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Properties of the Scalar Field in the Model of the Universe with M inimum Initial Entropy

Petro O. Kondratenko*
National Aviation University, Kyiv, Ukraine

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

Abstract: *Based on consideration of the properties of the Scalar Field (SF) in the model of the creation and evolution of the Universe with minimal initial entropy, it is shown that the Universe is a component of the layered space of the Super-Universe, which includes 4 layers with spaces of different dimensions. Zero-dimensional space is represented by a multidimensional sphere of fundamental dimensions, which includes all dimensions of the other three layers, that is, it has 12 spatial dimensions, as well as time and information dimensions. Thanks to the information dimension, the matrix of the Super-Universe is created, as well as the start of the expansion of spatial and temporal coordinates and the creation of vacuum particles in the created spaces. Simultaneously with this start, through the zero-dimensional space, the SF enters the Super-Universe, which at the same time receives a universal code from the information dimension. Being simultaneously present in the entire Super-Universe, the Scalar Field includes all dimensions of the layers of the Super-Universe and provides information communication between particles in neighboring layers through one delocalized point. At the same time, the information dimension played the role of a kind of legislative body, and the SF - an executive body. SF fills other spaces with matter and fields. It is also responsible for creating life in the Universe in full diversity. Since the Universe has a hierarchical structure, the SF has corresponding properties. It is responsible for the existence of mass in material particles, and also ensures the process of annihilation of a particle with an antiparticle with the creation of a vacuum particle. SF determines the structure of matter in an expanding space: nuclei of galaxies appear that rotate around their own center of mass, as well as nuclei of stars that rotate in the opposite direction. It also forms clusters of galaxies. By creating a hierarchical structure of matter in the Universe, SF is divided into hierarchical levels to ensure fundamental interactions at different hierarchical levels.*

Keywords: *Scalar Field, information dimension, universal code, space-time "atom", mass of particles, elementary particles of vacuum, annihilation, fundamental interactions.*

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1. Introduction

Modern cosmology arose after the appearance of A. Einstein's general theory of relativity, and therefore it is called relativistic. Then A. Friedman showed in his research that the Universe, filled with gravitating matter, cannot be stationary. This fundamentally new result was confirmed after Hubble's discovery in 1929 of a red shift in the radiation of galaxies, which was interpreted as the phenomenon of "receding" galaxies. In this regard, the problems of studying the expansion of the Universe and determining its age based on the duration of this expansion are brought to the fore.

The next period of the development of cosmology is connected with the works of G.A. Gamov. They study the physical processes that took place at various stages of the Universe's expansion. First of all, G.A. Gamov created a model of a hot Universe. According to his model, the Universe initially existed in conditions characterized by high temperature and pressure in a singularity in which all matter was concentrated. Then it gradually cooled as the Universe expanded. This model is accepted by most physicists and is called Standard.

Analyzing this model, it is easy to see that it contradicts the laws of physics. In particular, if all matter was concentrated in a singularity, why did a black hole not emerge? Are the laws of thermodynamics fulfilled during the evolution of the Universe? If the singularity had an extremely high temperature (~10^{28} K [1]) and high entropy (S_0 = 10^{88} J/K [2]), why did planets, stars, and galaxies appear, the appearance of which requires a decrease in entropy? What determines the arrow of time? Does the Universe have any limit in space? If the Universe is infinite, why is it dark at night? Can space exist without matter? What is the physical nature of annihilation? What is the nature of gravity? There are many other, no less important and fundamental questions.

Of course, not all physicists agree with the Standard Model. There are many attempts to clarify it.

Unfortunately, numerous models of the birth and evolution of the Universe bypass a number of the mentioned important issues and therefore cannot be accepted, as they clearly contradict the laws of physics and do not explain the reasons for the rotation of matter at all hierarchical levels of the Universe. A number of theories reject the Standard Model and believe that the Universe is infinite in time.

The development of quantum physics caused a new twist in the description of the development of the Universe. The first theories of quantum gravity appeared: string theory and loop quantum gravity [3, 4]. Physicists actually gave up on string theory, because there were many options for its continuation, despite the fact that it did not give new predictions that could be tested experimentally. And loop quantum gravity continues to develop. One of the most important features of loop quantum gravity is the cancellation of time. Why does loop quantum gravity throw off time? It is said in [4] that everything that characterizes the Universe (particles and interactions) consists of fundamental particles, but there is no understanding of what time can be "made of". In this regard, it is interesting whether the author of the work [4] knows what space is made of? After all, relativistic mechanics combines time and space, starting from the invariant of relativistic kinematics:

$$\Delta S^2 = c^2 \Delta t^2 - \Delta x^2 - \Delta y^2 - \Delta z^2$$

Yes, there is no particle that is responsible for time. But there is no particle responsible for space! Particles (bosons) are responsible for interaction, which is not mentioned in the description of space. This is a strange reason for discarding time from the Universe. So, a new problem arose, which did not confuse the supporters of this theory at all.

In addition, the quantum theory of gravity states that there really was no Big Bang from a singular point. Instead, there was a compression of the Universe to an elementary volume with zero energy. And in both directions in time, the Universe expanded from the elementary volume.

Noting the talent of theoretical physicists, it is worth saying that they work phenomenological, and not based on a certain self-consistent model of the creation of the Universe. Therefore, such theories are often disconnected from the real life of the Universe. There is the incredible conclusion hence about the absence of time in the Universe, as well as about the eternity of the Universe. This type of conclusions in theory can indicate only one thing: it is necessary to change the model of the birth and evolution of the Universe.

2. DIMENSIONS OF SPACES

The question of the dimensionality of spaces arose in connection with the work of T. Kaluza, who combined gravitational and electromagnetic fields based on the hypothesis that our world is imagined as a curved five-dimensional space-time [5, 6]. Having written the components of these fields in the form of a matrix

$$G = \begin{pmatrix} G_{00} & G_{01} & G_{02} & G_{03} & G_{05} \\ G_{10} & G_{11} & G_{12} & G_{13} & G_{15} \\ G_{20} & G_{21} & G_{22} & G_{23} & G_{25} \\ G_{30} & G_{31} & G_{32} & G_{33} & G_{35} \\ G_{50} & G_{51} & G_{52} & G_{53} & G_{55} \end{pmatrix} \equiv \begin{pmatrix} G_{\alpha\beta} & G_{\alpha 5} \\ G_{5\beta} & G_{55} \end{pmatrix} = \begin{pmatrix} g_{\alpha\beta} & A_{\alpha} \\ A_{\beta} & G_{55} \end{pmatrix},$$

we see that such a union revealed the Scalar Field (SF), represented in the matrix by the term G_{55}. Matrix form shows us, that just as gravitational and electromagnetic fields manifest itself in the Microworld and Macroworld, similarly the unknown SF must manifest itself in the Microworld and Macroworld. Common to these fields should be the dependence of energy on the distance to the field source.

In Kaluza's formula, the Greek indices α and β run through four values: 0, 1, 2, 3. The tensor G is symmetric, so it has only 15 different components. At the same time, 10 components correspond to the tensor of Einstein's general theory of relativity, and four components correspond to the components of the electromagnetic vector potential A_α ($G_{5\alpha} = \frac{2\sqrt{\gamma}}{c^2} A_\alpha$, where γ is the gravitational constant in Newton's formula).

After the publication of T. Kaluza's theory, many works devoted to the analytical description of five-dimensional space appeared in the literature. At the same time, it was shown that the fifth coordinate is spatial. Moreover, the fifth coordinate can vary only within small limits from 0 to T. To describe the fifth coordinate, A. Einstein proposed limiting it to only periodic functions with period T. Thus, the world turned out to be closed with respect to the fifth coordinate. In this case, one cannot limit the length of the fifth coordinate by the value T, but consider it infinite, but twisted into a spiral with a period T. Such a theory was later constructed, but there are coefficients that are multiples of the inverse value of the period T: 1/T, 2 /T, 3/T, etc. in it. Therefore, certain quantum values were obtained. At the same time, an expression for determining the period T was found:

$$\frac{ec}{2\sqrt{\gamma}\hbar} T = 2\pi n,$$

where n is an integer. The length of one cycle corresponds to n = 1.

The last formula can be rewritten as

$$T = 4\pi \sqrt{\frac{\hbar\gamma}{c^3}} \Big/ \sqrt{\frac{e^2}{\hbar c}} \approx 2{,}38 \cdot 10^{-31} sm.$$

In this formula, $\sqrt{\frac{\hbar\gamma}{c^3}} = \ell_0 \approx 1{,}616 \cdot 10^{-33} sm$ is the Planck length, and $e^2/\hbar c$ = α ≈ 1/137 is the thin structure constant.

T. Kaluza was able to combine gravitational and electromagnetic interactions by introducing the fourth spatial dimension (the fifth time-space coordinate). Additional spatial coordinates had to be introduced to combine these interactions with other physical interactions. It turned out that the gravity-electro-weak interaction, as well as the gravity-strong interaction, can be described by seven-dimensional time-space, in which three spatial coordinates are folded into rings of small radius. Thus, our Universe has 7 coordinates: 6 spatial and one temporal.

It follows from Kaluza's theory that SF can generate other fields, but it is not responsible for the manifestation of interaction. And therefore, the phenomenological introduction of SF into the theory of inflation with the corresponding particle of interaction looks absurd.

3. Hierarchy of the Universe

It is known from systems theory that the probability of instability increases with increasing system *complexity*, that is, large systems in Nature should not exist, which contradicts the facts. The analysis shows that only those large systems that are organized according to the hierarchical principle can be stable. All other systems in the process of evolution must end its existence due to their instability. Therefore, the result of the evolution of any large natural system is the formation of its hierarchical structure [7, 8].

Then it turned out that each separate structure corresponds to a separate physical interaction. However, an arbitrary hierarchical system should have 7 levels [7, 8]. This is also the hierarchical structure of our Universe (table 1).

Table1. *Hierarchical structure of the Universe.*

HL	Substance	Interaction	Reaction
1	Elementary particles	Weak	Particle decay and lepton scattering on baryons
2	Atomic nuclei	Strong	Interaction between baryons

3	Atoms, molecules, molecular systems	Electromagnetic	Interaction between charged particles
4	Planetary systems	Gravitational I	Interaction between gravitating bodies within the planetary system
5	Star systems	Gravitational II	Interaction between stars within the galaxy
6	Cluster of galaxies	Gravitational III	Interaction between galaxies (cellular structure of the Universe)
7	Metagalaxy	Gravitational IV	Interaction between galaxy clusters
8	God of the system		

Table 1 shows that, in addition to the known interactions, there must be other interactions that manifest themselves on a large scale [7, 9]. At the same time, [7, 9] describes 7 principles that describe hierarchical structures. And the first principle is the Law of Unity within the element of the hierarchical level (HL).

Interaction for a separate element of HL ensures temporal unity, and for all other elements of the same HL - interaction between them. Temporal unity means that within the time limit $\Delta t = h/mc^2$, the unity signal will cover the characteristic (smallest) element of the HL. This fact causes different properties of gravitational fields at different hierarchical levels.

It is important that each higher level consists of elements of the immediately lower level. In this regard, it is important that there are no intermediate levels between the levels of planetary systems and the level of atoms and molecules.

4. Properties of the Scalar Field

Information dimension

First of all, it is necessary to find out whether there was a beginning of the existence of the Universe in order to stop the many views on this matter. In this connection, it is worth paying attention to the Bible. In this regard, atheistic propaganda has done a lot of damage to the process of learning about the Universe. A detailed study of the Bible shows that it does not contain myths, and its content is fully consistent with the latest achievements of science [10]. And the first thing worth paying attention to is the verse "**In the beginning God created the heavens and the earth**" from the book of Genesis 1:1. So, there was the beginning of the existence of the Universe! And then, it is necessary to describe the mechanisms of creation of the Universe as we see it.

In connection with the identified shortcomings of the Standard Model of the creation of the Universe, in works [11, 12], based on the Law of Similarity and the Law of Unity, the author proposed a new model of the origin of our Universe, which does not contradict the laws of physics. This is a model of creation of Universe with minimum initial entropy (UMIE). At the same time, our Universe is a constituent part of the Super-Universe. In turn, the Super-Universe is represented by a layered space, and adjacent layers differ in the dimension of space per unit. The three-dimensional space familiar to us (the four-dimensional (3+1) Universe, World-4) borders on the two-dimensional space of quarks (World-3). Similarly, the two-dimensional space borders on the one-dimensional space of dions (World-2). Finally, one-dimensional space borders zero-dimensional space (World-1) - a multidimensional sphere of fundamental dimensions. World-1 is a space-time "atom" characterized by 12 spatial dimensions, as well as time and information dimensions. At the same time, the spatial and temporal dimensions are folded into rings, the characteristic values of which are described by the Planck length and time. Through World-1, the Super-Universe enters the SF, which carries with it energy and a **universal code**, i.e., a program for the creation and development of the material world. We equate the SF from Kaluza's theory with the SF entering through World-1 [11].

In this model, the information dimension acts as a legislative body, while the SF is an executive body.

Such a model avoids all the inadequacies of the Standard Model of the origin of the Universe. This is achieved by the fact that in the new model, unlike the Standard Model of the birth of the Universe [1-4], the minimum possible value of entropy is ensured due to the fact that at the moment of creation of the Universe, a space filled only with vacuum particles appears [13]. After a certain time ($\sim 3 \cdot 10^{-5}$ s [11]), a substance is born in space, the initial state of which is absolutely cold. In this case, the initial density of matter in the Universe has a limited (zero) value, which ensures a zero value of entropy.

First of all, the hierarchical matrix of the stratified Super-Universe is created through the information dimension. At the same time, in each layer, all spatial and temporal coordinates are folded into closed rings, the radii of which have fundamental dimensions. Appropriate information is required to create such a matrix. Therefore, we can conditionally talk about the existence of an informational dimension. SF receives the necessary information when entering the Super-Universe through the information dimension. At the same time, the SF receives information about the creation of matter and fields in all layers of the layered space, i.e., a **universal code**. The start of the process of **expanding time and space** is set through the information dimension. Therefore, in the first moments of the existence of three-dimensional space, when the SF has not yet entered it, thanks to the information dimension, vacuum particles are born in it, with which the SF can interact. In addition, SF after filling World-2 and World-3 receives additional information when it begins to fill the three-dimensional space in which life is created.

Therefore, SF enters through the zero-dimensional space and at the same time certain spatial coordinates begin to expand in all layers. SF ensures the creation and existence of a hierarchical structure of particles and fields in each layer of the Super-Universe. A hierarchical structure requires a hierarchy of matter, as well as a hierarchy of interactions between structural elements of matter. It follows from this that the SF itself has a hierarchical structure.

Thus, thanks to the information dimension, with the beginning of the expansion of the Universe and the flow of time, appropriate vacuum particles of the corresponding space are created in all layers of stratified space [13]. Then SF creates elementary particles in each of the layers of the Super-Universe, endowing them with the necessary physical properties.

Since the SF can determine the evolution of the entire Super-Universe, it is clear that the dimension of the SF includes all the spatial and temporal dimensions of the stratified space layers.

Being multidimensional, SF provides information communication between arbitrary points of two-dimensional and three-dimensional Worlds and two-dimensional and one-dimensional Worlds. Thus, there is an informational interaction between neighboring layers of the Super-Universe through one delocalized point. This interaction is provided by the SF, which connects all layers of stratified space into a single Super-Universe. At the same time, the layers of the stratified space do not intersect anywhere.

Each of the specified spaces is a brane of a space that has a larger dimension by one unit. The radius of the last spaces increases with time at the speed of light, which is the limit for the entire Super-Universe. The flow of time occurs equally in all layers of the stratified Super-Universe.

SF creates corresponding elementary particles in each of the specified layers, and the process of creating particles started from a one-dimensional space. Upon reaching a stationary concentration of particles in one-dimensional space, two-dimensional space begins to be filled with particles, and only then does our three-dimensional space become filled. Such a scheme of filling the spaces with appropriate particles deprives the theory of the creation of the Universe of those inconsistencies that are present in the Standard Model. In particular, our Universe cannot turn into a black hole.

5. MASS OF PARTICLES AND VACUUM PARTICLES

It is worth briefly dwelling on the properties of vacuum particles. Their main property is the equality of all quantum numbers (mass, charge, spin) to zero. They are created as a result of the complete overlap of a particle with a corresponding antiparticle. Only SF can provide such interaction. All other types of interaction cannot ensure the annihilation of a particle with an antiparticle. SF provides both annihilation and the reverse process - the creation of a particle with an antiparticle by exciting a vacuum particle.

The monograph [13] shows that there can be 9 types of vacuum particles, but the basis of vacuum particles is a proton-antiproton pair. The concentration of such vacuum particles is $1.54541 \cdot 10^{39}$ sm^{-3}, while the concentration of electron-positron vacuum particles is only $1.73009 \cdot 10^{29}$ sm^{-3}, that is, 10 orders of magnitude lower.

At the birth of the Super-Universe, when the SF energy begins to enter the Universe, it excites proton-antiproton vacuum particles, and then creates a bineutron around the proton. And further, near each nucleon SF can create a bineutron. At the same time, antiparticles are not created. This process explains the complete absence of antimatter in our Universe. All mass particles are endowed with SF, which **determines the presence of particle mass** [14]. During the annihilation of a particle with an antiparticle, energy due to the presence of mass is released. Therefore, vacuum particles are not endowed with SP. Therefore, their mass is zero.

Thus, SF successively fills all layers of stratified space, creating complexes of mass particles in each, which are characterized by the absence of charges and other (except mass) quantum numbers. In World-4, neutron pairs or clusters of neutron pairs in the singlet state meet this requirement. In World-3, these will be complexes of quarks that correspond to a pair of neurons. In World-2, these will be complexes of diones, i.e. particles that simultaneously carry electric and magnetic charges.

Such a structure of the Super-Universe causes the appearance of hadrons in the Universe (World-4) as a result of the interaction between quarks in World-3 and the transmission of information about this interaction to World-4. Therefore, one hadron of World-4 can be matched with a group of quarks of World-3, which includes, in the zero approximation, 2 or three quarks. At the same time, there is a strong interaction between quarks and hadrons, which has been studied in detail since 1935. The corresponding theory was created by Hideki Yukawa using exchangeable particles - mesons. According to Yukawa's model, the strong interaction in World-4 is manifested due to the fact that one nucleon emits a π-meson, and the second one absorbs it during the time t $\sim 10^{-23}$ s. Such particles are called virtual. To make these particles real, they must be freed from interaction with nucleons. For this, it is necessary to provide the pion with energy to overcome the output work and provide kinetic energy (an analogue of the photoelectric effect).

6. FUNDAMENTAL INTERACTIONS IN THE UNIVERSE

Table 1 show that the hierarchical structure of the Universe contains 7 levels, each of which corresponds to its own fundamental interaction.

To describe the strong interaction, let's take into account the theoretical ideas about the nature and structure of the physical vacuum (PV) set forth in [13]: during the annihilation of a particle-antiparticle pair, they are not eliminated, but combined into a system called an elementary vacuum particle (EVP). In the EVP in the unexcited state in our laboratory space, all quantum numbers (including the mass) are equal to zero. EVP form all stable particles of World-4 and World-3. Excitation of EVP is possible by the action of SF with the formation of a free particle-antiparticle pair or a virtual pair. On the other hand, with the polarization of EVP in the Coulomb field of heavy nuclei, it is possible to excite EVP by an electromagnetic wave with the birth of a free particle-antiparticle pair. This fact shows that the mass of the photon is also determined by the presence of SF.

Strong colorless interaction between nucleons occurs simultaneously in World-3 and World-4. At the same time, in World-4, we have the standard Yukawa scheme for transferring a virtual pion between nucleons. Virtual pions in World-3 are born by exciting SF quarks of vacuum particles [${}^{1/2}d(\alpha)^{-1/2}\bar{d}(\bar{\alpha})$] or [${}^{1/2}u(\alpha)^{-1/2}\bar{u}(\bar{\alpha})$], where α = r, g, b. Therefore, the energy of SF quarks will generate from vacuum particles under conditions of reduced symmetry only a neutral quark-antiquark pair, which corresponds to a neutral pion in World-4. If this pair was born in the trinity of quarks that are the constituents of a neutron, then it should have a quark structure $\pi^0 = {}^{-1/2}u(\alpha)^{1/2}\bar{u}(\bar{\alpha})$, and the constituents of a proton - $\pi^0 = {}^{-1/2}d(\alpha)^{1/2}\bar{d}(\bar{\alpha})$. At the same time, neutral pions in World-4 are born by excitation of vacuum particles of World-4 by the Field of nucleons due to the energy of the same Field.

In all cases, colorless virtual pairs of quarks in World-3 and neutral pions (themselves particles and antiparticles), which consist of a quark and an antiquark in a singlet state, are primarily formed from vacuum particles. At the same time, **the energy of the system of quarks that make up the nucleon decreases by the amount of excitation of the virtual neutral pion**. The corresponding virtual pair of quarks has the opportunity to interact with the triplet of quarks that gave birth to it (both in World-3 and in World-4) or to return to the vacuum. In the latter case, the energy of the nucleon field is restored.

A virtual pair (pion π^o) can move to another nucleon, causing a strong colorless interaction between nucleons. The movement of a virtual pion between nucleons causes a movement in the opposite direction of the Field energy, which caused the birth of a virtual pair. After moving, the virtual pawn will return to the vacuum. At the same time, the energy of the nucleon field will increase to the standard state. **The overlapping of the SF of interacting nucleons and the reduction of the total energy of the SF will determine both the direction of movement of the virtual boson and the interaction between nucleons** (Fig. 1). Therefore, the role of SF in the interaction between nucleons with the participation of bosons is similar to the role of the electromagnetic field in the interaction between atoms with the participation of a pair of electrons in the singlet state.

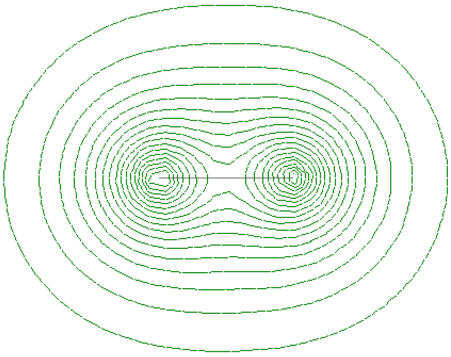

Fig1. *Overlapping Scalar Fields of Interacting Nucleons in the Triplet State.*

After the birth of a virtual pion $\pi^0 = {}^{-1/2}u(\alpha)^{1/2}\bar{u}(\bar{\alpha})$ in the Neutron Field, it is possible to exchange quarks without changing colors

$${}^{-1/2}d(\alpha) + \pi^0 = {}^{-1/2}d(\alpha)^{1/2}\bar{u}(\bar{\alpha}) + {}^{-1/2}u(\alpha) = \pi^- + {}^{-1/2}u(\alpha).$$

At the same time, π^- flies out of the neutron, and the neutron turns into a proton.

The reaction proceeds similarly in the proton field. At the same time, quarks are exchanged

$${}^{-1/2}u(\alpha) + \pi^0 = {}^{-1/2}u(\alpha) + {}^{-1/2}d(\alpha)^{1/2}\bar{d}(\bar{\alpha}) = {}^{-1/2}u(\alpha)^{1/2}\bar{d}(\bar{\alpha}) + {}^{-1/2}d(\alpha) = \pi^+ + {}^{-1/2}d(\alpha)$$

Therefore, π^+ flies out of the proton, and the proton turns into a neutron. It can be expected that the exchange of quarks with a virtual neutral pion will require additional energy from the SF quarks.

The movement of the charged pion to the partner nucleon requires the reverse reaction of the transformation of the charged pion into a neutral pion and relaxation of the latter to the vacuum state. At the same time, in all transformation processes, the antiquark that enters the virtual particle remains in the virtual particle.

The process of birth of a virtual particle and its relaxation to a vacuum state resembles an oscillatory motion. Therefore, this process is constantly occurring, ensuring a constant amount of interaction between quarks and between nucleons.

The transfer of a neutral pion provides a binding energy of 0.5 MeV [15], while the transfer of charged pions gives a binding energy of 2.22457 MeV [16].

Let us now consider the **electromagnetic interaction**.

Using the Law of Similarity, we will consider the role of SF in ensuring electromagnetic and gravitational interaction.

The article [17] shows that a virtual photon can provide interaction between electric charges of elementary particles.

The energy of the electrostatic interaction between an electron and a proton, depending on the distance between them, is

$$U = \frac{1}{r} \cdot 23.04 \cdot 10^{-29}\, J$$

Let's imagine now that this interaction occurs by transferring a virtual photon between charges. In this case, a standing electromagnetic wave will be established between the charges, and the length of this wave will be equal to twice the distance between the charges. The energy of such a photon

$E = \frac{2hc}{\lambda} = \frac{2}{\lambda} \cdot 19.878 \cdot 10^{-26}\ J,$

i.e., 3 orders of magnitude greater than the Coulomb interaction energy.

Therefore, a virtual photon can provide interaction between electric charges of elementary particles. Being virtual this photon is deep in the potential well and ensures electrostatic interaction. At the same time, a virtual photon is generated by a charged particle due to the energy of the Scalar Field.

It was shown in the article [18] that it is possible to describe the Coulomb interaction using virtual photons only by assuming that such an interaction is provided by circularly polarized photons. This fact is facilitated by the presence of helicity of electrons [19]. At the same time, the helicity of electrons is negative, i.e., they are left-polarized, and positrons are positive - right-polarized. Therefore, it can be assumed that a negative charge will absorb a left-polarized circular electromagnetic wave, and a positive one - a right-polarized one. At the same time, they will emit a wave of a different polarization.

A right-polarized wave emitted by a negative charge is described by the sum of two linearly polarized waves:

$E_z = E_0 \cos(\omega t - kx),$

$$E_y = E_0 \sin(\omega t - kx) = E_0 \cos(\omega t - kx - \pi/2). \qquad (1)$$

Of course, an electromagnetic wave should be described by the formula $E = E_0 \exp[-i(\omega t - kx)]$, but for clarity, the representation of waves by trigonometric functions is used here.

The distance between the charges will be equal to λ/2. The E_z wave resembles a standing wave in a pipe, that is, the reverse wave occurs without losing phase. As for the E_y wave, it resembles a standing wave in a string. In this case, the return wave loses its phase by a factor of π. As a result, the wave reflected from the positive charge will become left-polarized. As a result, an interaction will be established between these charges, which ensure attraction between them. If the charges had the same sign, the absorption of waves by the mechanism described above would not occur. There would be repulsion between them.

It is worth detailing the interaction between the charges a little. We will use the strong interaction mechanism to explain electromagnetic and gravitational interactions.

The energy of the electrostatic charge field is determined by the formula

$$W = \frac{1}{2} \cdot \frac{q^2}{4\pi\epsilon\epsilon_0 R}, \qquad (2)$$

where $R = \hbar/mc$ [13].

The emission of a virtual photon by the charge field will lower the energy of the electrostatic field of this charge. The charge of a particle is quantized, i.e. constant. Therefore, the emission of a virtual photon is carried out by the electric field of the charge of the particle at the expense of the SF energy localized on the same particle and responsible for its mass. The transfer of a virtual photon between particles is accompanied by the reverse transfer of energy of the Scalar Field, which restores the energy of the Scalar Field of the first charge. The absorption of a virtual photon by a charge of the opposite sign leads to the transfer of the energy of the virtual photon to it and the restoration of the energy of the electrostatic field, and therefore the SF localized on it. Thus, the binding energy between charges of opposite signs will be equal to twice the energy of a virtual photon. The absorption of a photon is a dynamic process; therefore it is immediately accompanied by the emission of another virtual photon with the opposite polarization, which can be perceived as the appearance of a standing electromagnetic wave.

Another important note: the energy of interaction between charges due to the creation of a virtual photon depends on the magnitudes of the charges of the interacting particles and is proportional to the product of the interacting charges. This is easy to understand because an arbitrary charge consists of elementary charges, and each elementary charge of the first particle interacts with every elementary charge of the second particle. The interaction occurs between the charges, but it is controlled by the SF.

When charges of the same name interact, there is no condition for absorption of a virtual photon directly by the charge. In order to detect such an interaction, an additional transfer of SF energy to the charge is required. As a result, this leads to an increase in the energy of the system of two identical charges due to SF. There is repulsion between the charges.

Thus, we have interconnected electric and magnetic fields, as well as free and virtual photons. And all of them are in three-dimensional space, providing electromagnetic interaction between electrically charged particles using the control of the Scalar Field as a process catalyst.

There is one more very important detail. Electromagnetic interaction can be observed between two distant charges if the vector connecting them has an unchanged orientation in space. When one charge rotates around another over a long distance, the condition for the functioning of a virtual photon disappears. Therefore, there is practically no electrostatic interaction between the Sun and the Earth, although the average value of the charge on them is not equal to zero. What is different about the gravitational interaction that it manifests itself at an arbitrary distance between objects?

Let's consider the **gravitational interaction** in detail.

A completely different situation is observed in the case of gravitational interaction. It strictly manifests itself not only within the boundaries of the solar system (gravitational I), but also in the Galaxy (gravitational II), in a cluster of galaxies (gravitational III), between clusters of galaxies (gravitational IV). This interaction is fully manifested, regardless of the constant movement of stars, galaxies and their clusters.

If the gravitational field was similar to the electrostatic field, that is, it was described by a vector field and manifested only in our three-dimensional space, then the behavior of these fields would be the same at large distances. In addition, neither electromagnetic nor gravitational waves could go beyond the boundaries of a black hole. However, experience shows that the transformation of a star into a black hole does not lead to the disappearance of the gravitational attraction of stars to the black hole. It exists and ensures that matter from near space is captured by a black hole, including stars and other black holes that have come close enough to the black hole. In particular, Galactic arms have formed only as a result of the black holes merge. At the same time, only the multidimensional Scalar Field [14] could ensure the exit of matter beyond the boundaries of black holes.

Therefore, only the Scalar Field is capable of carrying the gravitational interaction.

Based on Kepler's empirical laws, Newton formulated the law of gravitational interaction. It follows that the gravitational interaction within the Solar System is described by the same law. In Table 1, this interaction is mentioned as gravitational I.

Using its multidimensionality and the presence of information interaction between the layers of stratified space, which occurs through a delocalized point, the Scalar Field "knows" the coordinates of all masses in the Universe [14]. Therefore, it can always organize interaction between massive bodies or massive systems of bodies (galaxies).

It is known that the flow of an electric or gravitational field from spherical objects is equal to the corresponding flow from a point with the same mass in the center of such objects. Something similar happens with the functioning of the gravitational interaction. We are talking about the fact that information about the gravitational radiation of a massive object from World-4 is transferred to World-3 to a certain region of quarks, which corresponds to the object's center of mass. This is how a dynamic imprint of the Solar System is formed in World-3 on a reduced scale. Then the gravitational interaction is transferred between the imprints of the Sun and the planets, and then returns to the corresponding planet. Such a path for the propagation of the gravitational interaction causes its decrease by approximately 40 orders of magnitude relative to the electromagnetic interaction.

In a similar way, the interaction between stars in the galaxy (gravitational II) is formed. In this case, information about the galaxy from World-4 is transferred to World-3 to a certain region of quarks, which corresponds to the center of mass of the galaxy, and a dynamic imprint of the galaxy is formed on a reduced scale. In this case, the gravitational interaction is transferred between the dynamic imprint of the stars and the center of mass of the galaxy.

Gravitational interaction III is formed in the galaxy system that creates the cluster. In this case, the entire galaxy is transferred to a point from World-4 to World-3. Now the gravitational interaction will be manifested between the centers of galaxies within the cluster.

Similarly, gravitational interaction IV is formed in a system of clusters, with each cluster being transferred to a point from World-4 to World-3. Such an interaction is found between all clusters in the Universe.

It is clear that not only the Scalar Field, but also the gravitational field generated by it, as well as gravitational waves, must have a dimension that exceeds the dimension of our Universe. The tensor nature of the gravitational wave indicates that it is a double spiral with the same initial and final phases.

At the same time, the standing wave of interaction (virtual graviton) between massive bodies must contain the full wavelength so that the phases at both ends are the same. At $x = r = \lambda$, the phase of the wave will change by 2π, that is, the condition for the next radiation is preserved. This wave is generated by the mass of the object, that is, the Scalar Field due to the energy of the same Scalar Field. Since the flow of gravitational field intensity in our space is spherically symmetric, its value does not depend on the distance from the field source. Therefore, the force of gravitational interaction between massive bodies will depend inversely proportionally on the square of the distance. In addition, it will be proportional to the product of the masses of the interacting bodies (see above for charges).

Thanks to its dimensionality, the Scalar Field has the ability to instantly overcome arbitrary distances in the Universe. Therefore, the interaction between galaxies will occur almost instantaneously. The author indicated this possibility in the article [20]. Note that this possibility is caused by the hierarchical structure of the Universe [20], as parts of the Super-Universe.

Finally, the **weak interaction** can be considered.

The weak interaction describes the processes of nuclear and particle physics that occur relatively slowly, as opposed to the fast processes caused by the strong interaction. In particular, for the strong interaction, the characteristic time is 10^{-23} s, while the neutron lifetime is $\tau = 877.75 \pm 0.28$ s [21].

Many scientific papers have been written about the nature of weak interaction [22]. In addition, the electroweak interaction has received wide attention of scientists [23]. However, both of these theories are based on the Standard Model of the creation of the Universe, and therefore need to be refined using the UMIE model.

Experimental and theoretical studies of the weak interaction showed that the radius of action of the weak interaction is only $2 \cdot 10^{-18}$ m [24], which is related to the heaviness of the $W^{\pm}$ and Z^{o} bosons, the carriers of this interaction.

It was also shown that at a distance of 10^{-18} m, weak and electromagnetic interactions have the same intensity, which contributed to the creation of the theory of electroweak interaction.

Such facts indicate that the mechanisms of these interactions should be close. First of all, in both cases the main role is played by SF, however, without the participation of vacuum particles. In the case of electromagnetic interaction, the electric charge generates a virtual photon due to the energy of the SF. Similarly, in the case of a weak interaction (for example, in the case of neutron decay), the d-quark gives rise to heavy virtual $W^{\pm}$- and Z^{o}-bosons. We will use these data to describe the weak interaction in the UMIE method.

Thus, in the depths of neutrons in the four-dimensional World, $W^{\pm}$ (Z^{o}) bosons appear, responsible for the weak interaction [21]. Since such an interaction is accompanied by a change of both neutrons and quarks, such bosons should be found both in the three-dimensional and in the four-dimensional World.

If the $W^{\pm}$ (Z^{o}) boson was emitted by one particle and absorbed by another, a superstrong interaction (heavy boson) would occur between them. In reality, the radius of the weak interaction is significantly smaller than the size of a neutron. So these bosons during their lifetime do not go beyond the boundaries of the nucleon, which makes it impossible for the super-strong interaction between particles to occur.

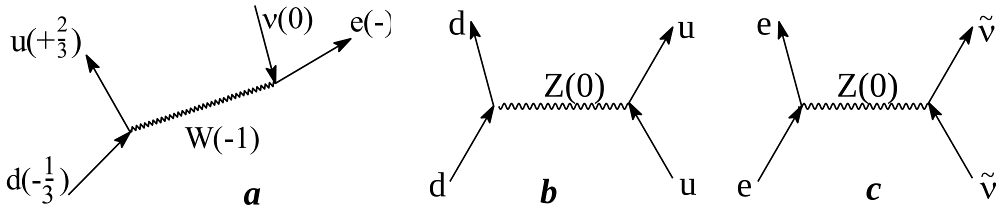

Fig2. *Feynman diagrams of the weak interaction are known [25]: a – transformation of a neutron into a proton with the release of an electron and an electron antineutrino; b – scattering of the u-quark by the d-quark; c – neutrino scattering on an electron.*

Currently, the scheme of weak interaction is accepted, according to which the d-quark emits a W– boson, turning into a u-quark (Fig. 2a). In turn, the virtual W– boson decays into a pair of real leptons: an electron and an antineutrino. So, we have the first contradiction of the known scheme of weak interaction. In addition, it is not clear why nature needs the Z boson, except for the scattering of quarks and leptons on it.

This approach to solving the problem should be considered wrong. To solve the given problem, we will consider several steps of successive approximations, which as a result should allow us to describe the mechanism of weak interaction.

In the case of a weak interaction due to the SF energy, one of the quarks creates a virtual boson, which must necessarily return to the particle that created it. Otherwise, this boson will be responsible for the superstrong interaction.

Since World-3 is electrically neutral, the number of d-quarks should be twice as large as the number of u-quarks. In the accepted Standard scheme of the weak interaction, the d-quark transforms into a u-quark, which violates the electroneutrality of World-3.

Also, a particle (real or virtual) cannot disappear in one space to appear in another. Something must remain in every space.

Therefore, it is necessary to change the scheme of the weak interaction in such a way that one particle emits and absorbs these bosons. First of all, you need to understand that during the life of a virtual particle, it has the opportunity to turn into another virtual particle with the birth of quarks or leptons ($W^{\pm}$ - boson and Z^{o} - boson belong to World 3 and through information transfer to World-4). At the same time, as a result of weak interaction with the formation of other charged particles, the $W^{\pm}$ boson must transform into a Z^{o} boson or vice versa (Fig. 3).

The fact that the free Z^{o} boson is more massive (91.2 GeV) than the $W^{\pm}$ boson (80.4 GeV) does not interfere with such processes, since both bosons remain virtual (associated with quarks). Moreover, the energy released during such a transformation (the energy level of a more massive virtual particle must lie much deeper) should provide the possibility of the birth of a pair of free leptons, in particular an electron and an electron antineutrino. Such a process will not affect the distribution of energy between the formed leptons, as a result of which the electron can obtain an arbitrary value of kinetic energy from zero to the maximum possible value, which is observed in experiments.

Thus, the proposed scheme shows why the Z^{o}- boson is needed.

Since the instability is detected only by the neutron, it must be assumed that the d-quark can emit weakly interacting bosons only in the presence of a pair of quarks (ud). The proton also includes a pair of quarks (ud), but it is not capable of activating the u-quark boson emission. Nevertheless, the β^{+}- activity of nuclei is known, from which it follows that the u- quark can be activated by additional interaction with surrounding protons (β^{+}- activity exists only with an excess of protons).

The presence of activation of the weak interaction by neighboring nucleons can be traced on the example of β^{-} activity of nuclei. While the characteristic decay time of a free neutron is $\tau \approx$ 877.75 s, in the case ${}^{6}_{2}He$ it is reduced to 0.797 s, for ${}^{9}_{3}Li$ - 0.176 s, and for ${}^{13}_{5}B$ - 0.0186 s, etc. [26]. Therefore, with an increase in the number of neutrons in nuclei with excess neutrons, β^{-} activity increases. We have a similar result for β^{+}- activity: the characteristic decay time of a proton in the nucleus ${}^{10}_{6}C$ is 20.34 min, and in ${}^{9}_{6}C$ - 19.48 s, in ${}^{13}_{7}N$ - 9.96 min, and in ${}^{12}_{7}N$ - 0.01095 s. We have a similar result in the case of heavier nuclei.

Since the law of conservation of electric charge must be observed in both Worlds, the process of transforming the W- boson into a Z^o– boson must be accompanied by the birth of a pair of quarks that have a total electric charge of -1 and a total spin of s = 0. This is the same pair of quarks that forms π - meson.

The experiment shows that when a neutron decays, a proton, an electron, and an electron antineutrino are formed (Fig. 3). This can happen if, in World-3, the reaction of the transformation of a W- boson into a Z^o– boson is accompanied by the formation of a $d + \tilde{u}$ pair in a bound (virtual) state with a Z^o– boson. Since the density of quark matter in World-3 is high [11], this causes interaction between the virtual particle $\tilde{u}$ and the real u. When this pair is annihilated, the energy needed to release the d-quark will be released. At the same time, it is worth mentioning that the mass of the d-quark (~7 MeV/c^2) exceeds the mass of the u-quark (~5 MeV/c^2), which could hinder the flow of the weak interaction reaction. However, this reaction will be facilitated by the transformation $W^- \to Z^o$, during which a lot of energy is released. In this case , the decay of a neutron into a proton and leptons will not be accompanied by the emission of γ-quanta.

So, the refined scheme of the transformation of a neutron into a proton with the release of leptons can be depicted in the form shown in Fig. 3:

In this scheme (Fig. 3), the appearance of a pair of quarks $\left(d\tilde{u}\right)$ in World-3 is accompanied by the appearance of a pair of leptons $\left(e^-\tilde{\nu}\right)$ in World-4.

Similarly, the scheme is transformed, in which the birth of a virtual Z^o– boson is primary event with its transformation into a W^+– boson. However, in this case, there is not enough energy to create a pair of leptons. Therefore, this scheme cannot be implemented.

Now let's consider a more detailed explanation of the processes of the weak interaction, let's pay attention to the fact that a boson in World-3 must correspond to a boson in World-4 (Gerlovin's spatial metamorphosis [13]). Therefore, we will name it $W_3^{\pm}$ and Z_3^0. The bosons in World-3 and we will keep the old designations for bosons in World-4.

Since, thanks to informational interaction and spatial metamorphosis, the processes in World-3 and World-4 must be synchronized, the final scheme of weak interaction processes will have the form shown in Figure 3. At the same time, in World-3, the d-quark emits a weak interaction boson only in the presence of a pair or group of ud quark pairs. Similarly, the u-quark emits a weak interaction boson only in the presence of a group of ud quark pairs.

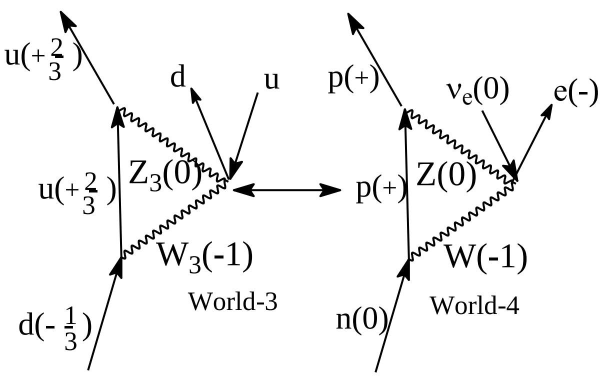

Fig3. *Neutron decay reaction in the UMIE model*

In the process of transforming quarks according to the scheme of weak interaction, the W_3 boson turns into a complex ($Z_3 d\tilde{u}$), which during the life of the complex interacts with a free u-quark. At the same time, the pair of quarks $u\tilde{u}$ annihilates, the complex decays into a free d-quark and a Z_3-boson. As follows from the appearance of the scheme of the weak interaction, the transformation of the d-quark into the u-quark is accompanied by the transformation at the second stage of the u-quark into the d-quark, which ensures the electroneutrality of World-3.

If a boson and a free pair of quarks are born as a result of boson fission ($Z_3 d\tilde{u}$), then further interaction will lead to the emission of γ-quanta. If the virtual complex ($Z_3 d\tilde{u}$) first interacts with a free u-quark, then there will be no emission of γ-quanta.

From the appearance of the final scheme of the processes of the weak interaction, it follows that a pair of quarks ($d\tilde{u}$) is born, which is included in the structure of the pion π^-. Therefore, it is not surprising that charged pions decay with the formation of leptons. On the other hand, pions are quite massive particles (it has 264.1 and 273.1 electron masses), and the total mass of the formed leptons (electron and electron antineutrino) during neutron decay does not exceed the difference between the neutron and proton masses (2.5309 electron masses). In the case of β-activity of nuclei, the energy of the formed leptons can increase by an order of magnitude due to the energy of the active nucleus. There is nothing surprising in this, since in the processes of weak interaction, the initial state corresponds to virtual particles that require energy for their release, which causes a decrease in the energy of the born leptons.

A similar process takes place in World-4. In this case, the W boson turns into a complex ($Ze\tilde{\nu}_e$), which within the lifetime of the weak interaction boson decays into a Z-boson and a pair of free leptons e+$\tilde{\nu}_e$. This is facilitated by the large energy released during the transformation of the W-boson into the Z-boson and the small total energy of the lepton pair.

The fact that the sum of the color charges formed in the process of the weak interaction of quarks is equal to zero, as well as the sum of the lepton numbers of the formed leptons, attracts attention. The total electric charge of these particles in World-3 and World-4 is the same. A particle and an antiparticle are formed in both Worlds.

The scheme of scattering of quarks or leptons on weakly interacting bosons can be described as shown in Fig. 4. A group of quarks emits a Z_3 boson, and a neutron in heavy nuclei emits a Z-boson. At the same time, the boson returns to the particle that emitted it. It is important to note that leptons do not have the ability to emit a boson of weak interaction, and therefore there is no scattering of leptons on leptons.

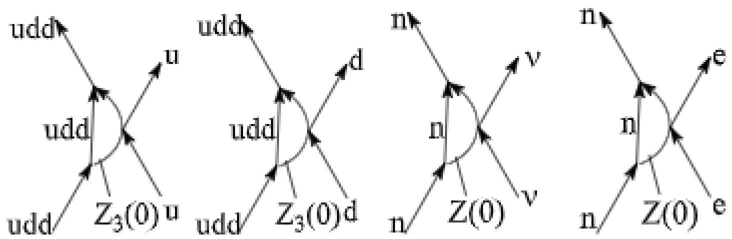

Fig4. *Scattering of quarks and leptons on weakly interacting bosons in the UMIE model.*

This scheme simultaneously explains why there are parallels between the quark composition of matter in World-3 and leptons in World-4 (Table 2).

Table2. *Parallels between the quark composition of matter in World-3 and leptons in World-4.*

quarks	d, u	s, c	b, t
leptons	e, ν_e	μ, ν_μ	τ, ν_τ

So, there is a parallel between quarks and leptons, which indicates a connection between them. Indeed, lepton pairs are formed in one act with the transformation of quarks in the course of weak interaction reactions. There are three pairs of quarks and three pairs of leptons.

7. Creation of the Universe in the UMIE model

About 20 of the author's articles and monographs [12, 10] with amendments, the texts of which can be found on the author's website, are devoted to the issue of the creation of the Universe in the UMIE model. Therefore, in this article, we will pay attention to only some details.

Based on the fact that the Universe had a beginning, it is clear that it is expanding, while each of the three coordinates of space is closed on itself in a ring. So, the space of our Universe is a brane of four-dimensional space. The radius of the ring increases with the speed of light. All matter in the Universe is formed in the form of galaxies. Intergalactic space has extremely little matter. Each galaxy expands in accordance with the expansion of space.

At the birth of the Super-Universe, thanks to the information coming through the information dimension, a matrix of layered space is created, the expansion of the corresponding spatial dimensions begins, and the flow of time starts. Vacuum particles are created in all relevant Worlds. The Scalar Field receives the program (**universal code**) for the creation of matter in these Worlds. Before entering the three-dimensional space, the SF receives additional information about the creation of life in the Universe through the information dimension.

After a certain time ($3 \cdot 10^{-5}$ s), the SF begins to enter World-4 and generates matter at a constant rate of $1 \cdot 10^{34}$ kg/s. To do this, the SF first creates a kind of matrix where, on a reduced scale, it outlines the excitation points of vacuum particles, forming the seeds of future stars and galaxies. A bineutron is formed near an excited vacuum particle (proton) due to the SF energy. Next, bineutrons are formed near each nucleon, that is, the mass of the future star increases rapidly. At the same time, the excess of neutrons due to β-activity is transformed into protons, creating heavy unstable nuclei. The future star is quickly gaining mass. All stars and the galaxy get rotational motion due to the properties of SF. The calculation shows that the diameter of the galaxy increases in accordance with the rate of expansion of the Universe. Celestial bodies are formed near each star due to the matter of the star itself, including planets that revolve around the star in the star's equatorial plane. The mass of the star and planets continues to increase due to the energy of the SF. The radioactivity of heavy nuclei causes heating of the central regions of the star and planets. There are no thermonuclear reactions to create heavy nuclei.

Crystallization of diamonds and oxides of various compounds occurs in the hot magma of the Earth at high pressures. These are energetically beneficial processes. When volcanoes erupt, diamonds and deposits of various minerals can come to the surface of the Earth. Crystallization of heavy nuclei, such as uranium, takes place in the magma. At a certain stage, this will cause a nuclear explosion, which is felt on the surface of the Earth as an earthquake. Only such a mechanism explains the occurrence of strong earthquakes born at depths of several hundred kilometers.

8. CONCLUSIONS

Based on consideration of the properties of the Scalar Field in the model of creation and evolution of the Universe with minimal initial entropy, the following is shown:

1. The UMIE model requires consideration of the Super-Universe, represented by a layered space consisting of four layers: one-dimensional space (World-2), two-dimensional space (World-3), three-dimensional space (World-4), as well as zero-dimensional space (World-1) – a multidimensional sphere of fundamental dimensions, which includes all dimensions of the other three layers, i.e., 12 spatial dimensions. In addition, the dimension of all layers of the Super-Universe also includes time and information dimensions.

2. Thanks to the information dimension, the matrix of the Super-Universe is created, as well as the start of the expansion of spatial and temporal coordinates and the creation of vacuum particles in the resulting spaces. Simultaneously with this start, through the zero-dimensional space, the SF enters the Super-Universe, which at the same time receives a universal code from the information dimension. Being simultaneously present in the entire Super Universe, the Scalar Field includes all dimensions of the layers of the Super Universe and provides informational communication between particles in neighboring layers through one delocalized point.

3. The creation and development of all layers of the Super-Universe requires that the informational dimension plays the role of a kind of legislative body, and the SF - the executive body. The resulting properties allow the Scalar Field to fill one-dimensional (World-2), two-dimensional (World-3) and three-dimensional (World-4) spaces with matter and fields. It is responsible for the creation of life in the Universe in full diversity.

4. Three-dimensional space begins to fill with a delay of $3 \cdot 10^{-5}$ s, so that the initial density of matter cannot exceed the density of nuclear matter. The speed of filling the spaces with matter is the same and constant over time.

5. Since the Universe has a hierarchical structure, the SF has corresponding properties. It is responsible for the existence of mass in material particles, and also ensures the process of annihilation of a particle with an antiparticle with the creation of a vacuum particle. SF determines the structure of

matter in an expanding space: the nuclei of galaxies appear that rotate around their own center of mass, as well as the nuclei of stars that rotate in the opposite direction. It also forms clusters of galaxies. By creating a hierarchical structure of matter in the Universe, SF is divided into hierarchical levels to ensure fundamental interactions at different hierarchical levels.

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