximately in the same plane, and the lighter components should occupy the entire space of the heliosphere. This is in fact the case: planets and heavy asteroids are concentrated in planes close to the ecliptic plane, and lighter ones (comets, Kuiper belt asteroids) go beyond its limits. Since the structure of the heliosphere obeys the laws of mechanics, it is interesting to conduct a theoretical study. It can help to find patterns that, in principle, cannot be established by the Newtonian theory of gravitation.

In order to determine the boundary of the bubble in which the solar system is located, we extend the concept of a *light cylinder* to the gravitational field of ordinary stars, since all of them rotate at one or another angular velocity. The magnitude of the angular velocity of rotation characterizes a portion of the energy of a star, manifested as the rotation of the surrounding space. More precisely, the *star rotates space*. Considering this rotation as a solid-state (as it was done for pulsars), we determine the distance at which the speed of space will be light. The angular velocity of rotation of the Sun at the equator is $\omega = v/a$, where the linear velocity of rotation is $v = 2$ km/s, and the radius is $a = 7\times10^{5}$ km. Since $\omega = 2.8\times10^{-6}$ s^{-1} for the Sun, we find $r = c/\omega = 10^{16}$ cm = 666.666... A. U. Extreme planet is Neptune, located at a distance of 30 A. U. from the Sun, since Pluto (39.55 A. e.) is assigned to the minor planets. It turns out that the planet's habitat area ends much closer to the boundary of the Sun Bubble. Maybe we don't know something or simply forgot about the knowledge that our previous generations had? And if the knowledge about the past comes to us in any form right now, perhaps there is a reason to think: what if this information came to us by chance?

In Russian fairy tales, storing in their depths Knowledge of the past, it is said that there are 27 earthes (far away of the lands of the Triad Eighth Kingdom, followed by the Tentieth State, including the Trident because of the fractality of the structure).The word "earth" corresponds to the modern concept of "planet", and all lands are divided into 3 systems of 9 earths each. In this case, the mass of all the planets is equal to the mass of the Yaryla-Sun. The last 9 earths comprise the earths of border control, the gravitational fields of which are arranged in such a way that the inner planets cannot leave the Solar System. In order to compare ancient knowledge with modern, we construct table 3.The first two columns of table 3 contain the names of lands and the periods of their rotation in the Earth years, indicated in [38]. The second column contains the values of the major semiaxes of the planets, calculated in accordance with the third Kepler law: *the squares of the orbital periods of the planets around the Sun are referred to as cubes of the major semiaxes of the* *planets.*The third column lists the names of modern objects of the Sun, identified with the lands from the first column. Some remote lands are identified with the planets used in astrology, but they were not found by astronomers, so they are not listed here. Perhaps for some reason these lands are now hidden from us. The fourth column contains the values of the average orbital velocities of the earths calculated from the weightlessness condition, which establishes a relationship between the orbital speed of rotation and the magnitude of the gravitational potential of the central body: $v^2 = GM/r$, where in this case $M = 2.0\times10^{33}$ g is the Sun mass, r — distance from the Sun to the orbiting body. In the fifth and sixth columns, the current meanings of the periods of revolution and major semiaxes for objects known in Vedic knowledge are given. Of particular interest here is the land of Deya, better known as the Phaeton. The Deya was destroyed over 150 thousand years ago, as a result of which the asteroid belt appeared. In the study of the gravitational field of the liquid Sun [23], it was shown that it has a feature (gap of space) at a distance of 2.3 A. U. It turns out that the most modern (relativistic) method of describing the Solar system contains the memory of a long-term catastrophe.

The speeds of the orbital rotation of the planets are calculated from the condition of zero gravity $GM/r = v^2$, where v is the orbital speed of rotation. The condition of weightlessness is a different formulation of Kepler's third law. In Newton's theory, it follows from the condition of equality of the force of force and centrifugal force, in GR, from the condition of synchronizing the time of the observer, who is in the gravitational field of the rotating body, and the ideal (ephemeris) time. Recall the elementary interval of the observed time $d\tau = [1 - (w + v_iu^i)/c^2]dt$, where τ is own time observer , w — gravitational potential, v_i — space rotation speed, u^i — own speed of a rotating body, t — ideal (ephemeris) time [12]. Synchronization of the observed and ephemeris time takes place under the condition $d\tau = dt$, which has the form: $w = -v_iu^i$. In the case of a gravitational field created by a solitary mass, $w = -GM/r$ is the Newtonian gravitational potential, $v_iu^i = v^2$, where v is the linear velocity of rotation. Weightlessness is the first step in getting rid of brute force by reaching the first cosmic velocity. This state is a balance between the attraction to the center of the gravitating body and the vortex (rotational) motion that carries away from the source of the gravitational field. The second stage of liberation from gravity is the exit from the gravitational field of the attracting center by reaching the second cosmic velocity. But any body that has a mass will certainly fall into the field of attraction of a body that has a greater mass. Gravitational attraction and vortex movements are the main forces acting in the material world, but their roots lie outside this world and are subject only to Time.

At the very beginning of 2018, American astronomers from the California Institute of Technology Mike Brown and Konstantin Batygin reported finding another planet in the Solar system. The results of their searches were published in the Astronomical Journal. According to their research, the “new” planet is an object the size of Neptune, and its mass is about 10 times greater than the Earth. It moves in a highly elongated orbit and an orbit tilted to the plane of the ecliptic, making one revolution around the Sun in about 15,000 years. The minor and major axes of the planets are inhabited, respectively, 600 and 1200 a. A. U. Thus, this planet is located closer to the Oort Cloud. Turning to table 3, it is easy to see that the “new” planet, is most likely Dime, the outermost planet located closest to the border of the 27-planetary Yarila-Sun system, determined by the distance to the wall of the light-like cylinder.

It was obtained above that the boundary of the Solar system, defined as the region where the speed of rotation of the space of the Sun is equal to the speed of light, is located at a distance of 666.666 ... A. U. from the sun. From the table it can be seen that the extreme land of border control Daim, moving at a speed of 1.19 km/s, is closest to this border. Thus, the planets (earths) are located inside the light cylinder of the Sun, and the most distant ones — are not far from its borders. However, the objects of the Solar system are far beyond the limits of the area of existence of the planets. Astronomers suggest the existence of the Oort Cloud — a sphere-like region of the Solar System, which serves as the source of long-period comets. The estimated distance to the outer limits is approximately 50000–100000 a. e. (about one light year = 9.5×10^{17} cm).The Oort cloud includes two areas: the inner in the form of a disk (2000–20000 A. U.) and the outer spherical. Objects consist of water, methane and ammonia ices. There is a certain analogy of the structure of the Solar System and the Milky Way, where heavier stars and dust are concentrated near the equatorial plane, while lighter stars form a spherical subsystem.

The outer boundary defines the gravitational boundary of the Solar system — the Hill sphere. This is the name of the space around the astronomical object in which it is able to hold the satellite, despite the attraction of the object around which it rotates itself. This task will not be considered here, since the question of which star the Sun rotates around while it remains open. Recall that the Sun, located just above the galactic plane, moves relative to the galactic center towards the constellation Cygnus at a speed of 230 km/s, making 1 revolution in about 200 million years. Recall that the Sun, located just above the galactic plane, moves 1 km into the galactic center, making 1 revolution in about 200 million years. The speed of the Sun relative to interstellar gas is 25 km/s, relative to the nearest stars it moves at a speed of 19.4 km/s up from the galactic plane in the direction of the constellation Hercules.The Sun is almost in the middle of the star cloud, called the Local Group of Stars. This cluster has a slightly oblate spheroidal shape and is in the direction of the constellation Keel. The sun is located in the Gould belt, which is a disk of young stars, 10–20 million years old. he size is 1500–3000 light years, and the center is at a distance of 500–800 s. g. from the sun. Gould's belt is inclined to the plane of the Galaxy.

The motion of the Sun relative to more nearby stars, unfortunately, is not precisely established in modern astronomy. In 1847, German astronomer Johann Medler, based on observations, suggested that the sun revolves around the Pleiades-Alcyone central star of the open star cluster, making 1 revolution in 18.2 million years [39]. In the ancient description of the World, there is the concept of a palace т a system of stars with surrounding planets orbiting a common center. It is assumed that the center of the palace, in which the Sun is located, rotates around a star in the constellation Ursa Minor (the palace of Zimun or the Heavenly Cow). It is possible that this is the neutron star 1RXS J141256.0 + 792204, which was described above. Moreover, it is claimed that the Sun enters a system of three stars, two of which are —white giant and brown dwarf (Mara, which has a satellite Nemesis). Some researchers identify this satellite with the mysterious planet Nibiru, which has a catastrophic effect on the Earth in certain periods of time. According to astronomers, the distance to the Pleiades is approximately 440 light years, the distance to the neutron star lies in the range of 250–1000 light years. If we consider that Alcyone is a white (more precisely, blue and white) giant, then the Pleiades can easily communicate with the neutron star mentioned: for example, Alcyone can rotate around her, dragging the Sun. If this is true, then the Sun feeds on the high-frequency energy of an X-ray neutron star. Of course, if the Sun is the satellite of Altiona, then the energy of a neutron star, re-emitted by Altion, comes to it, therefore, is lower frequency. Perhaps this is for the better: it is not known if we could withstand the higher energies obtained directly from the x-ray neutron star. By the way, Alcyone itself is a very interesting star: its mass is 6 solar masses, the radius is 10 solar, and the rotation speed at the equator is 215 km/s, i.e., 100 times higher than that of the Sun. Due to such a fast rotation, Alcyone has a disk located in the equatorial plane, which is formed by the star matter lost to it due to the high rotation speed. It is about 10 times the size of the Sun. Knowing the radius of the star and its linear rotational speed, it is easy to calculate that the radius of its light cylinder is 1015 cm, i.e., about 2 a. e., which is about 330 times smaller than the sun's light cylinder So if Alcyone has a planetary system, then its distance from the star to the farthest planet does not exceed 2 A. U.

Table 2.
Characteristics of the Solar System Planets

Object	Masse M (g)	Surface radius a (cm)	Density ρ (g/cm^3)	Hilbert radius r_g (cm)	r_g/a	Major axis a (A. U.)	The radius of the sphere r_{br} (A. U.)	The location of the sphere of the gap
Sun	$1{,}98\times10^{33}$	$6{,}95\times10^{10}$	1.41	$2{,}93\times10^{5}$	$4{,}22\times10^{-6}$	—	2,3	crosses the asteroid belt
Mercury	$2{,}21\times10^{26}$	$2{,}36\times10^{8}$	4.1	0,033	$1{,}39\times10^{-10}$	0.38	1.3	inside the SRS of the Sun
Venus	$4{,}93\times10^{27}$	$6{,}19\times10^{8}$	5.1	0,73	$1{,}18\times10^{-9}$	0.72	1.2	inside the SRS of the Sun
Earth	$5{,}97\times10^{27}$	$6{,}38\times10^{8}$	5.52	0.88	$1{,}38\times10^{-9}$	1	1.1	intersects with the SRS of the Sun and the asteroid belt
Mars	$6{,}42\times10^{26}$	$3{,}44\times10^{8}$	3.8	0,01	$2{,}76\times10^{-10}$	1.52	1.4	intersects with the SRS of the Sun and the asteroid belt
Jupiter	$1{,}90\times10^{30}$	$7{,}14\times10^{9}$	1.38	281.2	$3{,}94\times10^{-8}$	5,19	2.3	intersects with the asteroid belt and with the SRS of the Sun
Saturn	$5{,}68\times10^{29}$	$6{,}00\times10^{9}$	0.72	84.06	$1{,}40\times10^{-8}$	9.54	3.1	intersects with Jupiter's SRS when approaching
Uranus	$8{,}72\times10^{28}$	$2{,}55\times10^{9}$	1.3	12.91	$5{,}06\times10^{-9}$	19.19	2.3	no intersections with other SRSs
Neptune	$1{,}03\times10^{29}$	$2{,}48\times10^{9}$	1,64	15.24	$6{,}14\times10^{-9}$	30.07	2.4	Crosses Kuiper Belt
Pluto	$1{,}03\times10^{25}$	$1{,}1\times10^{10}$	2,03	0,002	$1{,}35\times10^{-13}$	39,48	1,0	no intersections with other SRSs

Here the letters PSA mean “sphere of rupture of space”.

Table 3.
Orbital characteristics of the planets of the Yaryla-Sun system

№	Earth's name	Circulation period *T* (in Earth's years)	*Big axis a* (in A. U.)	Modern name	Orbital speed (km/s)	Modern value *T* (in Earth years)	Modern meaning *a* (in A. U.)
1	Horse	0,24	0,39	Mercury	48,06	0,24	0,39
2	Mertsana	0,61	0,72	Venus	35,06	0,61	0,72
3	Midgard	1,00	1,00	Earth	29,8	1,00	1,00
4	Ouray	1,88	1,52	Mars	24,23	1,88	1,52
5	Daya (Phaeton)	5.25	3,02	Asteroid belt	17,13		2,8
6	Perun	11,86	5,20	Jupiter	13,07	11,86	5,20
7	Stribog	29,46	9,54	Saturn	9,64	29,46	9,54
8	Indra	58,92	15,14	Chiron, asteroid 2060	7,66	50,76	13,71
9	Varuna	84,02	19,18	Uranus	6,80	84,01	19,1
10	Niy	164,79	30,06	Neptune	5,44	164,79	30,07
11	Viy	248,70	39,55	Pluto	4,74	247,70	39,46
12	Velez	346,78	49,36		4,24		
13	Semargl	485.49	61,77		3,79		
14	Odin	689,69	78,06		3,37		
15	Lada	883,60	92,08		3,10		
16	Udrzec	1147,38	109,60		2,85		
17	Kolyada	1501,62	131,13		2,60		
18	Radagost	1952,11	156,21		2,38		
19	Tora	2537,75	186,05		2,18		
20	Prove	3456	232,97		1,95		
21	Krod	3888	247,26		1,90		
22	Polkan	4752	282,65		1,77		
23	Zmiy	5 904	326,66		1,65		
24	Ruchiy	6912	362,86		1,56		
25	Chur	9504	448,68		1,41		
26	Dogoda	11664	514,32		1,31		
27	Dime	15552	623,05		1,19		

§7. The attraction of the planet — the range of its gravitational state

Now about the planet Earth, which is part of the space of the yellow dwarf — the Sun, belonging to the Main sequence of stars. The Earth is at the mercy of the gravitational force of attraction of the Sun and itself has its own gravitational field. Our planet is a spheroid with a mass of $M_{\oplus} = 6{\times}10^{27}$ grams and an average radius $R_{\oplus} = 6{,}4{\times}10^{8}$ cm. It flies with the Sun in the Local Group of Stars at a speed of 250 km/s. But we do not feel this rapid flight, just as we do not feel the vibrations of the planet’s body: after all, our safety and sense of integrity are provided by the range of the gravitational state of the planet. Its presence, in particular, is manifested in the fact that every body on the surface of the Earth is attracted to it with an acceleration of g = 981.56 cm/sec^2, called the acceleration of free fall. We are attached to our planet, like Gulliver, by invisible “threads” of gravitational attraction. The earth can be approximately considered as a sphere whose center coincides with its geometric center, i.e. the Schwarzschild sphere. But before doing the calculations, let's see how its inhabitants, in particular, the plants, react to the gravitational field of the planet.

A tree is a materialized state of certain energies, including gravitational. It lives according to the laws, determined by the conditions of its energy exchange with the surrounding space. The physical body of the tree is in two environments — air and solid (subsurface layer). More precisely, the root system is under the surface, and the upper part (trunk, crown) — in air. A tree grows in different ways (cyclically) in one place all its life and is constantly under the influence of two forces: 1) the force of the direction of the center of the Earth; 2) Coriolis forces due to the rotation of the Earth around its axis and directed perpendicular to it. The ratio of these forces at each time point determines the shape of the plant, since the effect of the force of force is equivalent to the effect of the Coriolis force. For plants growing on the surface of the planet, the effect of the addition of the force of force and the centrifugal force caused by the rotation of the Earth is clearly not manifested. The linear speed of rotation of the surface points v depends on the latitude of the place φ and is described by the formula $v = v_{eq} \times \cos\varphi$, where its maximum value is v_{eq} = 500 m/s. Obviously, to obtain a visible effect of the geometric addition of force due to rotation, and the force of rotation, the linear speed of rotation must significantly exceed the linear speed of rotation of the planet. Experiments were carried out in which the seed of a plant was placed in the center of a rotating centrifuge. In this case, the germ was stretched out in the direction of the vector of the geometric sum of the force vectors and force caused by the rotation of the centrifuge and directed tangentially to it. In other words, the rotation of the centrifuge plants react as a gravitational effect.

The ability of all plants to perceive gravity and react to it is called *geotropism.* This is a response to the action of the acceleration of gravity. From ancient times comes the knowledge of the ability of all plants to perceive gravity and react to it. A vivid example of a geotropic reaction is the direction of growth of trees growing on a hillside: regardless of the steepness of the slope, trees grow toward the center of the Earth, but not in a direction perpendicular to the surface. Plant roots have positive geotropism — they grow to the center of the planet. The aboveground part of plants (stem, stem) reacts to gravitational attraction by negative *geotropism*, i.e. it grows in the direction opposite to the center of the Earth. The knowledge of geotropism comes from deep antiquity, but for the first time it officially appeared in the 18th century. In 1837, the French biologist Dutrosche (1776–1847) wrote: "The deepest secret is that the stems grow up and the roots in the opposite direction". Experiments with plants placed on the Earth's satellites convincingly show that the upper and root parts of the plant grow strictly along the line directed toward the center of the planet, but in opposite directions. It turns out that the lower part of the plants react to the gravitational pull coming from the center of the planet. It does not matter whether the plant is on the surface of the planet or in near-Earth space: in both cases, its roots grow strictly in the direction of the center of the Earth, and the stems in the opposite direction. So, plants, both on the surface of the planet and in near-Earth space, feel: 1) gravitational attraction, directed to the Center of the Earth; 2) gravitational repulsion directed in the strictly opposite direction. You might think that the upper part of the tree stretches towards the sunlight (phototropism) but this is not so. Phototropic (depending on light intensity) bending, like geotropic, usually represents the movement of an organ caused by growth, which is manifested as a result of the unequal growth of its opposite sides. But it is necessary to consider the material plant as a whole, and not just its part growing above the surface of the Earth. And the gravitational "repulsion" for the upper part of the plant is strictly connected with the direction from the center of the planet.

But what is the "Center of the planet"? A geometric point that has no dimensions, or a structure that has a certain size? In classical physics, there is the concept of "center of mass", which is also called "barycenter", "center of inertia", which coincides, as a rule, with the geometric center of the body and characterizes the movement of the body as a whole. In GR, its analogue can be considered the Schwarzschild sphere, which theoretically exists inside each massive body, that is, in the centers of most galaxies, stars, planets and their satellites (see section 5 of this chapter). They possess the gravitational fields of attraction of the Newtonian type, in contrast to neutron stars and pulsars — sources of gravitational repulsion. We just live in a corner of the Milky Way where gravitational attraction dominates, chaining us to the planet. But what exactly does not allow us to break away from its surface without the use of various technical means? Most likely, this is the "black hole" that is inside each material body, including the human body. For the Earth, rg = 87 mm is the radius of the Schwarzschild sphere into which it is impossible to penetrate into our physical body. It is this sphere with its "gravitational threads" that binds to itself every material body both on the surface of the planet and in the area of its gravitational influence in near-planet space.

We live on the surface of the planet, the radius of which is $a = 6.4\times10^8$ cm, and the gravitational radius of the planet is r_g = 87 mm, so the ratio is $r_g/a = 1.4\times10^{-8}$. The law of universal perception was formulated by Newton, who was on the surface of the planet, i.e., in a weak field. Recall, the gravitational field is considered weak if its three-dimensional gravitational potential $w<<c^2$. The mathematical basis of Newton's theory is a flat three-dimensional space, and time is not a coordinate: it is the same in all space. The expression for the Newtonian gravitational force can be obtained in the framework of GR, the base space of which is curved space-time. As an initial metric for describing the gravitational field of the Earth, we choose a spherically symmetric Schwarzschild metric describing the gravitational field of a solitary mass [26]: see the expression (3.4), Chapter 2. §3. This field is used to describe the movement of the planets in the solar system, as well as in connection with the tasks associated with the description of black holes. Although Schwarzschild himself nowhere indicated that the mass is very distant from the observer. He simply considered her to be secluded, that is, not bound by gravitational forces with other bodies. The only exceptions are small bodies, considered as trial bodies, which are in the field of a given body. Therefore, we will make calculations without prior assumptions about the weakness of the field.

Find the expression for the vector of gravitational-inertial force for the metric (3.4) using the formula $F^1 = h^{11}[c^2/(c^2 - w)]\partial w/\partial r$, where h^{11} is the component of spatial metrical tensor, $w = c^2[1 - (1 - r_g/r)^{1/2}]$ is the 3-dimensional gravitational potential of the given field [11]. From calculations we find that $F^1 = - c^2 r_g/2r^2 = GM/r^2$, that is, it is a Newtonian force of attraction. It decreases inversely with the square of the distance from the center of gravity. The gravitational potential in the weak field approximation w << c2 has the form GM / r, that is, it is the Newtonian gravitational potential of a “point” body. It should be noted here that Newton discovered the law of the world, being on the surface of the planet, where the gravitational field is considered weak: $w/c^2 = 6.9\times10^{-10}$, and the gravitational potential $w = 6.2\times10^{11}$ cm^2/s^2. However, after the Theory of Relativity, which represents a fundamentally new, broader view of the world, entered our worldview, scientists began to measure some physical quantities with the speed of light, more precisely, with the value of c^2. Comparison of the speed of movement of a material body v with the speed of light c is quite understandable, since in our time its value is considered to be the limit. Comparison of the potential w with the value of c^2 can be explained by the fact that the weak gravitational field cannot accelerate the physical body to a speed commensurate with the speed of light. Nevertheless, even a weak gravitational field strongly binds us to the planet. The gravitational force decreases inversely as the square of the distance from the Center. But what is this “Center”?

From the expression for the Schwarzschild metric (3.4) it follows that this Center can be considered a gravitational sphere of radius $r_g = a$, which is the boundary between the space-time of GR and the inside of a black hole, which has a fundamentally different structure. But the gravitational field of the planet is part of the gravitational field of the Sun, inside of which there is also a black hole with a radius of 3 km. It is possible that the gravitational attraction between the bodies is the result of the instantaneous exchange of the energies of the black holes inside them. Indeed, on the surface of a black hole, time for the observer stops, that is, there is a synchronization between the times of the observer and the object being observed. Since black holes exist inside each possessing a body mass, all of them are instantly connected to their gravitational fields, i.e. synchronized, since information (energy) spreads instantly from their surfaces . Conventionally, this can be represented by lines connecting the black holes of gravitationally connected bodies. Only they cannot be considered as lines in three-dimensional Euclidean space: “gravitational lines” can be compared with three-dimensional lines of zero length that exist in zero-space. It is difficult for us to imagine such a system of relations, since it takes place not in space-time, where the speed of light is the limiting one, but in the null-space enclosing it with completely different properties. In particular, long-range action is possible in the null space (instantaneous transmission of information). But this information (energy) is realized in each body with a speed depending on the properties of the body itself. Newton-type gravitational fields exist throughout the Universe, forming a single field, the energy-information centers of which are black holes that exist inside each massive body. This field is built according to the fractal principle: each body, on the one hand, is a part of another body (the Earth is part of the space of the Sun, ...), on the other — itself consists of other bodies (stars and their clusters are parts of the Galaxy body, ...) So, the Newton-type gravitational fields are combined into a single field, where the connection between the bodies is carried out instantly through black holes. And how are interconnected objects possessing non-Newtonian gravity?

It was previously shown that non-Newtonian gravity is inherent in bodies for which the condition holds: $r_g = a$. In other words, if a black hole is hidden deep in the body, then it is the source of Newtonian gravity attraction, directed to the center of the body. The gravitational force decreases in inverse proportion to the distance from the Center. If the body surface itself is the Schwarzschild surface, then the body is a source of non-Newtonian repulsion gravity directed from the center of the body to its surface, and the gravitational force is proportional to the distance from the Center. Due to the fact that the gravitational repulsive force created by the body, for which $r_g = a$ is directed from the body into outer space, it can be called a “white hole”. From the point of view of the geometric structure, it can be compared with a “black hole” turned inside out (the inner becomes external). If we consider our Universe as a “white hole”, then it processes the external time of the future into the internal time of the past, and all its objects (parts) also process the time of the Universe into the space of the past. Each body of the Universe is the materialized state of the “Time” fragment of the fractal. Therefore, the material body is the materialized state of a certain period (range) of Time, which determines the duration of stay in the world of each object. Having reworked its supply of Time, the body is dematerialized, while giving its energy to the “common pot”, which is Time. But not all objects of the Universe live according to this schedule. Neutron stars and pulsars turned into “white holes” emit certain time ranges themselves, which can become an additional source of energy for surrounding space objects with smaller ranges of time allotted to them. It is possible that the neutron star nearest to us also feeds us with additional energy, which will help humanity to go to other stars: after all, our yellow dwarf is not eternal, and we are created by its gradually decreasing energy.

Thus, the gravitational forces of attraction and repulsion can be considered as different manifestations of the gravitational interaction. Recall the gravitational repulsive force $F^1 = c^2r/a^2$ manifested as centrifugal force $F^1 = c^2r/a^2 = \omega^2r$, where $\omega = c/a$ is angular frequency of rotation of space caused by the action of force F^1. This force rotates space at a linear rate $v = \omega r$, creating twists in it. Perhaps it is these vortices that appear as different perturbations of space, which are identified with gravitational waves. Experimental detection of gravitational waves is considered by scientists as one of the key problems of confirming the validity of Einstein's GR: because these waves are gravitational field changes of a wave nature, i.e., ripples of space-time. This ripple can be caused by the behavior of various space objects: the relative motions of stars in compact binary systems, accompanied by their convergence; supernova explosions; neutron star fusions; the capture of stars by black holes, etc. The most likely sources of gravitational radiation are double stars: the parameters of their orbits change in the process of movement, which leads to the loss of energy that can be detected. This effect is especially pronounced for binary neutron stars. At one time, Kip Thorn, now the main theorist of a successful project to detect gravitational waves, paid attention to them. In the 1960s he repeatedly visited the Sternberg State Astronomical Institute, where he attended the well-known cosmologist A. L. Zelmanov seminar; participated in the 5th International Conference on Gravity and Theory of Relativity, held in 1968 in Tbilisi. Thorne came to the conclusion that neutron stars, whose pulsations are not spherical in nature [40], can emit stronger gravitational radiation (compared to binary stars). Together with the staff, he carried out approximate calculations, which were based on the well-known decision of K. Schwarzschild [25]. At the same time, the scientist took into account not only the pulsations of neutron stars, but also their rotation, which may be non-stationary. The calculations made it possible to determine the periods of pulsations, the power of the pulses, and the decay times of the signals [40]. In addition to these sources, gravitational waves can occur when stars collide, a star or a planet falls into a black hole, or when supernova explodes. Since all these objects are distant from us, the amplitudes of the waves lie within 10^{-18}–10^{-23} cm, i.e., the waves are weak. Therefore, theoretical calculations are associated with the field of weak plane gravitational waves, creating perturbations of space-time acting on the receiving device (detector). Gravitational waves are also called *curvature waves.* Since the curvature is four-dimensional, gravitational waves can affect not only the displacement of the detector particles, but also the passage of time at the point of reception of the signal.

In addition to the search for gravitational waves, it is certainly possible to relate the measurements of Einstein’s predicted displacement of the perihelion of Mercury to successful experiments on confirmation of GR; deflection of the beam of light in the field of gravity (gravitational redshift) [41],establishing a connection between the direction of the flyby of the Earth and the sign of the amendment to the indications of the transported time standard [42]. The plane with the standard of time (chronometer) on board flew around the Earth twice along the equator: 1) in the direction of its daily rotation; 2) in the opposite direction. The difference in readings of the transported standard with respect to the remaining on the surface was ± 208 nanoseconds (ns): 1 nanosecond is 10^{-9} seconds. It was obtained that the sign (+) is obtained when the directions of movement of the aircraft and the planet coincide, and (–) — with their opposite direction. In addition, comparisons of the readings of the transported and fixed chronometers were made depending on the height of the flight. In addition, comparisons of the readings of the transported and fixed chronometers were made depending on the height of the flight. The planet can be considered as a rotating frame of reference. Then the elementary interval of the observed time (namely, it was measured) takes the form: $d\tau = [1 - (w + v_iu^i)/c^2]dt$, where τ is own time observer, w is gravitational potential, v_i is space rotation speed, u^i is observer speed, a convolution with index i = 1, 2, 3 means summation, t is ideal (ephemeris) time [11]. The existence of corrections related to the change in the height of the standard above the surface of the Earth does not cause any confusion, since it is completely explained in the framework of Newton's theory. And the corrections related to the rotation of the planet are directly related to the theory of physical observable quantities of Zelmanov [11], which is not widely accepted among relativists. The recently departed Hafele said that the presence of amendments related to the equatorial circumference of the planet caused a particular bewilderment. In this case, when flying in the direction of rotation of the planet, the speed of the aircraft is added to the linear speed of rotation of the planet; when flying in the opposite direction, the speed of the aircraft is subtracted. Amendments related to the flight around the Earth can be considered as an experimental confirmation of the idea of N. Kozyrev on the algebraic addition of Time flows [6]. Later similar studies were conducted in the USSR on the territory of Siberia. The plane flew strictly along the parallel $\varphi = 60^o$, and the measurements were carried out according to three parameters: 1) airplane speed; 2) height above surface; 3) flight direction. The author calculated all three types of amendments in the framework of the GTR. It turned out that they coincide with the experimental data obtained. Post job failed.

In publish way, the passage of time in the space of the planet depends: 1) on the speed of movement of the standard of time; 2) from its height above the surface; 3) from the geographical latitude of the flyby of the planet and its direction (in or against daily rotation). In this case, the higher the standard above the surface, the slower the progress of time goes compared to the course of the standard on the surface. From the expression for the interval of the observed time (see above) it follows that the observed time coincides with the ideal (ephemeris) under the condition $w + v_i u^i = 0$, which in this case is: $GM_\oplus/r = v^2$, that is, it is a *weightless condition*. To achieve a state of weightlessness from the surface of the planet, it is necessary to give the body a speed of 7.9 km/s, almost 16 times the maximum rotational speed of the Earth.This quantity, called the first cosmic velocity $v_{\rm I}$, is obtained from the equilibrium condition between the gravitational force of attraction $GM_\oplus/r^2$ and the centrifugal force v^2/r and on the surface $r = a$ has the form: $v_{\rm I} = (GM_\oplus/a)^{1/2}$. This orbital rotation occurs in the gravitational field of the planet. This orbital rotation occurs in the gravitational field of the planet.And how to escape from the gravitational captivity of the planet? Since the gravitational field of the Earth is subject to the Newtonian theory of gravity, the condition for the exit from the gravitational field of the Earth is the equality of the potential energy of the planet and the kinetic energy of the body $GM_\oplus/a = v^2/2$, where does the expression for the second cosmic velocity come from: $(v_{\rm II})^{1/2} = 2GM/a = v_{\rm I}\sqrt{2}$. Freed from the terrestrial, the body falls into the gravitational field of the Sun, which is part of the gravitational field of the Galaxy, etc. And the attraction mechanism itself is the result of instantaneous interaction between gravitational spheres (black holes) inside each structure (a fragment of the "Galaxy" fractal). Conventionally, we can assume that all these spheres are connected by zero-lines of three-dimensional length. Thus, being on the surface of the Earth, we are simultaneously located in the gravitational field of the Sun, etc. Due to the proximity of the Sun to us in relation to other galactic objects, we can consider ourselves as parts of the planet placed in the gravitational field of the Sun. In general, the Sun can be considered as a living organism, the cells of which are the planets and other bodies of the Solar system. And we are on Earth, attracting us to our Center, but in the field of the Sun, which attracts all the planets, including the Earth. We can say that two oppositely directed gravitational forces act on us: one pulls towards the Center of the Earth, the other — in the opposite direction. Plants at space stations, growing strictly along one line, feel this especially well. The roots of trees growing on the Earth are directed to its Center, and the upper (above-ground) parts are directed in the opposite direction. But this is not phototropism caused by solar radiation.

So what is gravity? According to Einstein, the phenomenon of gravity is due to the presence of masses, which bend space-time. The curvature manifests itself as: 1) changing the shape of the spatial trajectories of bodies that are in a gravitational field of mass; 2) the change in the pace of time in the surrounding space. The gravitational effect of mass is manifested as: 1) attraction; 2) repulsion. The gravitational orientation is determined by the nature of the distribution of the substance, i.e. the ratio between the density of the body and its size. If the mass distribution satisfies the ratio $\kappa\rho_0 = 3/a^2 = \lambda$, where $\lambda > 0$ was originally connected by Einstein to the cosmological repulsive forces. When the density of the Universe is about 10^{-29} g/cm^3 and the distance to the horizon is about 10^{28} cm, the cosmological constant is of the order of 10^{-56} cm^{-2}. However, this expression can be applied to neutron stars, since repulsive forces also act on them, but on a stellar scale. In this case, at a density ρ_0 of order 10^{14} g/cm^3 we obtain for the neutron star radius a value of the order of 10^6 cm, i.e. 10 km, which corresponds to the estimates adopted in modern science. Thus, at this stage of civilization (part of the span of the planet in the Galaxy), we know 2 types of gravitational effects — Newtonian type attraction and De Sitter type repulsion. In fact, the whole theory of gravity and relativistic cosmology rests on three pillars: 1) Schwarzschild's solution [26], which describes a Newton-type gravitational field created by a solitary mass; 2) Schwarzschild's solution [25], which describes gravitational field, created by a homogeneous incompressible sphere, generalization of which (3.2), obtained in [23], includes non-Newtonian gravitational fields of both attraction and repulsion; 3) the de Sitter solution with a positive cosmological constant (3.3), which directly follows from the relation $\kappa\rho_0 = 3/a^2 = \lambda$.

So, we live on a planet with a Newtonian-type gravitational field that binds us tightly to its surface. But have the inhabitants of the planet always been firmly tied to it by invisible threads? Myths and legends of different nations brought to us information about one of the early civilizations, called “feather”. Many images of winged creatures have come down to us. Sometimes they were depicted in the form of birds with human heads, sometimes in the form of winged people, images of aircraft were also preserved [43]. Maybe then the planet rotated around the axis much faster? And the wings and other devices for flight were simply necessary in order not to “fly away” from the planet at all. Or did the weakness of the planet simply allow the inhabitants of the planet to move in the air with the help of various aircrafts, which are often talked about in myths and fairy tales? But we are still tied to the surface of the planet tightly enough, and our task is to understand how to weaken these bonds. Obviously, to fly to the stars, it is necessary to master fundamentally different methods based on an understanding of the structure of Time. After all, flights to distant objects located far beyond the limits of the Solar System will occur as transitions from one range of Time to another (alignment of times). And for a start, it is necessary to recognize the existence in the Universe of instantaneous information transfer between all its objects, but, unfortunately, this is not happening yet. After all, the time when these flights will become a necessity, does not wait, it approaches and will come in due time. It is only necessary to prepare for it, while the conditions existing on the planet allow it. And help us in this study of neutron stars and pulsars — tiny worlds living according to the laws of the universe, but with lower vibrations than the universe. We will be easier to see them, feel, understand.

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