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Explanation of the observed dynamics of matter in the Universe in the framework of classical gravity

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Abstract

The paper shows the prematurity of introduction of a new category of "dark energy" into the theory. The observed dynamics of matter in the Universe can be explained within the framework of classical gravity, if the assumption about the existence of a primary plasma cloud at a certain evolutionary stage of the Universe is considered false. Comments are given on why this step is correct. The expansion of the Universe is not associated with the pressure that existed at any stage of its development; therefore, under the influence of gravitational forces, it must turn into compression, despite the observed accelerated motion of galaxies in the direction away from the terrestrial observer. In general, the Universe is not cooling down, but heating up. The brief review of astronomical observations, presented in this paper, confirms the need to develop a new view of cosmology.

***Keywords*:** gravitation; cosmology; cosmological redshift; expansion of the Universe; evolution of the Universe

1. Introduction

In 1905, Einstein, while developing his special theory of relativity, introduced an invariant quantity for Lorentz transformations: rest mass. The expression $E_0 = m_0c^2$ means the equivalence of the rest mass m_0 to the rest energy E_0 precise to the factor c^2, where c is the speed of light. This expression entered physics in the form of a statement that mass is a certain form of energy. To what extent this interpretation is correct will be discussed below. But the fact that the presented formula determines the internal energy of elementary particles was brilliantly proved by the physics of elementary particles that developed soon after the appearance of relativistic physics.

In 1915, Einstein formulated the general theory of relativity (GR), which states that gravity arises due to the contortion of space-time caused by matter. Trying to deepen the understanding of the new category "space-time" that appeared in the theory of relativity, in 1922-24 Friedmann created a non-stationary model of the Universe, modelled by a cloud of matter evenly distributed in space. The substance of the cloud had the property of continuity, was endowed with internal pressure which contributed to the expansion of this cloud, and curved space-time, imitating gravity, which tends to slow the expansion. The dynamics of galaxies discovered in 1929 by Hubble, associated with scattering of observable matter in the Universe, confirmed Friedman's calculations and created the foundation for a variant of general relativity, which indicated the expansion of the Universe. Moreover, at that time it was not about the expansion of space-time, but about the expansion of matter in space over time. Space-time, depending on the density of the substance in it, could only bend and influence the dynamics of the substance.

Gamow was the founder of the base of modern cosmology. In 1928, he took up the theory of alpha decay, then delved into nuclear physics, and in the 30s – early 40s of the XX century became interested in the theory of stellar evolution. In his scientific activities, he achieved world-class success and in 1947 proposed the hypothesis of a hot universe. Focusing on the abundance of chemical elements in outer space, on the theory of nucleosynthesis developed with his participation, and also relying on the position of the equivalence of energy and matter and the position on the expansion of the Universe, he suggested that our Universe must have been born by converting energy into mass. He did not present any detailed hypothesis on how this could happen. But the tendency in the direction of the evolution of the Universe was specifically determined by him: the Universe had to cool down, and at a certain stage of its evolution a dense, adiabatically expanding plasma in outer space had to appear. He also predicted the existence of background cosmic radiation left after the recombination of the primary plasma of the Universe.

Discovered in 1965 by Penzias and Wilson, the cosmic microwave background (CMB) served as the basis for the recognition of the hot Universe hypothesis and gave impetus to the development of cosmological theories based on the hot Universe model. Initially, the theory of the Big Bang was created and subsequently developed.

However, serious problems began to arise in the Big Bang model, based on the model of the hot Universe.

If we trace the reverse chronology of the evolution of the expanding Universe, then it will inevitably begin to contract into a singular point. The inevitability of the beginning of the evolution of our Universe from a singular point was mathematically proven by Hawking. The problem of the singular point is related to its lack of physical meaning. Therefore, when approaching a singular point, it is necessary to come up with some kind of metamorphosis, which is not only difficult enough to do, but also hardly ever possible to verify in experience.

In addition, mental "folding" of the Universe in the reverse chronology to a singular point using the Hubble constant makes it impossible to reach the Planck epoch: at the Planck moment of time, approximately equal to 10^{-43} seconds, the volume of the Universe is about 10^{90} times the Planck volume. And this means that the parts of the Universe at the dawn of its evolution were not causally interconnected (they followed their own evolution). At the same time, the electromagnetic radiation released after the recombination of the primary plasma, which was once in equilibrium with it (relict radiation, which is the CMB), is so isotropic that it obliges the Universe to be causally related at the Planck moment of time.

Another problem is related to the fact that astronomical observations unambiguously indicate the presence of gravitational mass in outer space, which bends space-time, which cannot be recorded at any range of electromagnetic radiation. Moreover, the amount of unobservable matter exceeds the amount of visible matter. However, the theory of primordial nucleosynthesis is not compatible with the abundance of deuterium observed in outer space, if we assume the complementation of unobservable matter with ordinary matter. For this reason, it was necessary to introduce a new category "dark matter" into the theory, removing unobservable matter from the category of "baryonic matter".

However, the problems do not end there. The rate of expansion of matter in outer space must slow due to its gravitational field (curvature of space-time). Moreover, depending on the specific initial conditions of expansion, it can theoretically even turn into contraction. However, the astronomical observations carried out unexpectedly revealed that the farther away from us is the substance that once made up the primary plasma, the faster it is moving away. From this it was concluded that the Universe is expanding with acceleration. Only anti-gravity can create acceleration. For this reason, it was necessary to introduce a new category of "dark energy" into the theory, which "pushes away" the substance.

Since a more rigorous theory of gravity, apart from Einstein's equations, has not yet been created, dark energy had to be interpreted by the Einstein's cosmological constant, and the expansion of the Universe was not taken as the expansion of matter in space over time, but the expansion of space-time, as if creating, including false anti-forces.

It is useful to note, without discussion at this point, that, due to the current situation in physics, the cosmological constant is already associated not with space-time, but with a physical vacuum. At the same time, the vacuum is by no means the equivalent of space-time. It is also not identified as absolute emptiness. Some form of energy is hidden within it. In fact, the vacuum is identified with something material, but not containing corpuscles. To get more information about the problems of physical interpretation of the essence of vacuum, see Belyaev [1]. The expanding space-time affects the vacuum, initiating the birth of matter and determining the evolution of the Universe (the vacuum itself, as it were, exists outside of space and time).

The idea of expanding space-time was picked up by the theory of cosmological inflation, with the help of which it was possible to explain the isotropy of the relic radiation and even the plane of space-time of our Universe. As a result, after a comprehensive solution of all the problems described above, the "Lambda-CDM" (Lambda cold dark matter) model was created, which is a generally recognized cosmological model today. This model suggests the appearance of a primary plasma at a certain stage in the evolution of the Universe, i.e. is based, as one would expect from the presented historical excursion, on the model of a hot Universe.

These are the historical facts. However, in the recent work of Belyaev [2], it was argued that any description of the evolution of our Universe based on a model of a hot Universe cannot be a true scientific theory and will forever remain in the rank of "hypothesis". This work lists 7 fundamental unsolvable problems that the incorrect model of the hot Universe has created by its existence. To "patch" two of them, it was necessary to introduce new categories "dark matter" and "dark energy" into the theory of physics in order to explain the emerging problems in cosmology. It was argued that this introduction was premature and unreasonable. But the detailed analysis in the mentioned work was carried out only for the category of "dark matter".

This work expands the topic of incorrectness of the model of the hot Universe and considers the possibility of interpreting the accelerated expansion of the Universe without a new category of "dark energy". If any options for explaining the observed physical phenomena appear within the framework of existing knowledge, albeit still crude and unprocessed, but not contradicting the principles of already existing theoretical provisions, then it is definitely unacceptable to continue to develop and substantiate the previously introduced new physical categories and essences.

It is useful to note that the illegitimate introduction of new categories into the theory hinders the development of science. Of course, over time, more and more new observations will accumulate that do not agree with modern cosmological models, and the rejection of new categories will inevitably occur. But until this happens, the vector of efforts to organize observational and theoretical work will not have an optimal direction.

The reason for introducing a new category of "dark matter" was the above-mentioned problem of the discrepancy between the observed abundance of deuterium and the amount of baryonic matter that appeared at the birth of the Universe, if unobservable matter is included in its composition. There are no other direct indications of the need to introduce a new unknown type of gravitational mass, which is not an inertial mass in this case (for more details, see [2]) into the theory. This indicates that such a step immediately subverts the general theory of relativity (the equivalence principle is not observed). However, at this point in time, that is not the focus of the discussion. The point is that astronomical observations show more and more ordinary baryonic matter in space, which could not be detected before. For example, in the work of Graaff *et al.* [3] it was revealed that filaments of the large-scale structure of the Universe mainly consist of baryonic matter, while Delhaize *et al.* [4] suggest that most of the giant radio galaxies with small cosmological redshifts (i.e. located in a zone not belonging to the era of mass ignition of radio sources) have not yet been discovered due to limitations in technical capabilities (in other words, there is a large population of "hidden" giant radio galaxies). More and more such information relating to the enormous density of black holes (the section below devoted to a review of the literature will give links that are directly related to this topic) is being accumulated. However, the calculation of the total amount of baryonic matter, if we do not include the invisible halos of galaxies, is unlikely to raise the crucial issue today. Nevertheless, without any doubt, the complementation of unobservable matter with dark matter will eventually become incapable of hiding the problem of the primary nucleosynthesis stage for cosmological models based on the model of a hot Universe.

2. General discussion of the current situation

2.1. Historical reasons leading to the flawed cosmological model

First, it is useful to note that physics, and later all natural sciences, including cosmology, are substantiated in detail by mathematics, but the physical meaning of the developed theories is not analysed separately, only grotesquely, to give additional weight to the mathematical calculations produced. In other words, there is an obvious tendency to abstract physics and natural sciences.

For example, the problem of a singular point in cosmology is associated not only with its lack of physical meaning, but also with its fundamental unobservability by an external observer, for whom time stops in the vicinity of such a point. Due to this interpretations of general relativity began to appear, speaking not about the expansion in space over time of the substance that constitutes the Universe, but about the expansion of space-time itself within the Universe. Then, for the inner observer, the singularity seems to disappear. He exists within the world that is expanding. Therefore, for him there is no specific spatial point of the birthplace of the Universe. The entire expanding world was, is and will be.

The possibility of such theoretical interpretation of the expansion of the Universe is connected with the fact that the physical concept of "gravity", which is fundamental for cosmology, is described not by physical criteria, but by geometry. This means that general theory of relativity reveals not the physical essence of gravity, but only the way of its manifestation through "fictitious" forces. This topic is very serious, requires a separate study and will be considered by the author in the next work. However, the basic reason for abstracting cosmology is already becoming clear.

The final preponderance in favour of the picture of the birth of a closed world, with a complete prohibition of knowledge about what is happening outside one's own Universe (the hypothesis of a plurality of worlds) occurred with the introduction of the theory of cosmological inflation. The outer universes are fundamentally unknowable (the presence of connections between them is hypothetical and untestable). Cosmological inflation implies an exponential increase in the rate of expansion of space-time, respectively, and of the Universe, at the earliest stage of evolution of the Universe. At that time, no matter was present. However, no one knows what space-time is without matter and without hypothetical observers with their own frames of reference that cannot be attached to anything, this is a purely mathematical abstraction. Due to such an expansion by many orders of magnitude, the Universe became flat (possible inhomogeneities of something abstract, called a vacuum, were greatly stretched).

At the same time, the theory of cosmological inflation itself, as explained in the above-mentioned work [2], has no physical meaning at all, even grotesquely. Moreover, even the most general analysis in physical terms presented in the underlying work (see [2]) already demonstrates total inconsistency of any inflationary models. The topic of incorrectness of the inflationary model in cosmology is also discussed in more detail in Belyaev [5].

The emergence of an erroneous cosmological theory was most likely predetermined by the vector of inertia of thinking, formed by the following historical factors:

1. The emergence of the general theory of relativity, which only explains the principle of gravity, but does not describe the scheme of physical realization of gravitational interactions and the reasons for the formation of force fields, which does not track the dynamics of the causal factors being realized.

2. The emergence of Friedmann's model of the non-stationary Universe, which made one think about the average density of matter in the Universe, and not about the reasons for the appearance and the physical nature of the "pressure" parameter at the base of the model.

3. Abstraction of physics, which is increasingly turning not into physics described by mathematics, but into mathematics described by physics.

4. Extension of the Gauss theorem not only to the media of matter, but also to physical fields, including the gravitational field, which does not have a clear physical interpretation, as a result of which a stable erroneous prejudice arose that with a spherically symmetric mass distribution, the peripheral elements of matter of the system do not gravitationally affect the internal ones (the prejudice is about the impossibility of the existence of electric and gravitational spherical capacitors).

The first and third factors will be considered by the author in a future work, the second factor has already been discussed in the above-mentioned work [1] and will be indirectly touched upon below, and the problems with the Gauss theorem in the theory of gravity according to item 4 have already been discussed in Belyaev's works [6,7].

Due to the fact that the position put forward in clause 3 evokes angry protests among theorists, and the whole practice of the development of science, including the review of scientific works, requires mathematics to be brought to the foreground, and not to be relegated to a modest position of systematization of experimental data only, and since the reference to the expansion of this question to something more in the future sounds rather unreasonable, a clear, albeit very brief, example of an abstract approach in cosmology is provided below.

The model of the hot Universe, in whatever theoretical interpretation it is being developed, implies the birth of matter in the Universe from some kind of initial energy. But what kind of energy and in what way could it be spatially localized in a point or in a spatial zone, even before the appearance of matter and, in particular, before the appearance of electromagnetic radiation and neutrinos, is impossible to even guess (the very meaning of the word is lost "energy"), and the possibility of converting this abstract energy into matter cannot be verified in experiment in principle. In addition, energy is not a substance, therefore, due to its physical nature, it cannot be transformed into a substance. It can only contribute to the process of transformation and the emergence of matter from something material. We know from experience that matter can be formed from a vacuum (the creation of particle-antiparticle pairs). But today there is no understanding about the physical essence of vacuum, there is only a variant of its mathematical description.

As a result, the degree of abstraction in cosmology has reached its apogee. Even narrow specialists do not know what the Universe is: on the one hand, it is energy, and only energy, especially when it comes to the expansion of the Universe at its initial stages of formation (instinctively implying the materiality of energy); on the other hand, at first the non-material space-time was born, and only after that, the material Universe appeared in the emerging space-time. At the same time, the reason and nature of the expansion of space-time cannot be explained in principle. An explanation from a physics point of view of such a non-physical phenomenon is fundamentally impossible. If another dimension of the world around us is considered as a source of energy that induces the expansion of space-time and causes physical effects in the material Universe, then theoretical constructions, indeed, look very interesting and intriguing, but the degree of abstraction from this does not decrease, but only is raised exponentially. Such explanations are useful for recognizing the depth and versatility of what is happening around us, but the truth of judgments at the same time recedes into infinity.

The fact that cosmology has made a tilt towards abstract judgments can be clearly demonstrated by the following example. Recently, the authoritative journal "The Astrophysical Journal" published an article by Kyu-Hyun Chae *et al.* [8] with a statement that external gravitational fields affect the dynamics of a gravitationally bound system. But this work was devoted not to the study of tidal forces, but to the development of the assumptions of a new theory, as it were, a modified theory of Newtonian gravity (MOND). But in fact, the whole modification of Newtonian theory consists in direct mathematical adjustment of the calculated results in such a way that they correspond to the observed results. And such a theory would have long ago come to the fore, despite the lack of physical meaning, if it could find a universal mathematical tool for adaptation.

2.2. Proposed general approaches to solving the accelerated expansion of the Universe

But is it possible to look at the evolution of the Universe differently?

Let there be a system of discrete elements, gravitationally interacting with each other. According to the principle of superposition inherent to gravity and experimentally tested, an arbitrary element of the system is acted upon by the resultant force of gravity, which consists of individual interactions with each of the other elements of the system surrounding this element, which is directed to the centre of mass of the system. If, for example, the mass in the chosen physical system is distributed evenly, then the gravitational force of the greatest magnitude towards the centre of mass will always act on the peripheral elements when compared to the corresponding force for deeper located elements, since the total projection of the vectors of gravitational forces caused by each element of the system on the direction connecting the considered element with the centre of mass of the system will inevitably be maximal for peripheral elements. Therefore, it is quite obvious that such a gravitationally contracting system in the process of its compression will inevitably begin to condense most intensively from the periphery. And since the forces of gravity depend on the distance between objects and their masses, in a system gravitationally contracting from the periphery such elements will inevitably appear in its inner zone, their movement will change from the direction towards the centre of mass to the direction towards the compacted periphery. Moreover, such movement from the centre of mass will be accelerated. In this case, the system as a whole will not stop compressing. This is obvious and does not require special proof. The emerging situation was interpreted in more detail in the work of Belyaev [9].

Our Universe is expanding. But how is it expanding? Observations in any arbitrary spatial direction indicate movement away from the observer of all galaxies that can be observed, regardless of their distance. Moreover, it is useful to emphasize once again that it is the real movement of matter in space that is observed, even if not even in space, but in mathematically curved space-time. The expansion of space-time is only a valid version of the mathematical interpretation of observations; it does not reflect the physics of what is happening. There are no other observational facts indicating the expansion of the Universe. This fact unambiguously speaks only of the fact that once the Universe occupied a smaller spatial zone. However, it does not indicate anything else. If we had been able to assert with confidence that the peripheral regions of the Universe, i.e. the most "extreme" matter (the most distant from the center of mass) was also moving in the direction away from the observer, this would have meant the expansion of the Universe. But such a statement cannot be made. Observations do not testify to this, it is only assumed.

In the basic work [2], mentioned earlier, it was shown that even if we accept the Big Bang model as a true theory, then the terrestrial observer, who appeared as a result of the evolution of the matter of the primary plasma cloud, is unable to observe the electromagnetic radiation of that era (from the "horizon of visibility") and even later subsequent events of the early stages of the development of the Universe because the source of electromagnetic radiation still needs to get into those spatial zones from which the electromagnetic signal comes.

The theory of cosmological inflation, which eliminates the concept of "extreme" matter, does not solve this issue. If an adiabatically expanding primary plasma cloud represents the entire Universe, as if expanding from the inside, and local evolutionary events occur in this cloud, which are of the same type and synchronous in time (as if occurring simultaneously in a single world time: usually this is not stated, but only implied), then, as a result of, for example, the process of simultaneous recombination of the equilibrium primary plasma, the released rays will move towards the terrestrial observer from the spherical "surface of the last scattering". But, firstly, as already mentioned above, the theory of inflation itself is not only completely devoid of physical meaning, but also generates fundamental contradictions, i.e. is not a true theory. And, secondly, the observed microwave background cannot consist of rays originating from the surface of the last scattering. This is not only because the processes of radiation release during recombination and the recombination itself are not instantaneous and must occur, by their physical nature, in a certain temperature range, i.e. the released photons cannot be characterized by a well-defined temperature of the Planck spectrum; not only because the observed Planck spectrum does not have emission and absorption lines, which is impossible for the "last scattering surface" version; not only because the rays of gamma-ray bursts remain gamma rays, although, like the rays of the released photon gas, they come to the terrestrial observer from the distant depths of space; not only because the homogeneous X-ray background, also coming from deep space, requires explanation as well; but primarily due to the fact that the expanding space-time is cannot "cool" the released photons, preserving the Planck spectrum with simultaneous observance of Wien's displacement law (see [2]). Moreover, as explained in Belyaev [10], the microwave background cannot confirm the recombination of the primary plasma, which occurred at some point in the past, no matter what methods are used to explain it's cooling, i.e. it cannot be a relict background. Consequently, the cosmic microwave background cannot serve as an argument in favour of the hot Universe model. Its existence, on the contrary, subverts the assumption about the stage of the primary equilibrium plasma in the evolution of the Universe.

Thus, it is impossible to observe the first stages of the evolution of the Universe, including those associated with the formation of the first generation stars. And not because of insufficient technical equipment, but fundamentally (the first stages of the evolution of the Universe have gone down in history forever, they are unobservable, see [2]). Moreover, the observations of quasars are not facts of the motion of the substance most distant from the terrestrial observer (see [5]). If the rays from the first stars (the first compact sources in the evolution of the Universe) were suddenly accessible to the terrestrial observer, they would not have such high cosmological redshifts. Accordingly, the redshifts of quasars do not indicate the ongoing expansion of the Universe.

If we had to consider a previously unknown version of the process of gravitational compression with simultaneous cooling due to heat losses with radiation, in order to explain the complementation of the hidden mass with baryonic matter (see [2], as well as the work of Belyaev [11]), then to explain the category of "dark energy" it is sufficient to carry out an analysis within the framework of the existing classical concepts of gravity.

The fact that the internal elements of an initially expanding gravitational system can accelerate from the centre of mass of the system in the process of free gravitational interaction, regardless of whether the forces of gravity turned the expansion of the system into compression from the periphery or had not yet had time to do so, was not considered before, this effect was not known. At the same time, it would seem that it is so trivial and indisputable that the discovery of the accelerated dispersal of matter in the Universe should inevitably lead to its formulation in the assumption that the peripheral matter of the Universe is somehow related to the observed microwave and X-ray backgrounds. This, however, did not happen. Moreover, an unusual step for science was taken to introduce a new essence into the theory. And such a development is associated with the style of thinking, inclined to abstraction, that developed in the natural sciences in the 20th century.

3. Consideration of the accelerated expansion of the Universe within the framework of classical gravity

3.1 Possible causes of the expansion of the Universe

From the modern point of view, the expansion of the Universe occurs due to pressure. But the pressure of what? In physics, the term "pressure" was introduced as a thermodynamic indicator characterizing any systems, including mathematical ones, obeying statistical laws. If there is no substance, then pressure cannot exist in principle, because it is impossible to single out even a mathematical system (mathematics is not applicable for absolute emptiness), not to mention a physical system. Consequently, space-time cannot expand due to pressure. Even if it can, it is first necessary to explain what exactly creates the pressure. The accumulated knowledge is unable to cope with such a task; only the creation of an abstract theory can really help.

In a continuous physical environment, statistics usually appear (if continuity is maintained due to the interactions of attraction and repulsion of the elements of the system; at the same time, a physical system created according to arbitrary rules does not have to obey the laws of statistics). Therefore, the pressure inside the plasma cloud is quite normal. And since the cloud of primary plasma in the evolutionary chain of the Universe was not limited by the shell, the pressure of the cloud was very much able to do the work of expanding the cloud.

But when the cloud of primary plasma recombined, and the expanding gas began to break into many clouds, the pressure created by the formed clouds as single structural elements of the Universe disappeared completely. No mathematics is required to explain the vanishing of the pressure of the Universe. After all, there is no longer a statistical system that can be described by thermodynamic parameters (we are talking about the Universe as a structural unit). Therefore, from this stage in the evolution of the Universe, it is possible to talk only about the deceleration of its expansion, the rate of which was originally set by prehistory. If the speed of dispersal of the peripheral clouds was less than the second cosmic speed, then the expansion with time must turn into compression.

However, at this stage of the presentation of the material it has already become clear that the primary plasma cloud did not exist in the evolution of the Universe. Then how was the universe born? Within the framework of knowledge confirmed by experiments, the only one process of the emergence of matter is known: the creation of pairs of elementary particles from a vacuum. Moreover, astronomical observations indicate (Hubble's law) that the substance of the Universe was formed in a limited spatial zone. So far only assumptions can be made as to the cause of the initialization of the avalanche-like growth of the production of "particle-antiparticle" and how it developed. The general principles with which the process of the birth of the Universe was to be associated were considered in the work [1], mentioned above. At the moment, it is important that the process of the creation of matter is associated with the appearance of particles that do not collide with each other and diverge radially with relativistic velocities from the place of their birth. This means that *it is not pressure that is responsible for the expansion of the Universe*, but some unknown process of spatial ordering of the directions of the scattering of the emerging elementary particles. How the first stars were formed from these particles is described in the base article [2].

With the described approach to the question of the birth of the Universe, which is close to the physical phenomena observed in practice, one very characteristic feature appears: despite the relativistic velocities of the particles being produced, the initial temperature of matter in the Universe is close to absolute zero (pressure, respectively, also; see [2]). *The entire evolutionary chain of the expanding Universe is associated not with its cooling, but with heating.*

The amount of energy released at the birth of the Universe has a quite definite value, determined by the kinetic energies of the born elementary particles and their internal energies. *The laws of conservation of energy begin to work*: what is energy and where it came from is not very clear, but its total amount cannot change. The gravitational forces deterring the dispersal of particles perform compression work, which in the many-sided processes of energy conversion, in compliance with the rules for its conservation, mainly turns into heat, into the internal rest energy of heavy isotopes, into electromagnetic and gravitational radiation, neutrinos, chemical compounds, degenerate structures. Many of these processes are not as obvious from an energy point of view as they might seem at first glance, and are related to fundamental issues. But this is a topic for a separate analysis. Here it is only useful to note that the total amount of energy that appeared along with the birth of the Universe is decreasing. The fact is that the material system that forms the Universe is in open space and is not isolated, therefore, the total amount of energy that appeared with the birth of the Universe is lost due to its escape from the Universe (with electromagnetic radiation, with neutrinos, with gravitational waves).

3.2. Trends in the occurrence of gravitational compression processes

At first glance, it may seem that for simplified initial conditions and approximations introduced into the solution algorithm, modelling the resulting spatial distribution of mass under gravitational compression of a closed physical system is an easy task. For example, it may seem easy to model the gas density distribution curve for any arbitrary moment in time, when the gas is in an undisturbed and quiet state in the form of a spherical cloud at the initial moment of time, and does not heat up during compression, maintaining absolutely elastic collisions of its elements with each other, regardless of on the degree of compression, and assuming that the gravitational field does not violate statistical laws. The apparent simplicity is due to the fact that the increase in pressure during compression will be determined only by the geometric factor (decrease in volume), but the state of the gas in each elementary volume will be described by the equation of state of an ideal gas.

However, this is only apparent simplicity. The main difficulty lies *in the lack of knowledge of the law of distribution of the gravitational field strength inside the cloud*. Even with a model simplification for the initial moment of time, when the gas density is uniformly distributed over the entire volume, the gravitational field strength will not increase linearly from the centre of mass of the cloud (in this case coinciding with its geometric centre) towards its surface, as is commonly believed today. It is true that the gravitational force, acting on the test mass located along the radius of the cloud, linearly depends on the mass of the gas enclosed in a concentric spherical shell passing through the test mass, which is replaced in the calculations by a point mass located at the centre of mass of the cloud, and the value of this point mass decreases in proportion to the third power of the decrease in the distance from it to the test mass; furthermore, the gravitational force depends on the distance from the test mass to the point mass, increasing in proportion to the second degree of its decrease. As a result, there is a linear dependence of the gravitational field strength along the radius.

But in reality, as explained in the above-mentioned papers [6,7,9], the corollaries of the Gauss theorem for the gravitational field with a spherically symmetrically distributed mass do not work. *When determining the strength of the gravitational field inside the considered cloud, it is unacceptable to ignore the shell external from the test mass as an influencing factor:* it will also create a gravitational force, but it will be opposite in direction to the traditionally considered force (directed to the centre of mass), weakening it. On the cloud surface, the thickness and mass of the outer (relative to the test mass) shell will be zero. Therefore, its effect on the test mass will also be zero. In the centre of the cloud, the thickness and mass of the outer shell will be at maximum. However, due to symmetry, the impact on the test mass will still be zero. However, when moving along the radius, the influence of the outer part of the spherical shell of the gas cloud on the test mass will no longer be zero and will pass through a maximum. This means that the form of dependence of the gravitational field strength on the radius of the cloud will be nonlinear: at first, it will decrease more intensively with depth, but after passing the critical point, the rate of its decrease will decline. Accordingly, *the force of gravitational attraction of the test mass to the centre of mass of the cloud will be at maximum on the surface of the cloud, zero at the centre and with a curve of the force versus the distance between the marks "zero" and "radius of the cloud" bent downwards*. This is the picture formed for the initial moment in time.

Over time, two trends can be observed. The first is an increase in the force of gravitational attraction of the test mass towards the centre of mass of the cloud at the periphery of the cloud (at the "cloud radius" mark) due to the reduction in the size of the cloud at constant mass. Second, the uniformity of the density distribution in the cloud will begin to be disrupted. In this regard, *further consideration of the problem will be required, with the separation of methods for its solution depending on the initial conditions.*

If the cloud is large in size, rarefied and cold, i.e. the layer-by-layer increase in pressure occurs mainly due to an increase in density and does not have time to equalize over the volume of the cloud, then *the cloud will have the largest density at the periphery*. But the increase in density, in turn, will start to shift the peak of the curve of dependence of the force of gravitational attraction (towards the centre of mass of the cloud) of the test mass from its location at the radius of the cloud towards the periphery. Moreover, the amplitude of the peak will start to grow and, under certain circumstances, will be able to even cross the zero mark (abscissa axis) into the region of negative values. And this means that *some of the elements of the cloud, falling into the area of negative values, will change the direction of their movement under the influence of the forces of gravity of the cloud:* they will start moving towards the periphery. Since such movement will occur for freely moving elements, their movement towards the periphery under the influence of gravitational forces will be accelerated. In this case, the most extreme elements of the cloud will continue their movement towards the centre of mass of the cloud, and with greater acceleration in comparison with other elements of the cloud, moving towards the centre of mass. Thus, *the cloud as a whole will be compressed, despite the movement of elements close to the periphery away from the centre of mass.*

But these are all just trends. Real processes will be complicated by many concomitant circumstances: heating, radiation, loss of statistical regularities. Therefore, building a model is extremely time-consuming work, which can only be sustained by many research teams.

Another sub-issue of explaining the gravitational compression of a model gas cloud is associated with an option when the increase in pressure during compression is mainly due to the temperature factor. Then *the compression of the gas cloud is accompanied by an increase in its density not from the periphery, but from the central zones.* The increases in temperature rise and losses due to radiation are the most influencing factors. The mass of the compressing gas cloud will be of great importance. Various effects (convective processes, thermonuclear reactions, radiation pressure, etc.) will add variety to the resulting processes. A review of possible directions of stellar evolution, depending on the initial conditions of gravitational compression of gas clouds, is presented in the work of Belyaev [12]. This work also shows *the possibility of spontaneous compression of even very light clouds, the gravitational field of which, it is believed, cannot create high pressure inside itself and, moreover, maintain high temperatures inside* (this topic was developed in more detail in [2]). In addition, work [12] discussed the nature of degenerate structures, which are often the end products of the processes of gravitational compression of gas clouds.

A single template, as can be seen from the above example, in which even an extremely simplified model was broken down into subvariants, cannot be created. There are many factors influencing the direction of development of the process of gravitational compression, therefore there are also many issues for gravitational compression. For example, as mentioned above, in [11] the possibility of *the existence of a new type of gravitational compression of a gas cloud with self-cooling was demonstrated*, the initial conditions for the realization of which are reflected in [2]. And in Belyaev [13,14], the processes of gravitational compression of a single, calm and rarefied gas-dust cloud were considered, which made it possible to form a completely *new view of the evolutionary processes of single-star systems*, creating new prospects for explaining many unresolved problems. To describe the distribution of matter in the Universe, in particular, to describe the formation of galaxies, stellar and galactic clusters, to describe the formation of the large-scale structure of the Universe and other particular problems, it is necessary to develop individual schematic solutions. Nevertheless, it is already possible to characterize the general tendencies in the distribution of matter in the Universe even at this stage.

3.3. Trends in the distribution of matter in outer space

As follows from what has already been said, and is described in more detail in the above-mentioned works [2,5], a characteristic feature of the creation of matter in the Universe are relativistic radial velocities, which are the same in magnitude for particles of the same type and with zero projections of their vectors to other directions. This means, firstly, that at the first stages the forces of gravity can only slow down the scattering matter, and the elements that have already been accelerated towards the centre of mass, will begin to appear exclusively from the periphery; and, secondly, that the set of scattering particles will not be gas at the first stages due to the absence of collisions with each other.

In order to adhere to the physical principle of the formation of "particle – antiparticle" pairs, peripheral particles must, over time, not just slow down but begin a reverse movement towards the place of their birth. In other words, our Universe has already proceeded or will proceed in the future to the stage of compression. This is inevitable, and such a conclusion does not require mathematical justification. The inevitability of the transition of our Universe to the stage of compression is due to the following circumstance.

The process of creation of a pair "particle – antiparticle" is realized in such a way that the kinetic energy of the scattering particles is enough to remove the particles from each other at an infinitely large distance, when the forces of gravitational attraction between them will vanish (otherwise the pair will not be born). The forces of electrical interaction will also vanish, but the reason why they are not being mentioned now is a subject for a separate discussion (in short, the internal energy $E_0 = m_0c^2$ already takes into account the presence of an electric charge in an elementary particle). If the nascent couple is isolated, i.e. is born in an absolutely empty space in the absence of any other substance, then at an infinitely large distance from each other the born particles will stop moving relative to each other (stop). Moreover, the reverse motion of the elements of the pair after their complete stop at an infinitely large distance from each other will not arise in the sense of the physics of the ongoing process of creation of a pair of elementary particles from vacuum.

But when particles similar to them appear behind the slowing particles, then they will begin to slow down the moving particles in front by means of their gravity. Therefore, the return of the scattering elementary particles to the place of their birth is necessary, and the first characteristic feature of the expansion of the Universe can be formulated: *the expansion of the Universe has either already turned into compression from the periphery, or will do so in the future*.

However, even if this statement is hypothetically recognized as erroneous (this work is not devoted to its substantiation, this will be done by the author in the future), the essence of the topic under discussion remains the same: *the peripheral matter, despite the observed accelerated expansion of observable space objects, is inevitably slowed*. This is the second characteristic.

The deceleration of radially scattering elementary particles, formed during the act of the birth of the Universe, means that they will begin to turn into gas, heat up and increase their density from the periphery. Thus, the above-described process of gravitational acceleration of internal matter towards the periphery within the framework of classical gravity becomes theoretically inevitable (if the initial velocities of all scattering elementary particles of the same type were the same in magnitude), and judging by the observations – already proven "experimentally". Therefore, the third characteristic feature of the expansion of the Universe is the required accelerated motion of galaxies in the direction of their radial expansion: *the farther from the terrestrial observer the galaxy is, the more acceleration it will have as it moves away* (not only the speed of removal increases, but also the acceleration).

If we draw a sphere with a centre located at the center of mass of the Universe and with a radius passing through the Milky Way, then the mass enclosed in such a sphere will hardly change, while the attraction to the center of mass of this sphere will weaken approximately in proportion to the square of the growing radius of the sphere over time. Since the Hubble law for the area closely surrounding the terrestrial observer testifies to the proportionality of the velocities of galaxies to the distances to them, from closer inspection it follows that the compression of mass at the periphery of the Universe does not yet have a very strong effect on the dynamics of our galaxy. This indirectly indicates that the terrestrial observer is far enough from the periphery of the Universe on the scale of its distance from the birthplace of the Universe (in the above-mentioned work [6] it was shown that the rate of growth of the gravitational force of attraction from the inside to the outer spherical shell is lower than the rate of reduction of the distance to the inner surface of this shell: the force of gravity acting on the test mass is proportional to the distance from it to the surface surrounding the inner spherical cavity, to the power of -3/2).

At a remote distance from the periphery of the Universe, which most likely applies, as just mentioned above, to our galaxy as well, the evolution of galaxies should have been sufficiently isolated from other nearby forming galaxies. This means that most of the surrounding galaxies evolved as solitary objects. Of course, over time, sufficiently isolated galaxies must inevitably begin to form clusters. Moreover, this is also facilitated by gravitational forces of a large-scale nature (from all other galaxies in the Universe in aggregate). Nevertheless, for the vicinity of the terrestrial observer, the independent individual evolution of galaxies can be considered predominant (from the next subsection it will be clear that this is not a rigid statement, but only admissible for a model approximation). *With an increase in the distance from the birthplace of the Universe (and from the terrestrial observer) to the periphery, the non-equilibrium of all large-scale processes, accompanied by an increase in the frequency of collisions of galaxies, should increase*, and become more active, the closer it is to the periphery. Moreover, for very distant galaxies, conditions for their individual development might not even have formed, and the prevailing mechanism of the development of such galaxies could have been their formation from other galaxies that had not yet been completely formed. Thus, the appearance of non-equilibrium galactic structures, including the shift of their "black holes" from the centre of the galaxy to the periphery of the Universe, should increase with increasing distance from the terrestrial observer. This is the fifth characteristic feature of the expansion of the universe. The emergence of a large-scale structure of the Universe can also be attributed to this factor. The term "black hole" is put in quotation marks because it has no physical meaning (this topic was discussed in [5,12,14]). But objects with the corresponding mass exist, although we do not yet know what they are: this is confirmed by astronomical observations.

The sixth characteristic feature of the expansion of the Universe suggests itself: the density of matter and the number of galaxies that have already collided with each other should increase towards its periphery. Accordingly, *towards the periphery, the masses of black holes will also increase*.

But the seventh characteristic feature, although obvious, is quite unexpected: the acceleration of the scattering of matter towards the periphery of the Universe first increases to a certain value of the distance from the birthplace of the Universe, and then begins to decrease. This means that *the scattering matter with the same redshift can be located at different distances* from the birthplace of the Universe (including from the terrestrial observer). Moreover, in the most peripheral regions, the direction of movement of matter may even be directed towards the terrestrial observer (characterized by a blueshift, if the "extreme" matter is capable of emitting electromagnetic radiation: neutron stars and black holes do not emit radiation in the absence of nearby matter).

3.4. Astronomical observations

At closer inspection, the modern cosmological model poses a lot of questions to the obtained observational data. It becomes not only more and more complicated to explain from the existing positions, but even leaves some emerging questions open. This primarily refers on observations of objects with large cosmological redshifts.

In the previous section, it was said that large-scale evolutionary processes of the Universe are associated with non-equilibrium processes of the structural elements of the Universe (galaxies), which often collide with each other. Moreover, when approaching the periphery, orbital convergence of galaxies can even be replaced by rectilinear convergence, when a lighter overtaking galaxy is accelerated by a massive galaxy diverging from it. As one approaches the periphery, the collision frequency and density in clusters of matter should also increase. Moreover, modern observations demonstrate that the increase in the frequency of collisions of galaxies already begins in the very immediate vicinity.

For example, relatively recently, a new class of ultra-compact dwarf galaxies was discovered that are not very far from the terrestrial observer. Galaxies of this type, with their small sizes, have anomalously high stellar density. Recently, it was found that they contain supermassive black holes. For example, the observations of Afanasiev *et al.* [15] for the galaxy M59-UCD3, located at a distance of 60 million light years, have shown that the observed velocity dispersion can be explained only by the presence of a supermassive black hole inside it, comparable in mass to the black hole of our galaxy, while the mass of the studied galaxy is two orders of magnitude less than the mass of our galaxy. UCD3 has a high stellar density, and the mass of its black hole is 4% of the mass of the galaxy. The most logical explanation for such objects is associated with various types of collisions between galaxies.

And the farther from the terrestrial observer, the more this effect manifests itself. Reines *et al.* [16] studied nearby dwarf galaxies with small redshifts ($z < 0.055$) and found that massive black holes are not always located in the centres of their galaxies (so called "wandering" black holes).

Moreover, in the aforementioned work [4], it was shown that giant radio galaxies begin to occur at $z > 0.1$. The authors of this work suggest that at $z < 1$, a whole population of such still "hidden" radio galaxies would be discovered in the near future.

Thus, observations suggest that mergers of galaxies begin to actively occur in the immediate vicinity of the terrestrial observer. And in the redshift range of $0.5 < z < 2$, quite a lot of faint blue galaxies appear, the origin of which can be explained by the absorption of small galaxies. In general, the redshift range of $1.5 < z < 3$ is characterized by galaxy superclusters. Moreover, in this range, Yuan *et al.* [17] have discovered a large ring-shaped galaxy with a redshift $z = 2.19$. The mechanism for the formation of such a structure may turn out to be multivariate, but in any case, it is associated with the nourishing of the observed galaxy by a smaller galaxy in the recent past.

Another possible indicator of the non-equilibrium of this zone could be the frequency of gamma-ray bursts generated by collisions of neutron stars or acts of absorption of compact objects by black holes. But such signals are practically not recorded for the considered zone (the recorded signals are difficult to identify with the location of their generation). Nevertheless, Paterson *et al.* [18] not only reported the detection of an optical afterglow of the host galaxy with $z = 1.754$ after a short-term gamma-ray burst, but also estimated the probability of an increase in the frequency of signal registration for objects with $z > 1.5$.

At redshifts $3 < z < 5…4$, massive ignition of radio sources is already observed. At this stage, it is already beginning to become clear that large values of the cosmological *redshift do not characterize the early stages of the evolution of the Universe*! For example, Schaerer *et al.* [19], studying 118 galaxies with active star formation at redshift $z = 4.4…5.8$, revealed that they have a high dust content, exceeding, for example, the characteristic values for galaxies at $z \approx 4$. According to modern concepts, this fact shows evidence of the "overlapping" of the epoch of quasars with the epoch of reionization (for larger redshifts, the "overlap" will already be obvious, see below), since such a volume of dust can only be produced by stars of the previous generation. However, it is rather difficult to explain the significant accumulation of dust for population III stars.

At higher redshifts: $z > 4…5$, galaxies practically cease to be galaxies as such, losing their structure. One more characteristic feature of this redshift range can be distinguished in the light of new knowledge about the expansion of the Universe: matter at such a distance from the centre of the Universe's birth is already so strongly accelerated by gravitational forces in the direction of the periphery and pulled out into radial filaments that star formation processes begin to fade. For example, Forrest *et al.* [20] discovered a massive galaxy with a redshift $z = 3.493$ without signs of star formation. It becomes much more difficult to carry out such an analysis for objects with larger redshifts.

Of course, in order to imagine even a broad picture of what is happening at high redshifts, is impossible without mathematics. But there is still a long way to go before models can be built with the existing knowledge base. At large redshifts, it even becomes difficult to determine the population of this zone by space objects escaping from us. Nevertheless, Mignoli *et al.* [21] were able to decipher the composition of the structure with redshift $z = 6.31$ with the at least 6 objects.

Nevertheless, Mignuli *et al.* [21] were able to decipher the structure with a redshift of $z = 6.31$, comprising of at least 6 objects. This is the first spectroscopic identification of a supermassive black hole galaxy cluster at such large cosmological redshifts. *It is almost impossible to explain how such massive and super-dense structures could have formed at such large redshifts within the framework of models based on the hot Universe*. With the new approach to the issue of the principle of the evolution of the Universe, the description of the observed cosmological effects becomes fundamentally possible, but this is a step-by-step process associated with the accumulation of new data and with a rather long period of optimization of the created models.

The non-equilibrium expressed for objects with huge redshifts also manifests itself in the form of galactic super-winds. Moreover, heavy elements in the composition of objects, which were supposedly born at the dawn of the evolution of galaxies, do not disappear. For example, Zou *et al.* [22] examined 31 luminous quasars at $z > 5.7$ and demonstrated the presence of super-wind from the absorption lines of magnesium and iron.

However, even at the highest redshift values, dust and heavy elements do not disappear. For example, Wang *et al.* [23] found the farthest bright quasar to date with a redshift $z = 7.642$, in which vast deposits of dust have accumulated. The broad *C* IV and *Si* IV absorption lines and the strongly shifted towards the blue side *C* IV emission line indicate the presence of relativistic flows (jets or other types). Dust and a supermassive black hole for an object, which, according to modern concepts, is only 670 million years old from the moment of birth of the Universe, puts theorists in a very difficult situation. The reasons for the glow of such an object, which is perceived by observers not even just as an object, but is identified with a luminous galaxy, still needs to be explained. Perhaps, at approximately such redshifts, the transition from the acceleration zone to the peripheral braking zone begins.

Nevertheless, even if objects with $z > 7$ have already begun their deceleration, objects with an even larger cosmological redshift can still be discovered. For example, Jiang *et al.* [24] report the discovery of a candidate for the most distant galaxy with $z = 10.957$. There is no discussion of dust and heavy elements, with the exception of carbon and oxygen, due to the difficulty of such analyses. The very fact of the existence of an active galaxy with a similar redshift already raises fundamental questions for existing cosmological models.

This redshift poses a serious challenge to modern cosmological models. Therefore, the sources of possible errors for the obtained result are being comprehensively studied. For example, a preprint by Michałowski *et al.* [25] appeared quite recently, in which it is assumed that the reflected signal from the spent Breeze-M upper stage of the Russian Proton rocket, which is now space debris, underwent spectral analysis. Only the future will show whether this is true. But more objects with $z > 7$ will certainly be discovered.

At this time it is important to pay more attention to the above mentioned nuance about the inevitable duality of large redshifts when comparing their values with the distance from us. It is obvious that at the peak of its acceleration towards the periphery, the bulk of the accelerated matter will be absorbed by supermassive structures. But the transition to the deceleration zone must inevitably be characterized by a fairly uniformly distributed gravitational field. Therefore, it is very likely that after the peak of redshifts, a kind of repeated process of galaxy formation can be triggered, similar in its scenario to the observed processes in our vicinity. But with one important distinguishing feature: the presence of supermassive structures and moderate amounts of gas and dust, densely concentrated near the supermassive structures.

In the development of the topic discussed in this paper, it can be assumed (it is too early to state anything yet) that the "impossible" disk galaxy with a redshift $z = 4.2603$, discovered by Neeleman *et al.* [26], has short sleeves of cold gas-dust mixture with a high speed of movement of objects inside these sleeves, which are already beyond the peak of cosmological redshifts, i.e. located farther from us than the above-mentioned galaxy with $z = 10.957$. Moreover, from the estimates of probability of detecting such a disk galaxy in observations, it follows that it may turn out to part of a very extensive population of similar galaxies. Thus, it is possible that such a population (approximately with $z < 4.5$) can be attributed to objects more distant from us than objects with $z \sim 11$.

It can also be assumed that further evolution of such a population may be characterized by the spiral galaxy discovered by Yuan *et al.* [27] with a redshift $z = 2.54$, which is actually not the ancestor of galaxies, but their "granddaughter". The gravitational lens was instrumental in examining such a distant object. Although the galaxy is spiral, its arms are primitive. And, most likely, these are not nascent arms, but disappearing ones. Spiral galaxies are stable formations. Therefore, the "shortening" of the arms, if it really takes place, occurs not due to the loss of external objects of the arms, but from the inside due to supermassive structures in the centre of this galaxy. In any case, it turns out to be more difficult to explain such shortened arms from the point of view of their origin rather than degeneration.

And finally, it remains necessary to understand what happens next with decelerating and degenerating galaxies. Probably the best clue towards this comes from the discovery of gravitational waves, which was reported in 2016 by the LIGO and Virgo collaborations (see Abbott *et al.* [28]). This event is significant not only because of the detection of gravitational waves, but also due to the event that occurred that allowed these waves to be discovered: the merger of two black holes. Such events most likely occur en masse near the outermost peripheral zone of the Universe, under a thick inner gas shell, from the depth of which the X-ray background reaches us, and from its surface – the microwave background. At this point in time it is still very difficult to create a more detailed picture with a balanced and rigorous argumentation.

4. Review of current work

Earlier, the author has already touched on the topic of the incorrectness of the model of the hot Universe, which serves as the basis for all modern cosmological models, including the ΛCDM model (see the work [2]). The model of hot Universe assumes the existence of an expanding cloud of primary plasma at a certain evolutionary stage of the Universe and gives rise to many unsolvable questions, among them is the question of the accelerated expansion of the Universe, which it made it necessary to introduce a new physical entity "dark energy" into the theory. There are currently no other reasons for introducing this category into theory.

In this paper it is shown that the accelerated motion of scattering galaxies can be explained in terms of classical gravity. The described effect is not yet a generally accepted and well-developed proposition, but it unambiguously indicates that it is premature to introduce a new category into the theory.

The expansion of the Universe did not occur due to the pressure that existed at some evolutionary stage of the Universe, either pushing the substance apart or affecting space-time, but due to the kinetic energy that appears along with the birth of pairs of elementary particles from the vacuum. Therefore, from the initial moment of its appearance, the newly born matter scatters, reducing the speed of its removal under the influence of gravitational forces (it is acceptable not to talk about electrical forces on a cosmic scale). This means that the Universe does not cool down, but, on the contrary, it heats up.

An analysis of the dynamics of deceleration by gravitational forces of an expanding substance in the framework of the classical theory of gravity indicates the following:

- an increase in the density of accumulations of matter with increasing distances to these clusters;
- an increase in the frequency of collisions of galaxies with increasing distances to these galaxies;
- growth of the masses of black holes with increasing distances to galaxies which include these holes;
- a growing nonequilibrium conditions for the formation of single galaxies with increasing distances to them;
- a reduction of the time of the isolated evolution of galaxies before their collisions with each other;
- the termination of star formation processes at large distances from the terrestrial observer;
- the existence of a peak in the dependence of cosmological redshifts on the distance to objects;
- a growth of speeds and accelerations with increasing distances to galaxies receding from us, but only to the peak of redshifts;
- the restoration of the relative uniformity of the gravitational field at the peak of redshifts and, accordingly, the appearance of conditions for the revival of isolated galaxies, but with supermassive black holes and with a limited remnant of dust and gas;

- the emergence of cosmological redshift duality, which may be inherent to galaxies at different distances from us; accordingly, the diametrically different properties of galaxies with the same redshift values;
- the existence of galaxies at moderate redshifts that resemble nearby galaxies in structure, but with supermassive black holes and small sizes (including those with shortened arms of spiral galaxies); it should be understood that galaxies with moderate redshift values, but located further from galaxies with a redshift peak, are difficult to observe;
- the gradual disappearance of galaxies due to their transformation into supermassive black holes (the low probability of detecting galaxies with small redshifts beyond the peak of redshifts);
- the existence of a halo of the Universe, which generates cosmological backgrounds of electromagnetic radiation in various frequency ranges.

Analysis of astronomical observations confirms most of the expected effects of gravitational deceleration of the expanding matter of the Universe. It is not yet known whether the Universe as a whole is contracting at the present moment of time or only passing the critical point of changing its expansion to contraction.

5. Conclusion

The generally accepted cosmological ΛCDM model and all modern alternative models of the evolution of the Universe are based on the model of a hot Universe, which assumes the existence of an expanding plasma cloud at a certain stage in the evolution of the Universe. But this approach raises a number of unsolvable questions. To resolve one of such questions, a new category "dark energy" was introduced into science. In this paper, we considered the possibility of explaining the accelerated expansion of the Universe without this new category in the framework of classical gravity, but with the condition of the rejection of the hot Universe model. The rejection of the existing model, even if it is generally accepted, in terms of the scale of its negative consequences, cannot be compared with the premature introduction of a new category into the theory made to save this model. The main conclusion of this work is that *dark energy does not exist*.

Since there is no other mechanism for the creation of matter, except for the appearance of pairs "particle-antiparticle" from vacuum, in the previous works [1,2] of the author, it was assumed that the Universe appeared due to mass acts of the creation of pairs of elementary particles. In this work, the radial motion of all born matter has already been taken as basic without analysis. The radial scattering of elementary particles set by the acts of birth, means that there are no forces that make the substance expand, i.e. the observed expansion of the Universe is not due to the pressure that existed at any of the stages of its evolution. This means that in a large-scale analysis of the dynamics of the Universe, there is no opposition to the forces of gravity throughout the life span of the Universe.

Under the accepted initial conditions, *gravity leads to deceleration of the expansion of the Universe and, over time, to its contraction*. Moreover, *the Universe, due to the work done by the forces of gravity, does not cool down in the process of expansion, but, on the contrary, heats up*.

The paper considers the principles of the dynamics of matter in the Universe. Despite the deceleration of the peripheral layers, the inner layers move towards the periphery with acceleration. The work explains why the term "extreme" (extremely remote) substance becomes acceptable. Whether the extreme substance has changed the direction of its movement from expansion to contraction or has not yet had time to do so remains unknown.

Astronomical observations fit well into the presented paradigm of the evolution of the Universe. A preliminary analysis of astronomical observations demonstrates the possibility of tracking the ongoing processes, contributing to the upcoming or already initiated compression of the Universe, using the state of galaxies for various observed zones. For example, it is possible to track the expected *growth of local accumulations of matter and the increase in the density of matter inside them with increasing distance to the observed groups of objects*, i.e. towards the periphery of the Universe. Local densification of grouping objects and matter inside them should theoretically occur until the most the farthest zone of the Universe. Furthermore, *the frequency of collisions between galaxies and the loss of their equilibrium structures increases towards the periphery*. However, it is assumed that, *when approaching the most distant zones of the Universe, galaxies are reborn, but with new characteristic features*. This is due to the fact that *the radial accelerations of galaxies first increase towards the periphery of the Universe, and then, with approaching the border of the Universe, begin to decrease*. The change in the sign of the rate of change of accelerations also gives rise to another effect: *space objects with the same cosmological redshift can be found at different distances from the terrestrial observer*. Diametrically different characteristics of galaxies at the same values of cosmological redshifts can help track this effect.

The outermost matter of the Universe is its halo (see [5,9,10]), which collects all the expanding matter of the Universe and is a generator of electromagnetic radiation, which is observed in the form of microwave and X-ray backgrounds (it is too early to talk about the background of gravitational waves).

References

[1] Belyaev A S, *A new model of the birth of the Universe*, Universal Journal of Physics and Application, 11 (2017), 5, 182-189

[2] Belyaev A S, *Hidden mass and dark matter*, Journal for Foundations and Applications of Physics, 8 (2021), 1, 31-68

[3] Graaff A, Cai Y, Heymans C, and Peacock J A, *Probing the missing baryons with the Sunyaev-Zel'dovich effect from filaments,* Astronomy and Astrophysics (A&A), 624 (2019)

[4] Delhaize J, Heywood I, Prescott M et al, *MIGHTEE: are giant radio galaxies more common than we thought?* Monthly Notices of the Royal Astronomical Society, 501 (2021), 3, 3833–3845

[5] Belyaev A S, *Cosmic microwave background and matter disposition in outer space*, Journal of Applied Physical Science International, 11 (2019), 3, 128-139

[6] Belyaev A S, *Accounting for the geometric factor in classical gravity*, Frontiers of Astronomy, Astrophysics and Cosmology, 4 (2018), 1, 18-29

[7] Belyaev A S, *The Physical Meaning of the Gauss's Law*, Frontiers of Astronomy, Astrophysics and Cosmology, 6 (2020), 1, 1-13

[8] Chae K H, Lelli F, Desmond H et al, *Testing the Strong Equivalence Principle: Detection of the External Field Effect in Rotationally Supported Galaxies*. The Astrophysical Journal, 904 (2020), 1, 51

[9] Belyaev A S, *Gravitational Contraction of a Dust Cloud in Space*, Universal Journal of Physics and Application, 10 (2016), 1, 22-30

[10] Belyaev A S, *Photon gas*, Universal Journal of Physics and Application, 10 (2016), 1, 11-15,

[11] Belyaev A S, *The Possibility of Spontaneous Gravitational Contraction of a Gas Cloud in Outer Space with Simultaneous Cooling of the Cloud*, Universal Journal of Physics and Application, 12 (2018), 2, 24-29

[12] Belyaev A S, *Trends of stellar evolution in modern physics*, Universal Journal of Physics and Application, 11 (2017), 6, 247-263

[13] Belyaev A S, *The Process of Formation of a Single Star System for Gravitational Compression of a Gas-dust Cloud in Outer Space*, Universal Journal of Physics and Application, 13 (2019), 1, 15-28

[14] Belyaev A S, *The formation of a single star planetary system and heat balance of the planets*, Journal for Foundations and Applications of Physics. 7 (2020), 2, 66-100

[15] Afanasiev A V, Chilingarian I V, Mieske S et al, *A 3.5 million Solar masses black hole in the centre of the ultracompact dwarf galaxy fornax UCD3*, Monthly Notices of the Royal Astronomical Society, (2018)

[16] Reines A E, Condon J J, Darling J, and Greene J E, *A New Sample of (Wandering) Massive Black Holes in Dwarf Galaxies from High-resolution Radio Observations*, The Astrophysical Journal, 888 (2020), 1

[17] Yuan T, Elagali A, Labbé I et al, *A giant galaxy in the young Universe with a massive ring*, Nat Astron, 4 (2020), 957–964

[18] Paterson K, Fong W, Nugent A et al, *Discovery of the optical afterglow and host galaxy of short GRB181123B at z=1.754: Implications for Delay Time Distributions*. Archive (2020),

[19] Fudamoto Y, Oesch P A, Faisst A et al, *The ALPINE-ALMA [CII] survey: Dust attenuation properties and obscured star formation at z ~ 4.4–5.8,* Astronomy & Astrophysics, 643 (2020)

[20] Forrest B, Annunziatella M, Wilson G et al*, An Extremely Massive Quiescent Galaxy at z = 3.493: Evidence of Insufficiently Rapid Quenching Mechanisms in Theoretical Models*, The Astrophysical Journal Letters, 890 (2020), 1

[21] Mignoli M, Gilli R, Decarli R et al, *Web of the giant: Spectroscopic confirmation of a large-scale structure around the z = 6.31 quasar SDSS J1030+0524*, Astronomy & Astrophysics, 642 (2020)

[22] Zou S, Jiang L, Shen Y et al, *Strong MgII and FeII Absorbers at 2.2 < z < 6.0,* The Astrophysical Journal, 906 (2021), 1, 32

[23] Wang F, Yang J, Fan X et al, *A Luminous Quasar at Redshift 7.642*, The Astrophysical Journal Letters, 907 (2021), 1, L1,

[24] Jiang L, Kashikawa N, Wang S et al, *Evidence for GN-z11 as a luminous galaxy at redshift 10.957*, Nature Astronomy, (2020)

[25] Michałowski M J, Kaminski K, Kaminska M K & Wnuk E, *GN-z11-flash was a signal from a man-made satellite nota gamma-ray burst at redshift 11*, Preprint: arXiv:2102.13164v1 (2021)

[26] Neeleman M, Prochaska J X, Kanekar N et al, *A cold, massive, rotating disk galaxy 1.5 billion years after the Big Bang*,Nature, 581 (2020), 269–272

[27] Yuan T, Richard J, Gupta A et al, *The Most Ancient Spiral Galaxy: A 2.6-Gyr-old Disk with a Tranquil Velocity Field*, The Astrophysical Journal, 850 (2017), 1

[28] Abbottetal B P et al (LIGO Scientific Collaboration and Virgo Collaboration), *Observation of Gravitational Waves from a Binary Black Hole Merger*, Physical Review Letters, 116 (2016), 6