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EVOLUTION OF THE UNIVERSE ACCORDING TO THE NEW COSMOLOGICAL THEORY

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Abstract

The urgency of the issue under study is dictated by the constant interest in the knowledge of the surrounding Universe by mankind. The purpose of this article is to develop, consistent with experimental data of the cosmological theory, the evolution of the Universe. We believe that the leading approach to the attainment of this purpose is natural-scientific, regular and consistent consideration of this cosmological issue. Starting from the basic provisions of the General Theory of Relativity (which mathematical basis is the equations of A. Einstein), in this paper we analyze the well-known solutions of those equations in the light of cosmological theories development. Special focus is on the analysis of the modern theory of the Big Bang, in particular - its capabilities and limitations. The article deals with a fundamentally new cosmological approach to describing the Universe structure and its evolution. The main provisions of the proposed theory of a steady-state and dynamic Universe are determined, and the fundamental characteristics of the elements in its structure and the features of such elements motion are calculated. It should be emphasized that this theory, which is developed in the methodological plan in accordance with the philosophical principle of succession and conformity by N. Bohr, is good coherent with the well-known astronomical observations, and allows us to draw logical conclusions about the evolution of the Universe just to be guided by fundamental physical laws. The aspects of this article may be useful in both studying the issue under consideration based on the historical perspective, and interpreting the latest results in the study of the Universe.

Keywords

Motion of galaxies — Cosmological model — Big Bang — Steady-state and dynamic Universe

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Introduction

Mankind has always been interested in the structure and development of its surrounding Universe. That is why, along with the acquisition of everyday, common knowledge, the most advanced creative individuals have expressed hypotheses and formed theories and models of the World development. It is appropriate to mention here the geocentric model by K. Ptolemy, the Heliocentric System of the World by N. Copernicus, and the modern model of the exploded and rapidly expanding Universe, also called the Big Bang theory (BBT).

First of all, it should be noted that a full-fledged model of the Universe is a set of ideas about the spatial structure of the Universe and the motion of its constituent elements, supplemented by mathematical equations describing such motion. The BBT meets these requirements, the mathematical basis of which is the Einstein's equations written for the General Relativity theory (GRT) (the latter is also considered as the Gravitation Theory)[1]:

$$R_{\mu\upsilon} - \frac{1}{2} g_{\mu\upsilon} \cdot R + \Lambda \cdot g_{\mu\upsilon} = \frac{8\pi G}{c^4} T_{\mu\upsilon} \text{ or } E_{\mu\upsilon} + \Lambda \cdot g_{\mu\upsilon} = \frac{8\pi G}{c^4} T_{\mu\upsilon}, \tag{1}$$

where, Λ is a cosmological constant, *c* – a speed of light in vacuum, *G* – a gravitational constant, $E_{\mu\upsilon} = R_{\mu\upsilon} - \frac{1}{2} g_{\mu\upsilon} \cdot R$ – Einstein tensor, $T_{\mu\upsilon}$ – an energy-momentum tensor, $R_{\mu\upsilon}$ – Ricci tensor (tensor of order 2), $g_{\mu\upsilon}$ – a covariant fundamental tensor, and *R* – a scalar curvature.

By themselves, these equations are intended to reflect a complex metric (curvature) of the space-time continuum in the gravitational interaction of large material objects, but also allow one to draw conclusions about the evolution of the Universe on the relevant logical reasoning. So, actually, the majority of researchers-cosmologists acted.

For example, one of the first solutions of the Einstein equations, proposed by K. Schwarzschild[2], but without a cosmological term and for the empty space in a spherically symmetric static case (later, Birkhoff showed that the assumption of static nature is superfluous), turned out to be space-time M with topology (r^2x s^2) and an interval reducible to the following form:

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

where, *t* is a time coordinate, *r* – a radial coordinate, θ – a polar angular coordinate, φ – an azimuth angular coordinate, and r_s – the Schwarzschild radius of a body with mass *M*.

The time coordinate corresponds to the time-like Killing vector_∂_t,_which is responsible for the static character of space-time, while its scale is chosen so that *t* is a time

[1] A. Einstein, "Die Grundlage der allgemeinen Relativitätstheorie", Annalen der Physik, Vol: 354 (7) (1916): 769-822 y E. Kuransky (Ed.) Albert Einstein and the theory of gravity. Collection of Articles (Moscow: Mir, 1979).

[2] K. Schwarzschild, "On the Gravitational Field of a Point-Mass, according to Einstein's Theory", num 1 (1916): 10-19.

measured by infinitely distant resting clocks. The angular coordinates θ and φ correspond to the spherical symmetry of the problem and are related to the corresponding Killing vectors.

Based on the basic principles of GRT, it follows that such a metric will create (outside of itself) any spherically symmetric body with a radius $r > r_s$ and mass $M = \frac{c^2 r_s}{2G}$.

Another static Reissner-Nordström solution[3] of Einstein's equations for a spherically symmetric object called a "black hole" with a charge, but without rotation, determined the following metric:

$$ds^2 = -\left(1 - \frac{r_s}{r} + \frac{r_Q^2}{r^2}\right) c^2 dt^2 + \left(1 - \frac{r_s}{r} + \frac{r_Q^2}{r^2}\right)^{-1} dr^2 + r^2\left(d\theta^2 + \sin^2\theta d\varphi^2\right), \quad (3)$$

where *r* is a radial coordinate (length of the "equator" of the isometric sphere, divided by 2π), r_Q – a scale of length corresponding to the electrical charge *Q* (analogue of the Schwarzschild radius applied not for a mass, but for a charge), defined as $r_Q^2 = \frac{Q^2 G}{4\pi\varepsilon_0 c^4}$. Wherein the black hole parameters cannot be arbitrary. The maximum charge that Reissner-Nordström's black hole can have is equal to $Q_{\max} \approx \frac{10^{40} e\, M}{M_c}$, where M_c is the Sun's mass, and *e* – an elementary charge. This solution, while continuing beyond the horizon, is similar to the Schwarzschild's solution and generates an amazing geometry of space-time, in which an infinite number of "universes" are connected through black holes. And you can enter such universes successively through immersions into a black hole.

The solution proposed by Kerr-Newman[4] is the most common solution, corresponding to a finite equilibrium state of a black hole not perturbed by the external fields. In the Boyer-Lindquist coordinates and geometric terms, when *G* = *c* = 1, the Kerr-Newman metric is given as:

$$\begin{aligned} ds^2 = &-\left(1 - \frac{2Mr - Q^2}{\Sigma}\right) dt^2 - 2\left(2Mr - Q^2\right) a \frac{\sin^2\theta}{\Sigma} dt d\varphi + \\ &+\left(r^2 + a^2 + \frac{\left(2Mr - Q^2\right) a^2 \sin^2\theta}{\Sigma}\right) \sin^2\theta d\varphi^2 + \frac{\Sigma}{\Delta} dr^2 + \Sigma d\theta^2 \end{aligned}, \quad (4)$$

[3] G. Nordström, "On the Energy of the Gravitation field in Einstein's Theory", Koninklijke Nederlandse Akademie van Weteschappen Proc. Series B Physical Sciences, Vol: 20 (1918): 1238-1245.
[4] R.P. Kerr, "Gravitational Field of a Spinning Mass as an Example of Algebraically Special Metrics", Phys. Rev. Letters, Vol: 11 num 5 (1963): 237–238.
G. C. Debney; R. P. Kerr & A. Schild, "Solutions of the Einstein and Einstein-Maxwell Equations", Journal of Mathematical Physics, Vol: 10 (1969) 1842-1854

where, $\Sigma \equiv r^2 + a^2 \cos^2 \theta$; $\Delta \equiv r^2 - 2Mr + a^2 + Q^2$ и $a \equiv L/M$ (*L* is an angular momentum).

From this formula it follows easily that the event horizon is at a radius $r_+ = M + \sqrt{M^2 - a^2 - Q^2}$ and, consequently, the black hole parameters cannot be arbitrary: the electric charge and the angular momentum cannot be greater than the values corresponding to the event horizon disappearance. Limitation to the Kerr-Newman black holes shall be satisfied: $a^2 + Q^2 \leq M$.

If these restrictions are violated, the event horizon will disappear and the solution will describe the so-called "naked singularity" instead of the black hole, but such objects, according to popular beliefs, should not exist in the real Universe.

Thus, the event horizon radius for a non-rotating black hole is equal to a gravitational radius, and for rotating black hole - less than a gravitational radius. In the latter case, the event horizon is immersed into the ergosphere containing a vortex gravitational field, and the body trapped in it is picked up by rotating space-time and begins to rotate around the central black hole. The body, which falls freely under the action of gravity forces, is in a state of weightlessness and experiences the action of only tidal forces that, when dropped into a black hole, stretch the body in the radial direction, and in the tangential one - compress. The magnitude of those forces increases and tends to infinity at $r \to 0$ (*r* is a distance to the hole center).

Discussion

Before we cover this or other hypothesis and, in particular, the Big Bang theory, it is necessary to consider the following very important observational astrophysical facts[5]:

1) all galaxies move away from us and from each other and the faster they do that, the greater the distance between them - it's the Hubble's law:

$$\upsilon = H_0 \cdot r, \tag{5}$$

where, υ is a recession rate of space objects, H_0 – the Hubble constant, *r* – a distance between objects;

2) the velocity vectors of galaxies, if extrapolated backward in time, converge to a single point.

These facts played a decisive role in forming the paradigm of the expanding Universe and later - the Big Bang theory. The initiator of the modern cosmological theory was A. Einstein. Namely in his works of 1916-17's, the foundations of the General Relativity Theory - the gravitation theory - were laid, and the issues of the Universe structure and development were considered.

In his works, Einstein made a deep analogy between the motion of bodies in the gravitational field (i.e., when they move in accelerated motion) and the uniform motion of

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[5] M.V. Sazhin & O.S. Sazhina, “Modern Cosmology”, Metaphysics, num 1(19) (2016): 10-30.
M.V. Sazhin & O.S. Sazhina, “VST Project: a small telescope for large problems”, The Earth and the Universe, Vol: 17 num 5 (2017): 1-12.

bodies in the absence of gravity, but when observing them under the non-inertial frame of reference (i.e., a system moving with acceleration), for example, from the accelerated spaceship. Consequently, the accelerated frame of reference is equivalent to the gravitational field. Now it is considered to be the equivalence principle of gravitational and inertial masses. In the course of these arguments, Einstein came to the conclusion that the existence of a curved space-time is inevitable, i.e. non-Euclidean space.

Einstein compiled the gravitational equations that relate magnitudes describing the curvature of space-time (i.e., magnitude of the gravitational field) with the quantities forming such curvature (i.e., quantities forming the gravitational field). It should be noted that not only the masses were included in the process of quantities formation (as it was in the case with Newton), but also the kinetic energy of the motion of matter, pressure, and electromagnetic radiation. Here, the following theses are important: all kinds of physical matter are subject to the action of the gravitational field, and all kinds of matter participate in the field development; if the gravitating matter is moving, the curvature of space changes with time. In the case of weak fields, Einstein's equations change into the Newton's law of Universal gravitation, and the space-time continuum differs little from Euclidean space.

By extension of the BBT provisions, Einstein came to the conclusion that this theory can be used to determine the general structure of the Universe. In the conclusions of one of his works he suggests the first relativistic model of the Universe, where he applies two assumptions:

– the Universe is steady-state;
– on a large scale, the Universe is isotropic and homogeneous (i.e., the average density of its matter is constant).

The first condition was confirmed by the immutability of the space objects motion for thousands of years, and the observed changes in the bodies themselves (for example, supernova outbursts) and their trajectories seemed to be the local events against the Universe.

The second condition (isotropy) meant that there were no separate directions in the Universe. The homogeneity of the Universe is still a hypothesis: within our Galaxy (~ 30 kpc) and in the nearest neighborhood cluster of galaxies (~ 30 Mpc) it is not satisfied, and only starting from the sizes 100 - 300 Mpc, the matter distribution within the Universe may be assumed to be homogeneous. The requirement of Einstein's homogeneity was dictated by the complexity of the GRT equations themselves.

The assumption of steady-state required Einstein to include an additional Λ-term in the system of equations, which was intended to reflect the manifestation of universal repulsion forces (these forces should not depend on the masses or on the nature of bodies, but be determined only by the distance between them). The absence of repulsive forces led to the impassability of equation system and, as a consequence, to the instability of the Universe.

Einstein, definitely, understood the whole physical absurdity of introducing the Λ-term: one body attracts another body and simultaneously repels it, and, the greater the distance between bodies, the stronger the repulsion. He painfully sought a way out of that situation.

The solution was found a young Soviet scientist – mathematician by training and geophysicist by work experience - A. Friedman. In the early 20s, he has mastered the difficult for many Einstein's theory of gravitation and attempted to solve the GRT equations. Realizing the problem of Einstein, Friedman abandoned the original postulate of the Universe steady-state, and found three solutions that described three possible models of the Universe. Moreover, the Einstein model was considered here as a special case, while the other two models reflected the nonstable Universes: one of them corresponded to the continuously expanding surrounding reality, and the other described the cyclical nature of the evolution of the Universe (the reality expanded to a certain limit, and then the expansion was followed by the compression stage).

In 1922 Friedman published his results in a small article in the leading German journal on theoretical physics. The article immediately fell under the harsh criticism of Einstein, who found it erroneous. But Friedman, having persevered, writes a letter to the great physicist, in which he points out the error in Einstein's calculations. Only after fundamental astronomical discoveries in the late 20s did, Einstein recognized his error, and later, as early as 1945, characterized Friedman's approach and results as "the most general scheme that provides a solution to the cosmological issues"[6]. In 1923-24, Friedman wrote a couple more articles on the issue of the origin of the World from the "point" (from nothing) and the "age" of the Universe, which he defined as the time elapsed from the moment of its expansion to the present state. His estimate of the age - tens of billions of years - corresponds to the modern concepts in order of magnitude. Unfortunately, the talented young scientist could not finalize his theoretical studies, in 1925 the typhus laid him low.

After the experimental results of V. Slipher (by 1925 the latter managed to measure the velocity of nebulae 41) and the discovery of E. Hubble’s law (5) of the galaxy escapement in 1929, the theory of expanding Universe was further developed. It is appropriate to recall the independent works of J. Lemaitre conducted in the 1930s, and further research and improvement of the "redshift" method in Hubble's works, wherein the constant value H_0 was gradually clarified. Today, it is assumed that the Hubble constant depends on the temporary stage of the Universe development and at the modern period its average value is $H_0 \approx 75\,\frac{\text{km}}{\text{s}\cdot\text{Mpc}}$. The cosmological significance of this constant is irrefutable, since in magnitude inverse to H_0, it is easy to estimate the age of the Universe:

$$t_0 = 1/H_0 = 1/75 \approx 13\cdot 10^9 \text{ years}. \tag{6}$$

Also, through the Hubble constant, according to the methods proposed in[7], one can calculate another key cosmological parameter – the critical density of matter in the Universe:

$$\rho_{cr} = \frac{3H_0^2}{8\pi\cdot G} = \frac{3\cdot 75^2}{8\pi\cdot 6,67\cdot 10^{-11}} \approx 1\cdot 10^{-26}\,\frac{\text{kg}}{\text{m}^3}. \tag{7}$$

If the average density of the Universe's matter will be set and it will be equal to $\rho < \rho_{cr}$, the Universe will expand indefinitely (open model of the Universe), if the density will be

[6] E. Kuransky (Ed.) Albert Einstein and the theory of gravity. Collection of Articles (Moscow: Mir, 1979)
[7] I.D. Novikov, How the Universe exploded (Moscow: Nauka, 1988)

equal to $\rho > \rho_{cr}$, the expansion will be replaced by compression in the distant future (closed model of the Universe). At present, the most reasonable method of determining the average density is given for a meter, which is part of the galaxies, $\rho \approx 3 \cdot 10^{-28} \frac{kg}{m^3}$, which allows us to conclude with some degree of probability about the openness of our Universe.

In 1946 G. Gamov put forward the idea of a "hot Universe"[8], and in 1948, together with R. Alfer and H. Bethe, he presented the first calculation of deuterium and helium formation in the Universe (previously it was believed that a controlled thermonuclear reactor in the bowels of stars, like plasma spherical formations, could provide their energy reserves for billions of years, but there were no proposals for the initial deuterium production). Gamov believed that the First-Ever Universe was very hot and consisted of the nuclei of simplest atoms and elementary particles. During its gradual cooling, the first simple isotopes of hydrogen, and then even more complex atoms and molecules of stellar matter were formed. The theory predicted that the matter, from which the first stars and galaxies were formed, should consist mainly of hydrogen (~ 75 % by mass) and helium (~ 25 %) with a slight admixture of other elements.

Gamov also came to the conclusion that one of the consequences of the hot phase of the Universe and its subsequent cooling should be the non-directional radiation of the microwave range with a temperature of ~ 10 K. But neither Gamov himself nor his followers have set the goal of experimentally detecting this radiation, apparently suggesting that it is very weak against the stars emission and possible radio interference coming from the terrestrial sources. This radiation (with a temperature of ~ 3 K) was accidentally discovered only in 1965 by research engineers A. Penzias and R. Wilson in the course of detuning from the interference of the radio telescope they used. Soon, after the article publication about the existence of such radiation in the surrounding Universe, the world's leading cosmologists gave its explanation precisely on the viewpoint of "hot broth" radiation from the elementary particles in the earliest periods of the First-Ever Universe.

Generation of the modern model of the Universe basically completed in the 1960s. This model incorporated the expanding Universe of Friedman-Lemaitre, and the "hot Universe" of Gamov and ultimately formed in the Big Bang theory[9].

According to BBT, the Universe was formed as a result of a giant explosion of matter, which initially occupied an infinitesimal volume, being in a super dense singular state. As the explosion theory suggests, the dynamics of processes from the singularity state developed rapidly, but simultaneously epochally. Already by the first millisecond, after the explosion, the formation of heavy elementary particles (hadron era) and light particles (lepton era) took place, and the formation of the first hydrogen atoms began, while the temperature of the first matter reached 10^{10} K.

As long as the temperature of the First-Ever Universe remained high (more than 10^7 K), its matter was a mixture of highly ionized plasma and γ -ray quanta - such a medium was opaque to radiation. When the temperature during the monotonous expansion dropped to

[8] A. D. Dolgov; Ya. B. Zeldovich & M. V. Sazhin, Cosmology of the Early Universe (Moscow: MSU, 1988) y M. Yu. Dokukin, Concepts of modern Natural Science (Moscow: Publishing house of the MSTU named after N.E. Bauman, 2010).

[9] I. D. Novikov, How the Universe exploded (Moscow: Nauka, 1988) y A. D. Dolgov; Ya. B. Zeldovich & M. V. Sazhin, Cosmology of the Early Universe (Moscow: MSU, 1988).

3500 K (which could happen about 300,000 years after the explosion), the quantum energy was no longer enough to re-ionize the atoms, and the plasma began to turn into neutral matter, and the accumulated radiation was released and began its journey on the vast expanses of the emerging Universe. That long-ago era is called the era of recombination or the era of photon plasma. As this radiation propagates in the ever-expanding Universe, the frequency of radiation due to the Doppler effect is (for the observer) displaced relative to the original, radiated towards low frequencies (so-called "redshift"). This effect has accumulated over billions of years, and for our days the radiation frequency should correspond to the microwave band of waves and an equivalent temperature of less than 10 K. Just in 1965, the discovery of the universal microwave radiation with a temperature of 3 K, which later became known as the relict radiation, is regarded as the most important evidence of the BBT correctness.

When the age of the Universe has reached 10 million years, and its size - 3 - 4 Mpc, it began the process of formation of seals - proto-clouds, from which galaxies with corresponding star systems were formed in the future. This is the so-called post-recombinational era, which extends to present days. The experts still do not have a common opinion about the process of heterogeneities (seals) formation in an initially homogeneous environment. One of the hypotheses is the "pancakes" theor[10], which found confirmation in a computer simulation of probabilistic fluctuations for the density of matter and its subsequent fragmentation into clumps of ~ 50 kpc in size and weight of 10^5- 10^{11} of the Sun's masses. It is commonly known that the masses of observed galaxies are within this range. However, the question of how the initial fluctuations originated (and their size is needed at least 1 %) remains open.

In the conclusion of the modern cosmological model description – the BBT – let's focus on the limitations and difficulties of this theory.

First of all, it is the impossibility of the initial assumption of the expanding Universe hypothesis, namely, ensuring homogeneity of the matter distribution in the Universe.

Even A. Fridman, abandoning the stationary state of the Universe, retained the assumption of homogeneity for the mass distribution in it. The density of matter can change over time (for example, decrease), but at any time it is the same throughout the entire Universe. This condition is necessary to solve the GRT equation systems. However, in order for it to be performed in the expanding Universe, it is necessary that at every point of its peripheral region a new matter is continuously generated (from nothing), and in every inner region the matter continuously disappears (to nowhere). Neither one nor the other can be substantiate physically.

To eliminate this difficulty in the 1970s, a number of scientists put into the spotlight the idea of "physical vacuum", expressed back in 1928 by P. Dirac. A physical vacuum is considered as a quantum field with an inexhaustible source of virtual elementary particles of different kinds (and their antiparticles), which under certain energy conditions can appear (in pairs) in our real space or, conversely, leave it, dissolving in an intangible vacuum. The concept of a physical vacuum is very much in tune with modern ideas about the "dark" (invisible) matter and the "dark energy" contained in it. Unfortunately, even with such perfect technical and instrumental means, the scientists have not been able to confirm these representations to the present, and the vacuum remains a hypothetical medium.

[10] I. D. Novikov, How the Universe exploded (Moscow: Nauka, 1988).

Many difficulties in applying the BBT are associated with an explanation of events occurred at the very moment of singular state detonation for the primitive matter. Describing the singularity, the apologists of this theory manipulate the ultra-small sizes of this point formation (~ 10^{-35}m – Planck radius) with a colossal density of matter in it (~ 10^{96} kg/m^3 – Planck density). It should be noted that the highest realizable density of nuclear matter in atoms is only the value of ~ 10^{17} kg/m^3, and the size of electron - the smallest particle of matter – ~ 10^{-15} m.

Today it is unclear even what mathematical apparatus shall be used in describing the singularity. The equations of quantum mechanics work only up to Planck dimensions, and the GRT equations are applicable only for objects that move at a velocity less than the light velocity. That is why in the arguments of scientists there are statements like that in the singularity there is already no space or time as we know it. For the sake of formal mathematical constructions, some scientists are even ready to abandon the fundamental laws of nature (such as the law of matter conservation) and the well-checked knowledge of the internal structure of matter.

According to the law of matter conservation, the continuity of its transition from one state to another follows. This transition can be very fast, but always through an intermediate state (or a sequence of states). Therefore, the singular state must be associated with the state of matter not only after the Big Bang, but before it. Therefore, it is still necessary to explain the singularity physically.

Also, the big problem of BBT is the explanation of the "Bang" cause. Proponents of the theory argue that in the infinite Universe the action of gravity force causes the matter motion. But, firstly, the gravity is always associated with mass attraction and use, and it is very difficult to imagine the object extension; secondly, consideration of the infinite homogeneous Universe as an isolated sphere of finite radius, as some scientists try to do that – is absolutely not justified. Therefore, in the considered Universe there is no reason for self-movement.

In 2001, a group of American scientists expressed the idea of a possible (~ 15 billion years ago) collision of our Universe with another universe, after which they began to scatter. But this idea does not clarify the Bang mechanism.

Another difficult question for the BBT: what was the source of the explosion energy? It is clear that the explosion is associated with the allocation of colossal energy, but what mechanism could it ensure?

The most effective process of energy release for today is the annihilation of matter. When two particles (a particle and the corresponding antiparticle) annihilate, then, according to Einstein's formula, the energy $E = 2mc^2$ is released, where m – rest mass of a particle of matter. For example, in the annihilation of an electron and a positron, two γ-quanta are formed and energy ~ 1 MeV is released; and ~ 2 GeV are released when proton and antiproton are annihilated. But if the explosion was caused by annihilation, then in its "fragments" the content of matter and antimatter would be the same. Meanwhile, very little antimatter is found in the Universe - 1 antiparticle per 1 billion particles of ordinary matter (now we have the so-called baryon asymmetry of the Universe). It turns out that there was no annihilation.

But not only the singularity arises problems for the BBT. Much more recent processes in the expanding Universe, also, did not receive a convincing explanation within the BBT. Below you can see the list of the most important of them.

This theory cannot explain the increase in the velocity of scattered galaxies, i.e. it does not explain the Hubble's law (5). After all, according to the BBT, only the gravity force acts on the galaxy, and it creates a negative acceleration and, therefore, inhibits space objects. And it is neither consistent with the observed facts nor with the Hubble's law.

The BBT does not give intelligible answers to the following questions:

- how could galaxies and their clusters be formed from a homogeneous primitive matter?
- why do galaxies have such shapes - spiral, elliptical?
- why do galaxies rotate, what force causes hundreds of billions of stars to rotate as one?

Within the BBT, it is not possible to explain the nature of new space objects and the mechanism of processes associated with them. Among them:

- cosmic rays of extragalactic origin (streams of elementary particles with energy ~ 20 GeV);
- quasars - the most remote and rapidly moving space objects that have a huge radiation power that is tens - hundreds of times higher than the radiation of ordinary galaxies;
- electromagnetic radiation of different frequencies, penetrating the Universe;
- large-scale cellular structure of the Universe.

Even the microwave background radiation with an equivalent temperature of 3 K, originally included in the experimental confirmations of the BBT, in general, having an electromagnetic nature, is in sharp contrast with the provisions of this cosmological theory. It is known that electromagnetic radiation in vacuum propagates with the light velocity c, and particles of the matter - always with a velocity less than c. According to the BBT, the radiation under consideration arose in the era of plasma recombination and later it was not generated, i.e. its reserves are limited. Therefore, if the primary matter and primary radiation really began to independently and simultaneously spread in all directions, the radiation would be quickly overtaken the matter and came on the periphery of the Universe, where we could not observe it (due to the absence of photons scattering through the radiation of matter - the latter is not on the periphery).

To top it off, the BBT does not respond to global evolutionary questions about the future of the Universe:

- will it perish, unlimitedly expanding;
- will it ever start to collapse;
- will its evolutionary process be cyclical?

As the reason for the last set of questions, we can consider the modern uncertainty in the average density of matter within the Universe.

The global recession of galaxies can be explained differently than it is done in the BBT. For this we need to state the basic hypotheses[11].

The first hypothesis is "on the motion of galaxies."

Each galaxy (or a group of gravitationally bound galaxies) moves along a closed orbit, which is a very elongated quasiellipse, in one of the foci of which is the core - the gravitational center of the Universe.

However, if all galaxies move along the elongated closed orbits, then in addition to galaxies moving like our galaxy to the core, which emission spectra have a "red shift", we must observe a multitude of galaxies that move from the core to meet our galaxy, and, therefore, their emission spectra should have a "violet shift". We do not observe galaxies with a violet spectral shift. It remains to be assumed that in the areas of orbits, where galaxies are moving away from the core, their matter is in a special state (for example, destroyed to the level of corpuscles), which is optically invisible.

The second hypothesis is "on the vector pole."

Thus, the galaxies that are closer to the core managed to go a long way and gain more velocity - therefore, they continuously move away from the galaxies that started their movement to the core later. Moreover, since the orbits of galaxies are very elongated and the core is very far away, at a distance of billions of light years, the vectors of velocities of galaxies emanate from one point, that is, they are rather directed to a common point - the "vector pole".

The universe is limited in space; the propagation velocity of any signal is finite and does not exceed the light velocity. Let's call the minimum distance of the galaxy from the core as *pericore*, and the maximum – *apocore*. At the pericore point, the galaxy moves at the maximum velocity (judging by the measured values of "redshifts" of the galaxies that are the most distant from us, this velocity is greater than 0.5 *s*).

Let us continue the analysis of the galaxies motion. The orbits of galaxies lie in the arbitrary planes, but all planes pass through the core center (Fig. 1). Thus, the Universe is like a sphere filled with galaxies, which most of the time move towards the core or from the core, i.e. radially.

[11] M. Yu. Dokukin & D. S. Indyk, "On the possibility of the existence of black holes within the dynamic and stationary Universe", Don Engineers' Bulletin, num 4. (2016). URL: ivdon.ru/magazine/archive/n4y2016/3811

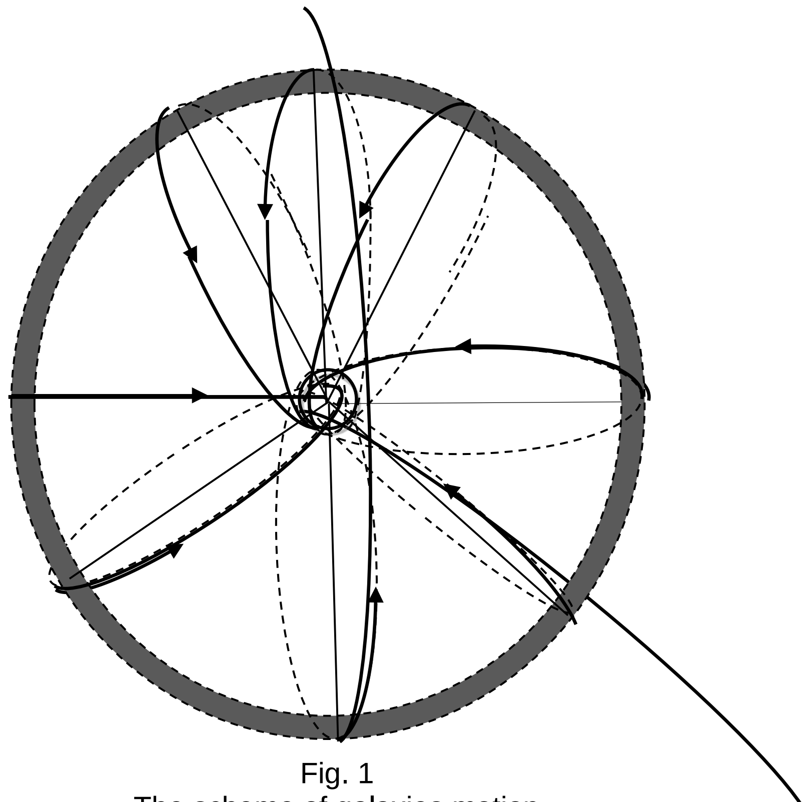

Fig. 1
The scheme of galaxies motion
within the Universe

According to the accepted hypotheses on the galaxies motion, there is a core in the center of the Universe, and each galaxy moves around it in a highly elongated quasi-elliptical orbit, and at the nearest point to the core the galaxy velocity is maximal and close to the light velocity *c*.

In fact, this formulation is reminiscent of Kepler's law on the motion of planets: planets move along ellipses, in one of the focal points of which the Sun is located.

In 1679, I. Newton showed that the orbit is determined by the velocity of the body at the trajectory point closest to the center of the force and can have the shape of:

- circle, if the body velocity is equal to the circular velocity (CV) v_{cir}, at which the body moves uniformly circumferentially around the center of force;
- ellipse, if the velocity value falls within the interval from the circular velocity to the parabolic velocity (PV) v_p – escape velocity, at which the body moves away from the center of force along a parabolic trajectory;
- parabolas, if the velocity is equal to the PV, i.e. $\sqrt{2}\, v_{cir}$;
- hyperbolas, if the velocity is greater than the PV.

Let us formulate the problem: determine the parameters of this trajectory and by them - the main parameters of the Universe (size, mass, orbit circularization period of the galaxy, etc.).

The system motion can be described using the equations of the General Relativity Theory.

Since at some point the trajectories of galaxy move with near-light velocities, which means that the unlimited growth of the body kinetic energy is accompanied by an unlimited growth of its mass, then analyzing the galaxy motion in the Universe, it is necessary to use the gravitational mass when calculating the gravity force acting on the galaxy, and in calculating the acceleration - the relativistic mass[12]:

$$m = \frac{m_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}}, \tag{8}$$

where, m_0 is a rest mass.

According to the hypothesis of the galaxies motion, we can proceed to a hypothetical circular orbit of radius R, along which the galaxy moves at a circular velocity:

$$v_{cir} = \frac{v_p}{\sqrt{2}} \approx \frac{c}{\sqrt{2}}. \tag{9}$$

Condition for this motion stability is the equality of centrifugal and centripetal forces acting on it:

$$F_{cf} = F_{cp}. \tag{10}$$

Here, the centripetal force is the gravity force:

$$F_{gr} = G\frac{m_{gr}M_c}{R^2}, \tag{11}$$

where, $m_{gr} = m_0$ is a rest mass of the galaxy, M_c – a core mass, G = 6,67·10^{-11} m^3/(kg·s^2) – a gravitational constant.

Centrifugal force is represented as:

$$F_{cf} = \frac{m_{in}v_{cr}^2}{R}, \tag{12}$$

where, $m_{in} = \frac{m_0}{\sqrt{1-\beta^2}} = m_0\sqrt{2}$ is an inertial mass, $v_{cr} = \frac{c}{\sqrt{2}}$, $\beta = \frac{v_{cr}}{c} = \frac{1}{\sqrt{2}}$.

Substituting these expressions, we obtain the equation for the forces:

$$G\frac{m_0M_c}{R^2} = \frac{m_0c^2\sqrt{2}}{2R} \text{ or } G\frac{M_c}{R} = \frac{c^2}{\sqrt{2}}. \tag{13}$$

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[12] M.Yu. Dokukin, Concepts of modern Natural Science (Moscow: Publishing house of the MSTU named after N.E. Bauman, 2010)

Now we can confidently take the path of finding some numerical characteristics of the Universe, for example, radius of the circular orbit for the galaxy motion, and radius of the core of the Universe and its mass.

You should start with the selection of the galaxy, which is to be rotated within the dynamic and stationary atmosphere of the Universe. More than 60 % of galaxies in our environment are spiral. Including our Milky Way galaxy. Therefore, consider the motion of a large spiral galaxy around the core. At the extreme end of a trajectory close to the core (point *B* in Fig. 2), we have the equality: $F_{cf} = F_{gr}$.

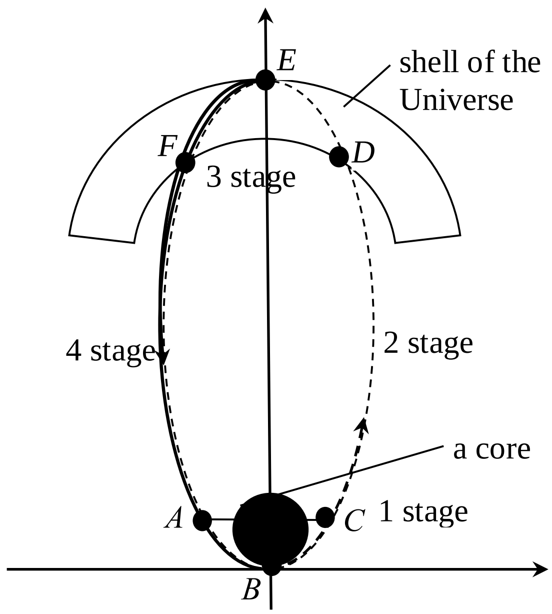

Fig. 2
Stages of the galaxy motion

Since the galaxy is large, this equilibrium is violated in it, and it begins to deform, stretching in the direction of motion, while its structural elements are destroyed.

However, the galaxy continues to accelerate, as it approaches the core, i.e. its inertial mass increases and its longitudinal size is reduced, i.e. the galaxy takes the shape of an ellipsoid, which major axis is oriented along a line connecting the center of the galaxy mass with the core center. The question is pertinent: is the impulse of rotational motion obtained by the galaxy, when the core is traversed, preserved in the future? Apparently, yes, unless the galaxy is experiencing a catastrophe!? A catastrophe, for example, a collision with another galaxy, can cause significant changes in its mass or shape. Thus, passing a trajectory around the core, the galaxies perform rotational motion, which is observed by astronomers.

When entering the ascending branch of the orbit, the spiral shape of the galaxy is gradually restored. We will assume that the problem of estimating the time for which the galaxy rotates near the core reduces to determining the initial period of rotation for a large spiral galaxy.

Data on the rotation velocities of matter near the centers of galaxies usually are absent. At small distances from the center (*r*) the velocity dependences are known only for two spiral galaxies: our Milky Way and the nearest M31. For example, for the galaxy M31 at a distance *r* = 6 kpc and at a circular velocity, taken from the range of 220-250 km/s, the angular velocity of rotation is:

$$\Omega = \frac{v_{rot}(r)}{r} = \frac{240\ \text{km/s}}{6\ \text{kpc}} = 12{,}9 \cdot 10^{-16}\ \text{s}^{-1}\,. \tag{14}$$

Then the circulation period will be:

$$T = \frac{2\pi}{\Omega} = \frac{6{,}28\ \text{rad}}{12{,}9 \cdot 10^{-16}\ \text{rad/s}} = 4{,}87 \cdot 10^{15}\ \text{s} \approx 154 \cdot 10^{6}\ \text{years}\,. \tag{15}$$

It is also necessary to determine the time at which the galaxy will round the core. The figure shows that bar axis of the galaxy when bending is rotated by γ = π rad. Knowing the orbital period of galaxy (bar) around its own axis, we can determine the time t:

$$t = \frac{T}{2\pi}\gamma = \frac{T}{2} = 154 \cdot 10^{6} / 2 = 77 \cdot 10^{6}\ \text{years}\,. \tag{16}$$

Let's calculate the core radius:

$$R = \frac{c \cdot t}{4{,}6} = \frac{3 \cdot 10^{8}\ \text{m/s} \cdot 77 \cdot 10^{6}\ \text{years}}{4{,}6} \approx 15{,}8 \cdot 10^{22}\ \text{m}\,. \tag{17}$$

Now, when we know the value of *R*, the core mass can be determined:

$$M_c = \frac{c^2}{G\sqrt{2}} R = \frac{\left(3 \cdot 10^{8}\ \text{m/s}\right)^2 \cdot 15{,}8 \cdot 10^{22}\ \text{m}}{1{,}41 \cdot 6{,}67 \cdot 10^{-11}\ \text{m}^3 / (\text{kg} \times \text{s}^2)} \approx 1{,}52 \cdot 10^{50}\ \text{kg}\,. \tag{18}$$

This simple expression reflects the most important interrelationships of this world - it shows that the ratio of the core mass of the Universe to its radius is a new physical constant:

$$\frac{M_c}{R} = \frac{c^2}{G\sqrt{2}}\,. \tag{19}$$

The proposed new cosmological theory can be defined as the *Theory of the steady-state and dynamic Universe*. Moreover, in contrast to the BBT, the recognition of the Universe steady-state allows us to maintain the basic materialist provision about the indestructibility of matter, and, therefore, to fully use the fundamental laws of conservation of mass, energy, momentum, and charge-without attracting "otherworldly forces" in the arguments. When dealing with the stationary Universe, we operate only with material objects and all the time we maintain the field of action of the laws of physics. It should be recalled that for a long time A. Einstein was an adherent of stationarity of the Universe and only the arguments of A. Fridman and the successes of observational astronomy inclined him towards the expanding reality.

It is very important to note that the stationarity of the Universe does not at all mean its static nature. The universe is in constant motion, and this movement is of an established nature. All the transient processes, if they took place, long ago ended, and now the universe is in a state of stable dynamic equilibrium. This does not exclude the possibility of changes in it of a local scale. So, the stationary cosmological theory, first proposed by I. Newton, has the right to life, of course, with modern dynamic additions.

The observed inhomogeneities in the distribution of the universal matter are consistent, if one remembers that the stationarity of the Universe is dynamic. In nature, there are many physical systems (both micro- and macro-scales), the stationarity of which is provided by different force interactions. Here, we can mention the atom, the molecule, the crystal, the star, and the solar system. The closed Universe should be included in the same type of systems. The thesis of closed condition lies at the basis of the proposed model of the Universe.

Now back to Fig. 2 and consider in more detail the individual segments (stages) of a certain galaxy motion along a quasi-elliptic trajectory. Here, the sections are also called stages - and not by chance. The point is that at these stages there are not only kinematic changes in the characteristics of motion, but also - the transformation of the galactic matter. The hypothesis of the matter transformation is consonant with the main hypothesis of galaxies motion and complements the latter.

So, in the general galaxy trajectory we can distinguish the following sections:

- short section *ABC*, where the galaxy velocity reaches its maximum $u_{ABC} \leq c$, and the matter is in a purely plasma state; due to that this section is called a flaming stage;
- extended section *CD*, where the velocity drops to a level of ~ 7500 km/s, and the matter dissociated to the level of corpuscles and, therefore, is not observable in the optical range; this section will be considered as a corpuscular stage;
- *DEF* section of the orbit (the velocity is minimum here ~ 7500 km/s and less); Here the condensation of the matter of the galaxy occurs and, therefore, this stage is called the condensate stage;
- Closing section *FA* of the orbit, where the velocity increases monotonically to sublight, and the galactic matter is in the classical stellar state; this stage is called the stellar stage.

Let's give some more detailed characteristics to the listed stages.

The duration of the plasma stage is only 77 million years, but during this period a number of important processes and substance transformations take place in the galaxy. First of all, at this stage there is a mechanical destruction of the structure of the galaxy by tidal forces and relativistic effects. In addition, as we approach the nucleus of the Universe, the galaxy is subjected to intense bombardment by high-energy protons, α-particles and γ-quanta, which emits the nucleus itself. Compression and irradiation lead to the heating and ionization of the galactic substance, and the latter turns into a fairly equilibrium plasma with a temperature not exceeding 10 MK, consisting of ions of different types and elementary particles. In this form, the galaxy falls within the range of the shell of the nucleus, where the probability of collision of a given galaxy with other galaxies, whose substance is also in the plasma state, increases sharply. In the area of the pericore, dozens of galaxies can collide at once, trajectories of which are in different planes, and it leads to a significant additional heating of their matter, and its transformation into high-temperature plasma. It is possible to estimate the realizable temperature of a system of particles with mass *t* participating in a chaotic motion from the basic equation of the kinetic theory of gases:

$$\frac{3}{2}kT = \frac{m \cdot \upsilon^2}{2}, \quad (20)$$

where k = 1,38·10^{-23} J/K is the Boltzmann's constant, υ – an average velocity of chaotic particle motion. In this case, let us consider, for example, a proton, and it is necessary to substitute in formula (20) its inert relativistic mass:

$$m = m_{in} = \frac{m_p}{\sqrt{1-\left(\frac{\upsilon_g}{c}\right)^2}} \approx 24m_p, \quad (21)$$

where, m_p = 1,67·10^{-27} kg is a rest mass of proton, υ_g = 0,9992c – orbital velocity of the galaxy near the pericore. It is clear that as the average velocity of chaotic particle motion, one should also take the orbital velocity of the galaxy, with which they approach the collision point, i.e. $\upsilon = \upsilon_g$ = 0,9992c. Thus, we obtain:

$$T = \frac{1}{3}\frac{m_{in} \cdot \upsilon^2}{k} = \frac{24 \cdot 1,67 \cdot 10^{-27}\,\text{kg} \cdot \left(0,9992 \cdot 2,9999 \cdot 10^8\,\text{m/s}\right)^2}{3 \cdot 1,38 \cdot 10^{-23}\,\text{J/K}} = 8,7 \cdot 10^{13}\,\text{K}. \quad (22)$$

At such high temperatures, the matter is destroyed to the level of stable elementary particles, i.e. to protons, electrons, neutrinos and their antiparticles. This complex mixture of particles and corresponding antiparticles tends to a greater extent to annihilation with the emission of high-energy photons, but the reverse reactions of the birth of particle-antiparticle pairs are not excluded. Violation of the unstable equilibrium between direct and reverse reactions occurs under the influence of a very strong gravitational field of the core, which causes precession of the spin moments of elementary particles and, ultimately, leads to a dominant state (preferred from the point of view of total energy minimization), when the spin directions of particles coincide with the direction of the external field.

Particles with a co-directional spin accumulate much more than particles with oppositely directed spin (according to some estimates, their ratio corresponds to the ratio of 10^9: 1); the first group of particles determines the dominant matter, and the second group - "insignificant" antimatter, and therefore, as a whole, the baryon asymmetry of the Universe is formed. In addition, very high temperatures and large particle densities in the pericore area do not allow the resulting radiation to leave the core shells - this portion of the galaxy trajectory is opaque to radiation. Only at the exit from the shell in the direction of galaxy motion is it possible to form a narrow γ-ray, which explains well the rare γ-flares, which are observed nowadays in the Universe. The second corpuscular stage of the galaxies motion is much longer than the first. Duration of the *CD* section (Fig. 2) is ~ 25 billion years. At this stage, the major plasma clots, which were formed at the first stage, move along the elliptical path in a decelerating gravitational field, gradually reducing its velocity along with the sub-light to the level of 7500 km/s; the plasma temperature also decreases.

The plasma in the clot is still completely ionized and electrically neutral. Interaction of bunches is determined only by gravity forces, and it manifests itself in the orbital and rotational motions of the galaxy. But within the clots, collective particle motions are maintained, due to the Coulomb interaction, and lead to the formation of plasma oscillations with a typical frequency:

$$f_{pl} = \frac{\omega_{pl}}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{e^2 \cdot n_e}{\varepsilon_0 \cdot m_e}} = \frac{1}{2\pi}\sqrt{\frac{\left(1,6\cdot 10^{-19}\,\mathrm{K}\right)^2 \cdot 0,85\cdot 10^{21}\,\mathrm{m}^{-3}}{8,85\cdot 10^{-12}\,\mathrm{F/m}\cdot 9,1\cdot 10^{-31}\,\mathrm{kg}}} = 2,62\cdot 10^{11}\,\mathrm{Hz}, \tag{23}$$

where, e and m_e – charge and mass of an electron, n_e – electron concentration. With this frequency, the plasma radiates at this stage.

As the plasma cools, the process of neutralizing hydrogen ions begins, and at this stage the radiation frequency rises to $10^{13} - 10^{14}$ Hz. It is this radiation, which is strongly shifted to the red region of the spectrum, that we observe on Earth and perceive it as a microwave radiation with an equivalent temperature of ≤ 3 K, since this galaxy is very quickly removed in the opposite direction from us (our galaxy is at the final stage of its trajectory, approaching the core of the Universe).

At the third condensate stage of the galaxy motion (*DEF* section of the trajectory), being in the outer shell of the Universe (apocore of the orbit), a sharp turn and re-direction to the core performs for ~ 3 billion years.

Being in a shell together with other galaxies and interacting with them gravitationally, the considered galaxy begins to form its protostellar matter due to the final neutralization of hydrogen and helium atoms and its subsequent condensation into clouds of stellar gas. The formed gas clouds of one galaxy actively interact with clouds of other galaxies, and as a result, more massive clouds entice smaller ones and form gravitationally bound systems. It is not difficult to guess that these are the future multiple stars.

Duration of the fourth stellar stage (*FA* section of the trajectory) is almost equal to the duration of the second stage (~ 25 billion years). At this stage, the galaxy moves along a large arc of the quasi-ellipse to the core of the Universe; its velocity is slow at first, and then it grows faster and at the end of the stage it approaches the light velocity.

The matter of the galaxy here is in a stellar state, when the star and planetary systems are developed. In certain parts of the galaxy, the conditions may arise under which the evolution of matter will reach its known, higher form – the biological life.

Near the core of the Universe, the stellar stage of the galaxy ends, and its new cycle begins. Having completed the consideration of the stellar cycle with the example of an individual galaxy, we can draw a conclusion about similar quasielliptic trajectories for all other galaxies, and, consequently, on the finiteness and stationarity of the Universe. The Universe is formed by galaxies moving in different planes and, as a whole, forms a giant sphere, constant in its dimensions. But the stationarity of the Universe, by no means, excludes its dynamism. The latter manifests itself in the constant motion of its structural elements, due to a variety of force interactions (in particular, intensive gravitational interactions).

Conclusion

Thus, in the course of this brief description, it was shown that the main observational facts (the "dispersal" of galaxies, the outcome of galaxy trajectories from one "point" of space; the ratio of hydrogen and helium formed in the Universe; isotropic background microwave radiation with a temperature of 3 K) can be easily and consistently (physically reasonably) explained from the standpoint of a new stationary and dynamic model of the Universe. At the same time, it was not necessary to fast the Universe on the infinity and to introduce the unreal objects in the likeness of a singular state, as it is done in the BBT. Even such exotic and diverse characteristics of space objects as "black holes"[13] can naturally be described by a new model[14].

It is very important that the new theory does not require imposing any restrictions on the fundamental conservation laws, and the unlimited growth of thermodynamic entropy for closed systems can be suspended in the very strong gravitational field of the Universe. This field keeps within the scope of the Universe not only the matter, but also all kinds of radiations.

The process of converting the energy of the scattered radiation into an active ("real") form occurs as follows. When the galaxy moves along the orbit from the core to the peripheral shell, it is retarded by the gravitational field, and its kinetic energy goes into the potential energy of the field. The same happens with any particle of matter or a separate quantum of radiation. Only if the particles of matter are retained during inhibition, then the quanta decrease in frequency, they "turn red" and, finally, disappear. At the same time, their energy is completely transformed into the energy of gravity: the potential of each point in the Universe field increases. As a result, the potential energy of all bodies moving in this field increases, i.e. galaxies and individual particles. When all of them are close to the core, this will manifest themselves in increasing their kinetic energy. It can be said that the unorganized energy of radiation quanta has passed through the gravitational field of the Universe into the kinetic energy of the organized mechanical motion of bodies and particles around the core, and this process is accompanied by a decrease in entropy.

Thus, the decrease in entropy caused by the deceleration of radiation quanta and the increase in entropy caused by intense radiation from galaxies are continuous and counterbalance each other. This explains the non-increase in the entropy of the Universe as a whole. The constancy of entropy is caused by the cycle of matter (matter and radiation), which is due to the cyclic motion of galaxies along the closed orbits.

Due to the steady-state, the Universe can exist in a very large but limited extend - forever, constantly updated during the transformation of galaxies.

The materials of this article may be useful to physicists and astrophysicists in both studying the cosmological issue under consideration based on the historical aspect, and explaining the latest results in the study of the Universe.

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