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Creation and Evolution of the Galaxy in the Universe Model with Initial Minimum Entropy

Petro O. Kondratenko

National Aviation University, Kyiv, Ukraine

Corresponding Author:** ***Petro O. Kondratenko, *National Aviation University, Kyiv, Ukraine*

Abstract: *In this article, based on the model of the creation of the Universe with the initial minimal entropy, the structure of spiral galaxies and in particular the Milky Way Galaxy is considered. It is shown that the Galaxy from the time of the birth of the Universe expands by expanding the space at a constant speed of ~1100 m/s, and its shape evolves so much that at present the velocity of the orbital motion of stars within the galactic disk is approximately the same. In the center of the Galaxy, due to the development of chaos caused by the great density of stars, a spherical region with a constant density of matter is formed; resulting in a period of rotation around the center of the Galaxy in this part of the Galaxy is a constant value for all the stars. Due to the chaos in the movement of stars in the center of the Galaxy, which lasted a limited time billions of years after the birth of the Universe, there was a collision of stars, resulting in the formation of a black hole or a few black holes in the center of the Galaxy. In the formation of the halo two processes are involved. The first one was manifested immediately after the birth of the galaxy due to the collapse of atomic nuclei in the nucleus of the stars. The second process involves the development of chaos in the central part of the Galaxy, in which the upper layers of the interacting stars were thrown outside the Galaxy. The absorption of a substance by a central black hole causes the ejection of the Scalar Field from the black hole poles. The Scalar Field generates the fluxes of the fast particles that feed the Fermi bubbles. Galactic Arms of varying power and central bar originated in pairs as a result of the absorption of lighter black holes by the central black hole. In this case, the excess kinetic energy forms streams of the Scalar Field, which in turn forms Galactic Arms and central bar. The configuration of Galactic Arms remains unchanged, since the shock waves are not related to the orbital motion of stars around the center of the Galaxy.*

Keywords: *galaxy evolution, black holes, halo, mechanism of Galactic Arms creation, Fermi bubbles.*

1. Introduction

In the model of the Universe with initial minimal entropy, it is shown that our four-dimensional Universe is part of the Super-Universe represented by the layered space [1]. Layers of the Super-Universe are a zero-dimensional space (fundamental multidimensional sphere), one-dimensional space, two-dimensional space and three-dimensional space. All of these spaces (except for zero-dimensional) are branes of spaces, the size of which is one unit higher.

Whole Super-Universe is created at the same time. However, its filling with substance comes from the step by step. Scalar Field enters through zero-dimensional space. It carries information about all physical interactions and the ability to create matter and field in all layers of the Super-Universe. It follows that the dimension of the multidimensional sphere, which corresponds to the size of the Scalar Field, should include all measurements of one-dimensional, two-dimensional and three-dimensional spaces, as well as time and information measurements. In [1] it is shown that the Super-Universe, and hence the fundamental multidimensional sphere, has 14 measurements.

Initially, the Scalar Field fills the one-dimensional space in which diones (particles that have both electrical and magnetic charges simultaneously) are localized. These diones are Planck's particles. Then two-dimensional space is filled with particles. These are the currently known quarks of two types. And only in a time $\Delta t = 3 \cdot 10^{-5}$ s begins to fill the three-dimensional space with particles of three-dimensional space.

The velocity of filling the spaces with particles is the same and constant in time, and the radius of the branes of the corresponding spaces expands with the speed of light. Therefore, in the course of the evolution of the Super-Universe, the concentration of diones remains constant, the concentration and density of time in the two-dimensional space decreases inversely proportional to the time of the existence of the Super-Universe T_U, and in the three-dimensional space is inversely proportional to the square of time T_U.

Since the Scalar Field is not a carrier of charges, the total charge of the time created by it in all the spaces in particular is zero.

According to the model of the Universe with initial minimal entropy, the Scalar Field has the ability to immediately give birth to a pair of neutrons in a singlet state. A substance that is born in a three-dimensional space has a fractal structure from the very beginning. At the same time, each element of this structure (future star) is rapidly rotating. The stars are immediately merged into future galaxies. With the expansion of space, the mass of stars increases with constant speed. The size of the stars and galaxies is generally increasing. However, the radius of the star increases with time in proportion to the cubic root from time, and the distance between the stars increases in proportion to time. Therefore, the stars are removed from each other.

If we take as a basis the existence of the Universe for 13.25 billion years ($4.18 \cdot 10^{17}$ sec) [1], and the modern radius of the Galaxy Milky Way 50 thousand light years ($4.73 \cdot 10^{20}$ m) [2-5], then it is easy to calculate that the magnitude of the radius of the Galaxy increases at a speed of 1132 m/s, which corresponds exactly to the velocity of expansion of the space within the Galaxy. We note that according to the modern estimates [2] the magnitude of the radius of the Galaxy increases at a speed of about 500 m/s, which, in magnitude, coincides with our calculations.

When created, the Galaxy has a disk shape. Over time, this form evolves, increasing the average density of matter closer to the center due to the gravitational interaction between the stars within the Galaxy. In addition, gravitational interaction causes an increase in the thickness of the disk [4, 5]. Let's illustrate this evolution.

2. The Motion of Stars in a Discoid Galaxy

Consequently, the model of the creation of the Universe with minimal initial entropy requires that, at the beginning of the existence of the Galaxy, it had a discoid shape. Since all star embryos have a great momentum of impulse, it is logical to assume that the corresponding momentum of opposite direction has a group of stars, which is the mass of the Galaxy.

If the initial disk was thin with a constant density of star germs ($\rho_1(r)$ = const) at a certain time t_1, then the mass of the nucleus of the Galaxy at that moment was

$$M_1 = \pi R_1^2 \rho_1$$

We have already noticed that the radius of the Galaxy increases in accordance with the speed of space expansion. However, the gravitational interaction between the stars, masses of which are continuously increasing leads to the evolution of the shape of the galactic disk, which causes the star density to increase as they approach the center of the Galaxy, and besides that, the thickness of the disk will continuously increase [4, 5].

In the scientific literature, based on the astronomical observations of distant galaxies, it was concluded that the galaxy originally had the form of a disk, and eventually a thickening was created in the center of the galaxy and a bulge was formed by the creation of new stars [6,7]. Nothing is said about the mechanisms of the birth of new stars. We note that the results of astronomical observations are described in [6,7], match the model of the Universe with minimal initial entropy.

Assume that such a form of a galactic disk is established, at which, for an arbitrary moment, the mass dm of stars entering a stratum of width dr at a distance r from the center of the Galaxy is the same for all distances r. In this case

$$\frac{dm}{dr} = const = 2\pi\rho_2(r) \cdot r = A\,, \qquad (1)$$

where $\rho_2(r)$ is the average density of the substance (per unit area) at a distance r, and

$$\rho_2(r) = \frac{A}{2\pi r}. \qquad (2)$$

Consequently, we consider an idealized case where the density of a substance depends only on the radius r.

In this case, the mass of the Galaxy of the radius R_G.

$$M_G = \int_0^{R_G} \rho_2(r) \cdot 2\pi r \cdot dr = AR_G \qquad (3)$$

Hence $A = M_G/R_G$, and the mass of the central part of this disk with radius R

$$M(R) = AR = M_G R/R_G \quad (4)$$

If the galactic disk was formed so that $\rho = B/r^2$, then

$$M(R) = \int_{r_0}^{R} \frac{2\pi B}{r} dr = 2\pi B \cdot ln\frac{R}{r_0}, \quad (5)$$

where r_0 is the minimum distance from the center of the Galaxy, which must be introduced in the transition from discrete to continuous mass distribution.

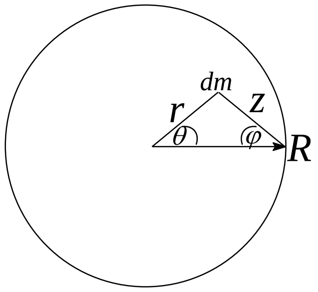

Fig1. *Illustration to calculation of the force acting at a distance R from the center of the galaxy.*

Now consider the forces acting on the stars, drawing them to the center of the Galaxy.

It is clear that in an idealized model, the force acting on a mass element at a distance R from the center will be directed strictly to the center of the Galaxy.

Let us consider the projection of the intensity of gravity on the radius R, which acts on the side of the mass element $dm = \rho r dr d\theta$, located at a distance r from the center at an angle θ to radius R (Fig. 1).. In this case, the magnitude of the tension will be determined by the general formula (we will not write the constant values before the integral):

$$I_k(R) = \int_0^R \int_0^\pi \frac{r^{1-k}(R - r\cdot cos\theta)drd\theta}{(R^2 + r^2 - 2Rr\cdot cos\theta)^{3/2}} \quad (6)$$

The value k represents the dependence of the density on the radius: $\rho = Ck/r\ k$, where C_k = const. In formula (6), we neglected the contribution of force from the mass of stars outside the radius R. Therefore, the contribution of this force will insignificantly change the functional dependence of $I_k(R)$.

In the process of integration, one must remember that in a discrete space the force acting on a star with the number i will be determined by the formula

$$\vec{F_i} = \sum_{\substack{j=1,\\ j\neq i}}^{N} \frac{Gm_i m_j}{r_{ij}^2} \vec{e}_{ij}, \quad (7)$$

where e_{ij} is a unit vector directed along r_{ij}

Consequently, the star does not attract itself to the Galaxy. Hence it follows that in the integral (6) one can not use a point that makes the denominator zero.

Introducing in the integral (6) the replacement of the variables $x = r/R$, we write the magnitude of the intensity of the gravitational field in the form

$$E_k(R) = D_k/R^k, \quad (8)$$

where D_k = const.

For k = 0, ρ = const, the magnitude of the intensity of gravity does not depend on the distance. For k >0, this value decreases with distance according to the formula (8).

The motion of a star at a distance R from the center of the Galaxy will be described by the formula

$$\frac{M_\odot v^2}{R} = M_\odot D_k/R^k \quad (9)$$

With such a distribution of the density of stars, we find the orbital velocity of the star's motion, which is at a distance R from the center of the Galaxy,

$$v^2 = D_k R^{1-k}. \quad (10)$$

From formula (10) it follows that at k = 0 the star velocity will increase with increasing distance R ($v \sim \sqrt{R}$), and the period of rotation of the star around the center of the Galaxy will be proportional to

$\sqrt{R}$. For $k = 1$, the velocity of a star does not depend on the distance R. In this case, the star's period of rotation will be proportional to the radius of the orbit R.

In ancient times, when the distance between the stars was several orders of magnitude smaller, and their mass has grown sufficiently, the gravitational interaction between them caused a change in the trajectory of the motion of stars in the Galaxy, which led to an increase in the thickness of the galactic disk. With the expansion of space, the thickness of the galactic disk increases. A projection of force appears, directed perpendicularly to the plane of the disk. In the direction of this force appears and the movement of the star, which resembles the oscillatory process.

The case $k = 1$ is important in the sense that the independence of the velocity of the star from the distance to the center of the Galaxy qualitatively corresponds to the observation data [4, 8, 9].

3. The Concentration of Stars in the Galaxy

Proceeding from the estimation of the magnitude of the mass of the Galaxy [3], we find an effective magnitude of the number of stars in the Galaxy

$$N_G = M_G/M_\odot = \int_0^{R_G} n(r)\cdot 2\pi r \cdot dr = \frac{R_G A}{M_\odot} = 6.82\cdot 10^{11}, \qquad (11)$$

where

$$n(r) = \frac{\rho(r)}{M_\odot} = \frac{A}{2\pi r M_\odot} = \frac{N_G}{2\pi r R_G} = \frac{6.82\cdot 10^{11}}{6.28\cdot 50000\cdot r} = \frac{2.17\cdot 10^{6}}{r} - \qquad (12)$$

concentration of stars (per square light year).

Hence $A = \frac{N_G M_\odot}{R_G} = 6.82\cdot 10^{11}\cdot 1.99\cdot\frac{10^{30}}{50000} = 2.714\cdot 10^{37}$ kg/(light year).

At $r = R_G$, the concentration of stars $n(R_G) = 43.4$ stars/(light year)^2.

Taking into account the fact that the disk thickness is about 1,000 light years [4,5], we obtain a bulk density of stars of 0,0434 stars/(light years)^3. Consequently, one star has a volume of 1/0,0434 = 23 (light years)^3, and the average distance between the stars will be 2.85 light years The fact that in the region of the solar system the distance between the stars is several times greater is easily explained by the fact that the solar system is located between the Galactic Arms of Sagittarius and Perseus, where the concentration of stars is significantly reduced.

On the other hand, at $r = 0.5$ light years we obtain $n(0.5) = 4.34\cdot 10^6$ stars/(light year)^2. In this case, the volume density will be $4.34\cdot 10^3$ stars/(light year)^3, and the average distance between the stars will be 0.061 light years, which is only 2 orders of magnitude more than the distance from the Sun to Neptune. If we take the period $(0{,}1 \div 0{,}3)\cdot T_U$, then the usual was the critical approach between the stars and the development of chaos in the central part of the Galaxy. It was a period of rapid evolution in the formation of the central part of the Galaxy. The chaos caused a change in the orbit of stars and their exclusion beyond the galactic disk, as well as the transformation of the central part of the Galaxy into the sphere.

4. Spherical Shape of the Galaxy Center

The rapid evolution resembles a complete chaos in the movement of stars, which can result in the movement of the star to the center of the Galaxy. This will cause the collision and sticking of stars, in which the resulting mass of the star grows much faster than the birth of a new substance [1]. In this case, the stars evolve to the black hole. At the same time there is the ejection of large masses of matter beyond the star and there is the formation of large clouds of space gas and dust. It is clear that with the approach to the center of the Galaxy, the probability of the formation of a black hole is increasing. Therefore, a black hole is formed primarily in the center of the Galaxy. The black holes creation becomes unlikely with the distance from the center. It is possible that there are cases when only one black hole is formed in the galaxy.

Note that manuscript [10] describes the chaos, which should exist in the period from 3.6 to 8 billion years from the birth of the Universe. The result of this chaos was the creation of spiral Galactic Arms, such as the Milky Way or Andromeda galaxies.

Assume that in this area the condition under which the average volume density of a substance $\rho_3(R)$ is constant is realized. Then the star speed around the masses center will be determined from the condition:

$$\frac{M_{\odot}\upsilon^2}{r} = \frac{GM(r)M_{\odot}}{r^2} = \frac{4\pi\rho_3 GM_{\odot}}{3r^2}\cdot r^3 = \frac{4\pi\rho_3 GM_{\odot}}{3}\cdot r.$$

From here

$$\upsilon = r\sqrt{4\pi\rho_3 G/3}. \qquad (13)$$

In this case, the period of rotation of the star around the center

$$T = \frac{2\pi r}{\upsilon} = \sqrt{\frac{3\pi}{\rho_3 G}} = \text{const}. \qquad (14)$$

This result resembles the rotation of the star around its own axis, where all its parts have approximately the same period of rotation. In the case of the Galaxy center, which has a spherical shape, there is no such axis, and the stars move almost independently in their orbits[1].

In this case, trajectories of stars will intersect each other. Stationary state can only be achieved thanks to full synchronization of trajectories, which is achieved after completion of the turbulent evolution of the Galaxy. However, in this case, the interaction between the stars will influence the form of the stars motion trajectory.

If the spherical shape of the Galaxy center formed without a rapid evolution from a discoid shape, where the dependence of the density of stars from the distance to the Galaxy center was described by the formula

$$\rho = \frac{A}{2\pi r},$$

then in the transition to a spherical shape we would receive a density distribution:

$$\rho = \frac{3B}{4\pi r^2}.$$

Here the constant is $B = M(r)/(3r)$. In this case, the velocity of the stars in orbit around the Galaxy center would be constant:

$$\upsilon^2 = \frac{GM(r)}{r} = 3GB = const.$$

Comparison of the obtained results with the observation data [4, 8, 9] shows that approximately the first version of the distribution of stars in the galaxy spherical region is implemented, with the result that the velocity of the stars increases with distance.

After aligning the density of the distribution of stars from the distance, their association becomes unlikely as a result of expanding space and increasing the distance between the stars. Consequently, there is a certain period of time that begins billions of years after the birth of the Universe and can last billions of years. In this period, among the stars in the center of the Galaxy a black hole or even a few black holes may be born [4]. Conditions for the emergence of a black hole in the first billion years since the birth of the Universe are absent.

This conclusion is consistent with recent astronomical studies [11] aimed at identifying small black holes, the existence of which is the Standard Model of the Birth of the Universe of Singularity [12]. These studies did not reveal the presence of small black holes, confirming the erroneousness of the conclusions based on the Standard Model.

Since in the spherical region of the Galaxy the velocity of stars decreases with a decrease in the distance to the center of the Galaxy, this leads to the fact that stars which orbits are located at a critical distance from the center of the Galaxy will be absorbed by a central star or a black hole. Therefore, the largest mass among black holes will have a central black hole [4].

[1] The presence of an axis in a galactic disk and an axis of rotation in a central black hole in this case does not affect the trajectory of stars in the central part of the galaxy.

Despite the equalization of the density of stars in the spherical region, the interaction between them does not disappear, resulting in the possibility of replenishing with the stars of the critical region in the vicinity of the central black hole and, as a consequence, capturing them with a black hole. This process must exist continuously since the creation of a black hole. At present, the mass of the central black hole is $4.31 \cdot 10^6$ solar masses [4, 13].

Halo

Halo is an invisible part of the Galaxy that has a spherical shape. The radius of this sphere exceeds the radius of the Galaxy several times [14, 15]. The halo consists of sparse gas, massive bodies, as well as stars that contain only light atoms.

The study of the halo of the Andromeda Nebula with the help of the spacecraft "Hubble" [14, 15] made it possible to conclude that the halo only includes old stars with the age of 11-13,5 billion years and 6-8 billion years. Any manifestations of stellar activity in the halo are extremely rare.

To understand the nature of the halo, we draw attention to the model of the solar system [16] in the Universe with minimal initial entropy. According to this model, the active decomposition of super-heavy nuclei in the star's nucleus leads to the ejection of electrons, protons, and nuclei of helium and lithium beyond the embryo. And since a magnetic field was formed around the nucleus, the charged particles move along closed trajectories, returning to the point where they were created. The increase in the mass of discarded particles, which effectively occurs at the initial moments of the evolution of stars, increases the radius of the trajectory, resulting in the appearance of satellites of light particles around the nucleus of the star, which mass grows over time. At the same time, these particles can not contain heavy atomic nuclei. Thus, the Oort cloud is formed. The orbit of this cloud is close to the equatorial plane of the nucleus of the star.

A similar process will occur in the case of the nucleus of the Galaxy. And in the initial galactic magnetic field, the clouds of light atoms and atomic nuclei will be formed. Since atomic nuclei are emitted from the nucleus of a galaxy at a sufficiently high speed, the resulting radius of halo should be several times greater than the radius of the galactic disk, which expands exclusively by expanding the space. The primary orientation of the orbit of this cloud will be close to the plane of the Galaxy.

At the second stage, when the processes of chaos dominate in the center of the Galaxy, the stars approached each other, causing a change in the trajectory of motion, and also throwing large masses of matter from the upper layers of stars into outer space. Consequently, light atoms and rather massive objects consisting of light atoms were emitted.

Both first-generation particles and second-generation particles most likely have an elongated elliptical orbit, from time to time approaching the center of the Galaxy, where processes of chaos continued. The latter caused a change in the orbit of these particles, resulting in the formation of a spherical halo. When the active processes of chaos in the center of the Galaxy were completed, the formation of the halo and objects in it ended. Such a mechanism for the formation of the halo was due to the fact that all the stars in it are old enough and, moreover, do not contain heavy chemical elements.

Galactic Arms

What do we know about Galactic Arms? The discs of galaxies, like ours, have the most notable formations - spiral branches (or Arms). Along the Arms are mainly concentrated the youngest stars, many scattered star clusters and associations, as well as chains of dense clouds of interstellar gas, in which stars continue to form. In spiral branches there are a large number of variables and flare stars, they are most often observed explosions of some types of supernovae. The galactic magnetic field that penetrates the entire gas disk is also concentrated mainly in the Arms. Each Galaxy's spiral Arm describes a logarithmic spiral with a slope of approximately 12°[2].

The Solar System is located in a comfortable, quiet and cozy place between the Arms of Sagittarius and Perseus in the area called the Orion Arm.

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[2] Considering the shape of the Galactic Arms in different galaxies [17], it is easy to see that this form is far from always described by a logarithmic spiral. In that part of the Galactic Arms, which is located on the periphery of the galaxy, often there is no distance, but the approach of the Arm to the center of the galaxy. In the Galaxy Milky Way [3] this fact is also noticed.

Let's take a closer look at the Galactic Arms. The first thing to notice is the symmetry of the Arms, that is, you can rotate the image to 180° and get the same structure of the Arms. The Scutum-Centaur Arm corresponds to Perseus's Arm, the Sagittarius's Arm meets the Norms Arm, and so on. In addition, Galactic Arms never go beyond the Galaxy.

It is clear that such a high symmetry of Galactic Arms can not be described, based on considerations of the existence of chaos [10]. And no fluctuations will ensure the appearance of symmetric entities.

To understand the processes of Galactic Arms, let's sequentially consider some simplified models of evolution of objects in the Galaxy.

When the star has a fairly large mass, and its evolution has led to the fact that the internal pressure does not restrain its collapse, there is a phase transition, which is, first of all, in the rapid reduction of the radius of the star. In this case, the law of conservation of energy is fulfilled: an increase in the absolute value of the potential energy of interaction between the particles of a star equals the increase of the kinetic energy of the particles of the star. However, for central-symmetrical objects there is a law (the viral theorem), according to which, in stationary state kinetic energy should equal half the potential energy with the opposite sign. Consequently, there is a large surplus of kinetic energy.

When there is compressing of a star, the density of matter in its central part continuously increases and is always higher than on the periphery. When the density in the center reaches the density of the nuclear material, it no longer increases, forming the nucleus of the future neutron star. In this case, the radius of the neutron nucleus will increase, and the region of matter with high kinetic energy will be displaced beyond the limits of the neutron core, while continuing to increase kinetic energy. At a certain stage of such an evolution, there is an explosion of the star, that is, excessive kinetic energy drops its upper layers from the star, leaving an almost intact central part that becomes a neutron star.

The second process worthy of attention in this section is the absorption of a black hole of an ordinary star. When a star meets a black hole, first of all its substance is extracted in the equatorial region of a black hole, covering it with a ring. Since we are dealing with a deep gravitational well, energy levels such as atomic are likely to exist. In this case, the reduction of the energy of the massive ring around the black hole must be accompanied by visible radiation and the release of gases simultaneously from the entire ring. The final step is to absorb the substance of the ring with a black hole. In such a process there is again an excess of kinetic energy of a substance absorbed by a black hole. So, you should expect the substance or energy to be ejected by a black hole. Since the substance is absorbed in the equatorial region, providing the cylindrical symmetry of the system, the separation of matter or energy must happen from the poles of the black hole or symmetrically from the equatorial region.

It can be argued that a substance can not leave a black hole. In this case, let us consider the possibility of illumination of excess energy from the poles of a black hole. Imagine that the illumination of electromagnetic waves with frequencies ν_o occurs from the gravitational surface of a black hole along its radius. In this case, you can write the equation:

$$\frac{GM_b m_p}{r^2}dr = \frac{GM_b h\nu}{c^2 r^2}dr = d(h\nu), \tag{15}$$

where M_b is the mass of the black hole, m_p is the mass of the photon.

Integration from r_g to ∞ gives

$$\int_{r_g}^{\infty}\frac{GM_b}{c^2 r^2}dr = \frac{1}{2}\int_{r_g}^{\infty}\frac{r_g}{r^2}dr = \int_{\nu_0}^{\nu}\frac{d\nu}{\nu} \tag{16}$$

We get it

$$2 = ln\left(\frac{\nu_0}{\nu}\right), \tag{17}$$

that is, the frequency of the electromagnetic wave decreases only in e^2 = 7.39 times.

However, in this case there is one non-matching thing: the symmetry of processes in time is disturbed. The matter is that the substance is absorbed, but an electromagnetic wave is radiated, which, in principle, can generate only a pair of antiparticle-particles that are again annihilated. Consequently, the energy of an electromagnetic wave will only dissipate, remaining electromagnetic wave.

In order to get out of the situation, which led to reflections on the processes, and to return the substance to space, one must assume that the wave that emitted is not actually the electromagnetic, but the Scalar Field [18]. Since the Scalar Field is capable of creating a substance, we will return to the initial state: the substance was absorbed and eventually radiated substance. Such a mechanism will allow us to understand the process of radiation of hot matter and energy at a certain distance from the poles of a black hole, which is observed in astronomical studies (see article [19] and the references therein). This radiation feeds the Fermi bubbles [20].

Finally, we came to the consideration of the mechanism of the formation of Galactic Arms.

We are talking about the absorption by the central massive black hole of smaller black holes, resulting in shock waves [21] that create Galactic Arms.

We have already realized that the interaction of a star with a black hole will form a disk in the equatorial part of the black hole. Unlike this case, the contact interaction between two black holes will not be able to stretch a smaller black hole into the disk around a massive black hole. A symmetry axis appears that connects the centers of the masses of two black holes. Then there will be an absorption by a massive black hole of a light hole. As in the previous cases, when converging and combining black holes, there will be a large surplus of kinetic energy equal to half the change in potential energy. Let's evaluate the change in the magnitude of the potential energy:

$$\Delta E_p = \frac{GM_1M_2}{r_{g1}} = \frac{1}{2}M_2c^2 \qquad (18)$$

Here M_1 is the mass of a massive black hole; M_2 is the mass of a small black hole. At the same time it is believed that, when capturing a small black hole by the massive distance between their centers will be equal to the gravitational radius of a massive black hole. In addition, to determine the gravitational radius of a black hole, not a relativistic, but a classical formula is used.

From formula (18) it follows that the excess of kinetic energy when combined with black holes will be about a quarter of the mass of a light hole. This energy value should be distinguished by combining black holes. The result is **new and unexpected**, but it explains the process of creating Galactic Arms.

We drew attention to the existence of the axis of symmetry in the interaction of two black holes. In addition, it should be noted that the pulse of the system was close to zero, and the momentum that corresponded to the rotation of the small hole around the large at the time of their union could be large. As a result, the union of two black holes will cause the birth of two shock waves [21], that is, the ejection of two equal in magnitude flows of the Scalar Field, characterized by the components of motion: radial in the equatorial plane, and azimuthal. The ratio between the azimuthal and radial velocity of the flows will determine the tangent of the angle of the logarithmic spiral of Galactic Arms. Different forms of Galactic Arms are currently well-structured [17]. Looking at the Hubble Camerton, one can see that no black hole has been created in elliptical galaxies E0-E7, or only one light black hole has been created. In galaxies SBa and SBb there was an association of a light black hole with a central massive black hole. Moreover, in both cases, the azimuthal projection of the velocity of matter in the Galactic Arms far exceeds the radial projection. In the case of the SBc, the situation is the opposite, that is, the radial velocity projection significantly exceeds the azimuthal. At the same time, the central bar is collinear to the Galactic Arms. Therefore, it is not visible. In this example it is clearly seen that the gravitational field of the galaxy affects the form of Galactic Arms.

If the mass of a small black hole was 10^5 solar masses, then two generated shock waves will be carried on 12500 solar masses of matter. Such streams will really be visible as powerful Galactic Arms. They will be able to provide a fairly large magnetic field in Galactic Arms and cause active processes of evolution of matter within Galactic Arms. Similar properties of Galactic Arms can provide processes for absorption of a massive black hole of the lungs (10^4 or even 10^3 solar masses) of black holes. It is clear that in these cases the power of the Galactic Arms will be much lower. And such Galactic Arms are really observed. A strong pair of Galactic Arms are Scutum-Centaurus and Perseus's Arms, the Arms of the Norma and Sagittarius are significantly weaker, and two 3-kiloparsec Arms are very weak. At the same time, a central bar forms together with the spiral arms.

It is worth noting yet another feature of the creation of Galactic Arms. The fact is that from a massive black hole radiated only the Scalar Field, which carries with it a lot of energy. After some time, the Scalar Field generates a substance, starting with bineutrons or bineutron associates. Consequently, the substance of the Galactic Arms is not born immediately after the radiation of the Scalar Field, but at a distance from the central black hole. As a result, the central bar of our Galaxy, whose length (~ 27,000 light years = 2.55×10^{17} km [22, 23]), substantially exceeds the diameter of the massive black hole (25.46×10^6 km [13]) Judging by the classification of galaxies, the length of the central bar and the number of galactic sleeves in different galaxies depend on the mass of the central black hole and the number of absorbed light black holes.

The surprise, at first glance, causes too much of the length of the central bar of our Galaxy. One of the explanations for this phenomenon is the removal of the onset of Galactic Arms from the center of the Galaxy. For billions of years of existence of Galactic Arms, such a distance (~ 13500 light years) is quite possible. However, in this case, the central bar should not be created.

Another version is related to the properties and dimensionality of the Scalar Field[3] [18]. Since the Scalar Field covers all layers of the layered Super-Universe space, it has the ability immediately to capture a light black hole with a heavy black hole to generate Galactic Arms at a distance of 13500 light years, with the preservation of information about the energy and momentum of a substance generated in the Galactic Arms. In addition, such a distance allows you to create Galactic Arms with a diameter much larger than the diameter of a massive black hole.

Thus, the onset of Galactic Arms appears outside the central spherical part of the Galaxy. Otherwise, the central part could be destroyed.

To explain the mechanisms of creating a central bar and transferring the beginning of Galactic Arms far beyond the spherical part of the Galaxy, we will consider simple examples. If we take the pebbles and cast them horizontally above the surface of the water, then we will see how it bounces many times from the water until it loses its speed. If the pebble throw over a viscous liquid or mud, then notice that the pebble will make a mark on the surface and stopped, drowning.

In the case of the Scalar Field, it has the ability to propagate in a two-dimensional space, each point of which is informally connected with a delocalized point of a three-dimensional space. In this way, the Scalar Field is instantly transferred to the point of birth of Galactic Arms, while forming the trace of its displacement in a three-dimensional space.

There is another idea that arises when considering the properties of Galactic Arms. The impression is that they have a constant configuration in time, like the knitting needles in the wheel, although their form and influence the gravitational field of the Galaxy. That is, the Galactic Arms has the same configuration, since the shock wave is not connected with the orbital motion of stars around the center of the Galaxy. In this case, it will be clear why the stars in the orbital motion around the center of the Galaxy, on the one hand, enter the Galactic Arms region, and on the other get out of it. Since the central bar is created at the same time as the Galactic Arms, its configuration must also remain constant. However, it is created as a matter of course moving the Scalar Field, and not as a result of a shock wave. As a result, the central bar actually stabilizes the position of the Galactic Arms.

There is a chaotic stream of matter to the central black hole, forming a ring of gas and dust in the equatorial plane of a black hole. At the same time there is a capture of matter with a black hole. As a result, part of the substance from the ring is thrown to all sides in the region of the galactic disk. If there are central bars, then the substance will be thrown mainly on the bars, like water from a crowded basin on the river. Such jets of matter will feed Galactic Arms. And since the flow of matter in a black hole is chaotic, then the stream of matter in the region of Galactic Arms will have an oscillating nonperiodic character. These oscillating jets will reach especially large amplitude when a black hole captures a star.

Somewhat different properties have the process of radiation of hot matter and energy from the poles of a black hole that feeds the Fermi bubbles. These fluxes of particles are too weak to influence the structure of the spherical part of the Galaxy, so they are created at relatively small distances from the poles of a massive black hole, but outside the critical region, which provides the possibility of returning the hot substance to a black hole. In addition, it is possible that along the central bar in both directions, there are immediate streams of hot matter that exist simultaneously with the fluxes fed by the Fermi bubbles.

[3] The fundamental space, through which the Scalar Field enters, has twelve rough spatial coordinates, one time and one informational. The scalar field carries with it the energy and program of creating the Super-Universe and matter in separate layers of the layered space. Therefore, after the radiation of the Scalar Field by a massive black hole, it has the ability to create Arms in a random place that corresponds to the program.

5. Conclusion

Based on the consideration of the processes of creation and evolution of the Galaxy in the model of the Universe with the initial minimal entropy, the following conclusions were made.

- At the birth of the Universe there is immediately created galaxy's germ in the form of a disk with a constant density of matter. The germ of the galaxy has a fractal structure, the elements of which are the embryos of the stars. The germs of the galaxy and stars have a rotational moment.
- The diameter of the galaxy increases over time solely by expanding the space.
- The increase in the mass and size of stars and galaxies causes a change in the dependence of the average density of matter from the distance to the center of the galaxy, including our Galaxy. In the center of the Galaxy, due to the development of chaos caused by the large density of stars, a spherical region with a constant density of matter is formed; resulting in a period of rotation around the center of the Galaxy in this part of the Galaxy is constant. Galactic disk is formed beyond the spherical region. The density of the substance in disk depends approximately in proportion to the distance to the Galaxy center. Such a distribution of stars in the Galaxy will cause a weak dependence of the stars velocity from the distance to the Galaxy center.
- The increase in the mass of stars over time and the gravitational interaction between them led to an increase in the thickness of the galactic disk. In this case, a projection of force appeared, directed perpendicular to the plane of the disk.
- Due to chaos in the movement of stars in the Galaxy center there was a collision of stars and the unification of their mass, resulting in the stars evolved to a black hole, which was formed primarily in the center of the Galaxy. The conditions for the formation of black holes appear after billions of years after the birth of the Universe and last a limited time. However, the weak process of capturing stars with a central black hole must exist continuously.
- Two processes are involved in the formation of the halo. The first one was manifested immediately after the birth of the galaxy due to the collapse of atomic nuclei in the nucleus of the stars. The second process involves the development of chaos in the central part of the Galaxy, in which the upper layers of the interacting stars were thrown outside the Galaxy. Both processes caused birth in halo of massive objects, in which there are no heavy chemical elements.
- The absorption of a substance by a central black hole causes the fluxes of fast particles, which feed on the Fermi bubbles, from the black hole poles.
- Galactic Arms of varying power flow in pairs, spreading the central black hole of light black holes. In this case, the superficial kinetic energy forms streams of the Scalar Field, which in turn forms the Galactic Arms. Simultaneously with Galactic Arms central bars also appeared.
- The configuration of Galactic Arms remains unchanged, since the shock waves are not related to the orbital motion of stars around the Galaxy center. Therefore, the stars on the one hand enter the region of the Galactic Arms, and on the other hand, they emerge from it.

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