The universe as a superorganism

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The assumption that the early universe was not hot but in a pure quantum state allowed the main problems of cosmology to be solved from a single point: the flatness and homogeneity of the universe, in addition to the predominance of matter over antimatter and the absence of monopoles. A model according to which this quantum state itself was formed under large compression as a result of a quantum phase transition is proposed. In this case, a Big Bounce can be treated as quantum scattering, as a result of which more than one universe can form. The properties of the universe, on the basis of which life arose within it, were encoded in topological states before the Big Bounce (scattering). At later stages, life evolved directly. Dark matter and dark energy can be used to control the lifetime of the universe. The universe itself can be considered to be a superorganism.

Key words: Big Bounce, directed evolution of life, pure quantum state, topology, superorganism

Introduction

The properties of the universe in the early stages after the Big Bang are closely related to the properties of life, which in such a universe can exist afterwards. These properties of the universe include, for example, such important properties as the flatness and homogeneity of the universe, in addition to the predominance of matter over antimatter. Violation of at least one of these properties would lead to life in the universe not arising.

There are a large number of articles devoted to the fine-tuning of the universe (see, for example, [1-3]), i.e., the manner in which these or other properties of particles (e.g., masses and charges) and the universe as a whole are connected with the possibility of the emergence of an Earth-type life in such a universe. Many of the properties of the universe are explained on the basis of the anthropic principle:

1. Life naturally occurs at a certain stage in the evolution of the universe - a strong anthropic principle.

2. We observe exactly our universe, because in the universe with other properties, observers simply cannot exist - a weak anthropic principle.

However, the application of the anthropic principle to explain the origin of life is practically not verifiable, since it is difficult to imagine an experiment of this type. A more consistent physical theory that would explain the emergence of life in the universe in a natural manner is needed. In this case, the anthropic principle should play only an auxiliary role.

On the other hand, these properties are only necessary but not sufficient for the emergence of life in the universe. This requires additional assumptions.

How are the mechanisms of life evolution and the mechanisms of the evolution of the universe related? The dominant theory of evolution - extended synthesis - does not take into account any connection of this type. In the framework of this theory, it is assumed that as a result of the evolution of the universe, only the building material for evolution – amino acids, RNA and other molecules – appeared. Further evolution proceeded according to the laws of selection and random mutations, as a result of which complex organisms arose. At the same time, the extended synthesis meets with conceptual difficulties when trying to explain the further complication of living systems and the emergence of complex organisms (see, for example, [4, 5]).

An alternative to Darwinism is the theory of directed evolution [4-7]. The basis of this theory is the assumption that the evolution of living systems is a priori directed, i.e., some structures contain information about the future states of the evolving system. In this sense, evolution is similar to morphogenesis. This assumption makes it possible to explain the appearance of complex systems in realistic times.

In the latter case, it is quite natural to assume that the mechanisms of the directed evolution of life are closely related to the mechanisms of the evolution of the universe.

The purpose of this article is to reconcile models of the evolution of the universe with models of the evolution of life for the construction of a single model based on common principles.

1. The problems of flatness, homogeneity of the universe, the absence of monopoles and the absence of antiparticles and the origin of life

The standard cosmological model, created by the 70th year of the 20th century, suggests that the evolution of the universe began with a Big Bang. However, this model met with a number of problems. Let us note the four most important of them.

The problem of homogeneity (the horizon problem) is that the temperature of the microwave radiation differs only by hundred-thousandths in different directions. However, the size of the universe is too large for this homogeneity, since the removed parts of the universe could not be related to each other even at the speed of light, and thermalization faster than the speed of light is considered impossible. The second is the flat world problem. At present, the geometry of the universe is only slightly different from Euclidean. This imposes very strong limitations on the curvature of the universe in the early stages of its evolution. Such limitations are difficult to explain within the framework of the standard cosmological model. The third problem is the lack of monopoles. According to the standard model, at 10^{16} GeV, the symmetry is violated and monopoles should appear. If they could not annihilate, then their ratio to the number of photons will remain constant. Then, for one nucleon at the present time, there should be one monopole, which does not correspond to the experimental data.

The fourth problem is the predominance of matter over antimatter. According to modern observations, antimatter is practically absent from our universe. Currently, a number of scenarios for this phenomenon have been proposed (see, for example, [8]), but its mechanism remains largely unclear. Note that most symmetry breaking scenarios also require going beyond the standard model.

These properties of the universe are closely related to the possibility of life in it. For example, if the curvature of the universe were not zero in the early stage of the expansion of the universe, then the universe would either have long ago expanded without the formation of galaxies, stars and life or would have collapsed long ago with the same result.

The presence of matter and antimatter in the early stages of the expansion of the universe would lead to their annihilation and consequently to an absence of baryons. A life known today without baryons is impossible.

2. The solution of the main problems of the evolution of the universe in the early stages on the basis of the assumption of the quantum pure state of the universe

To solve the first three of these problems, the inflation paradigm was proposed. The essence of this paradigm is that in a very early stage, the universe expanded exponentially, as a result of which it became practically flat (see, for example, [9-13]). However, the inflationary paradigm itself is beyond the scope of the standard model, and it has not yet been possible to justify it from first principles. Another disadvantage is that it assumes the existence of structures that are many orders of magnitude larger than the size of our universe. Such a prediction is difficult to verify experimentally.

To solve the above problems in the paper [14], it was suggested that the universe in the early stages was not hot but rather in a pure quantum state in which the particles were entangled with each other. This assumption makes it possible to solve the following problems of cosmology:

Horizon problem. If the particles of the universe are entangled with each other, the decoherence of their pure state occurs simultaneously. This means that the difference in the temperatures of the far regions of the universe will be small.

Flatness problem. The pure state differs from the mixed one in that it does not act on itself, so in the course of evolution, its curvature does not change. If at the initial moment it was zero, then this remains zero until the decoherence of the pure state. In this case, there is no need in fine-tuning of the initial state of the universe.

The problem of the *absence of monopoles* is solved automatically, since the absence of defects (monopoles) can be considered as a definition of the pure state. With further expansion of the universe, they no longer arise if the temperature of the universe is not too high.

The problem of the *predominance of matter over antimatter*. In the paper [14] it is assumed that the entangled particles, of which the expanding universe consists, can equally decay into some particles and their antiparticles. Such a decay is a random process, and in the event that the particles were not entangled with each other, matter and antimatter would be formed in equal amounts. For the case when the number of particles in the universe is large, the relative fluctuations of matter and antimatter will be small. However, if the particles are entangled with each other, their decay in matter or antimatter will occur simultaneously throughout the system. Thus, in the universe will remain either a matter or antimatter.

Thus, according to Melkikh [14], the pure state of the expanding universe in the early stages allows, without additional assumptions (within the framework of the standard model), explaining the flatness and homogeneity of the universe from a single position, in addition to the predominance of matter over antimatter and the absence of monopoles. Such a mechanism can be considered as an alternative to the inflationary paradigm.

Note that within the framework of the proposed model, gravity is classical, i.e., its quantization is not required. The fact that without the quantization of gravity it was possible to solve the basic problems of the early universe makes it possible to assume two variants: either gravitation is not quantized at all or the densities at which it is quantized are not achieved during evolution of the universe.

Richard Feynman [15] noted that "The extreme weakness of quantum gravitational effects now poses some philosophical problems; maybe nature is trying to tell us something new here: maybe we should not try to quantize gravity. Is it possible perhaps that we should not insist on a uniformly of nature that would make everything quantized?”

Note that at the present time, there are no experimental data confirming the existence of quantum gravitational effects.

3. Noninflationary models, bouncing cosmologies

Bouncing cosmologies are a separate direction, based on the assumption that a Big Bang followed a great contraction. For example, Batterfeald and Peter [16] reviewed the various theories of bouncing cosmologies. The main directions are quantum gravity-based models, ekpyrotic and cyclic scenarios, string gas cosmology, nonsingular bounces in string theory, antigravity, nonsingular bounces via a galileon, massive gravity, nonsingular bounces in the multiverse and the Horava-Lifshitz model. The aim of this article is not a detailed analysis of these models, but it should be noted that they, similar to the theory of inflation, have a number of shortcomings. The main disadvantage of these theories is that they contain a large number of adjustable parameters that cannot be deduced from first principles.

The conformal cyclic cosmological model of Penrose [17] is based on the general theory of relativity, in addition to the second law of thermodynamics applied to the universe as a whole. In particular, he supposed that the states at the beginning of the expansion of the universe (when the entropy is minimal) and at the end of the expansion (when it is maximal) in some sense correspond to each other. According to the author, right after the Big Bang, physical laws did not include the scale factor at all because particles could be considered massless because of relativistic effects. In this case, the structure of space was determined only by conformal geometry. Penrose argues that the state of the universe in the distant future will not differ from the state at the beginning, except for on scales that, according to the author, do not play a role.

According to the author, the universe passes through infinite cycles separated by a crossover, the transition through which turns out to be conformally smooth. The author pays much attention to the second law of thermodynamics in the formulation of the model, considering that by default, the second law of thermodynamics is applicable to any macroscopic system - including the universe. The problem, however, is that before the formulation of the second principle, we must first formulate the zeroth law of thermodynamics - the postulate of thermodynamic equilibrium. Often such a postulate is not considered at all, i.e., the existence of thermodynamic equilibrium in a macroscopic isolated system is considered obvious. However, it has been shown in [18, 19] that in systems with long-range interaction (in particular, with gravitation), thermodynamic equilibrium does not exist. In particular, such systems can exist for arbitrarily long (depending on the initial conditions) in a non-equilibrium state. This result applies, for example, to the case of small bodies rotating around a large body: for certain body masses and initial orbits, their temporal behavior will be only slightly chaotic [20].

This does not exclude a situation in which the concept of "local equilibrium" and all the associated thermodynamic quantities can be applied to some subsystem (in which additional forces are present) of the universe. Such subsystems can include, for example, stars, planets, gas clouds, and relic radiation. The paper [21] concluded that the simulation of most systems with long-range (gravity) cannot be based on the laws of thermodynamics, which cannot be formulated correctly for such systems. The main reasons for this are the failure of the statistical independence of the subsystems and the violation of ergodicity for systems with gravity. This conclusion also applies to the early stages of the expansion of the universe.

The use of thermodynamic parameters without sufficient grounds for this can be considered one of the most significant drawbacks of both inflationary and bounce-like models. Use of parameters such as entropy, pressure, temperature, etc. is not obvious in systems with gravity as the dominant force and should be justified. Meanwhile, such a substantiation is absent in the literature, and the application of Friedman's equations (in which, for example, pressure is present) is simply postulated.

We emphasize that the problem of the predominance of matter over antimatter, which is critically important for the emergence of life, is not usually considered in the framework of these models. That is, to solve it, additional assumptions are needed.

Another direction in the theory of the early universe is non-Archimedean dynamics. For example, in work [22] it is assumed that at the Planck density of the universe the basic postulates of Archimedean dynamics are violated, in particular, the known triangle inequality. In this case, the state of the universe at the early stages of its expansion can be encoded in the parameters of the non-Archimedean dynamics and in the parameters of the universe at the compression stage.

Models based on non-Archimedean analysis have been applied in many areas of physics, biology, and mathematics (see, for example, [41]). These models also showed their promise in modeling the evolution of life (see, for example, [23]).

Note that the models of a big bounce are in many respects similar to the scattering of quantum particles, which is described using the S-matrix. This means, in particular, that after the bounce (scattering), there is a probability that there will not be one universe but rather more and that these universes may, in general, be different.

Thus, the bounce (scattering) after which the universe (or universes) is in a pure quantum state allows us to solve the basic problems of cosmology on the basis of minimal assumptions.

4. Anthropic principle or physical law?

In the 1970s, the concept of fine-tuning of the universe (see, for example, [1-3]) was put forward, according to which the fundamental constants, in addition to the proton mass, the electron mass and its charge, have quite definite values. The emergence of these values for some fairly narrow interval would lead to the impossibility of the existence of life in the form in which it exists now. As already noted above, there are two extreme formulations of the anthropic principle: strong and weak.

The weak anthropic principle does not in fact represent any particular theory; in this sense, it can only be regarded as temporary in the study of the universe. Regarding the strong anthropic principle, the most common rationale is the multiverse and theology. The second case goes beyond science, and the version of the multiverse is practically impossible to verify, because, as will be shown below, the number of universes in the multiverse necessary to explain the origin and evolution of life in them can be exponentially large.

In a number of works, the anthropic principle has been applied to the climate of the planets [24], the magnitude of the cosmological constant and the position of the sun in the galactic habitat [25], the concentration of dark matter [26], the influence of dark matter on long-period comets [27], and other properties of the universe [28, 29].

However, a third variant is possible, according to which a large number of physical constants, on the "right" values of which the existence of a life such as ours depends, is only a consequence of a more general, yet unknown physical theory. When this theory is built, it will uncover the mechanisms by which constants take their meaning and explain why constants have exactly this value, and not some other. This variant will be discussed in more detail in Section 6.

We use the Bayesian approach to assess the probability of life in the universe. Previously, it was also used to assess the probability of the emergence of effective living structures in the evolutionary process (see, for example, [23]).

Consider the formula for the total probability in the form:

$$P\left(A/B\right)=\frac{P\left(A\right)P\left(B/A\right)}{P\left(B\right)}, \qquad (1)$$

where P (A) is the a priori probability of hypothesis A;

P (A / B) is the probability of hypothesis A at the occurrence of event B (a posteriori probability);

P (B / A) is the probability of occurrence of event B with the truth of hypothesis A;

and P (B) is the probability of event B.

Assume that at the beginning of the expansion of the universe, it is characterized by a set of constants, which can be encoded as a bit string. This bit string can be considered as a hypothesis. As an event, one can consider the emergence of life in such a universe.

If the hypothesis advanced (explicitly or implicitly) is good (corresponds to a universe in which life is most likely to arise), then the probability of life in the universe P (A / B) will be high. This means that the emergence of life in any of the universes will require order

$$n \sim \frac{1}{P(A/B)} \tag{2}$$

steps (different universes), that is, a small number.

Otherwise, the probability P (A / B) will be exponentially small, and the number of variants that must be enumerated in one manner or another will prove to be exponentially large. The fact that the probability of the appearance of complex living systems in the case of an *arbitrary* bit string, in which the initial conditions of the universe are encoded, is exponentially small is closely related to the number of possible variants of the genomes of these living systems. This problem was considered earlier in the works [6, 7]. It was shown that if the evolution is not a priori directed (there is no a priori information about future states), then the number of variants is exponentially large. Such a task cannot be solved by any number of organisms that existed on Earth for all time. However, any methods (block, etc.) cannot accelerate the enumeration of variants. The same applies to the number of universes if each universe is regarded as a separate attempt.

The only solution to this problem is a priori directed evolution. Only in this case can molecular exaptation, block methods, etc. make sense. In this second case, the a priori directivity of evolution should be expressed in the form of a set of physical laws that must in some form be encoded in constants that characterize the initial state of the universe.

It is in the case of a priori directed evolution governed by physical laws that the hypothesis (set of constants) turns out to be good.

Note that the Bayes formula for the probability of life in the universe is closely related to the Drake formula [30] in the sense that the results of both formulas depends critically on the mechanisms of life evolution [31].

On the basis of Bayesian analysis, it can be concluded that the emergence of complex living systems by enumeration of universes with different properties leads to the fact that such variants (universes) should be exponentially large (it does not matter whether they exist in parallel or sequentially one after another). However, such a variant should be recognized as not verifiable and therefore not scientific in view of its unrealizability.

Thus, some properties of the universe, in addition to its individual parts, can be explained by the presence of observers, but such a posteriori explanations cannot be recognized as final. The variant in which the number of experiments to verify it is exponentially large also cannot be considered satisfactory. It seems important to understand the physical laws that would explain the properties of the universe *a priori*. This approach is the basis of all natural sciences. The theory explaining the properties of the universe and life in it can just become the theory of directed evolution.

5. Theory of directed evolution and the number of habitable planets

The theory of directed evolution of life was proposed to solve the basic problem of the evolution of living systems - the problem of origin of complexity. The theory of directed evolution is based on the assumption that evolution is a priori aimed at the emergence of effective living systems. In this case, selection plays a secondary role. In the frame of the proposed theory it is possible to consistently explain many different evolutionary phenomena, such as the finite lifespan of organisms, the existence of the sexes, the genetic diversity of populations [4, 6], the origin of complex organs [23], the effect of the Red Queen, and phenotypic plasticity [5, 6].

It is clear that the directed evolution of life on Earth should be, in one manner or another, connected with the evolution of stars, galaxies and the universe as a whole. This issue was considered in the paper [31]. In particular, the relationship between the number of possible inhabited worlds and the mechanisms of life evolution was considered. It was shown that the enumeration of variants of genomes is an insurmountable obstacle for non-directed evolution. Other factors (the presence of planets in the habitable zone, the speed of formation of stars, etc.) are of secondary importance. In most works, in Drake's formula, it is considered as the default that the evolution of life is Darwinian, and no other mechanisms are considered. At the same time, it is considered that the problem of enumeration of variants within Darwinism is solved simply on the basis of block coding. That is, as soon as the necessary conditions for life arise, within a short time - several hundred million years - life arises. However, as previously shown [5-7], the attempt to solve the complexity problem within Darwinian (a priori non-directed) evolution leads to a contradiction, since in the absence of a priori knowledge, the use of old genes for new tasks, block coding and other means of accelerating enumeration do not work. This conclusion also applies to the cosmic scales, since even if the number of suitable planets is 10^{20} (see, for example, [32]), this in any case is many orders of magnitude less than the number of variants of the genome.

In work [31], it was noted that initial conditions in combination with fundamental constants can be the basis of the theory of directed evolution of life in the universe. Note, however, that to construct such a theory, the "big bounce" variants are more preferable, since the emergence of complex living systems "from nothing" cannot be considered justified. Much more logical is the existence of previous states of the universe, the properties of which predetermine the emergence of life in it at a certain stage.

From the point of view of directed evolution, a strong anthropic principle can be understood as a physical law. Such a physical law does not require the mandatory introduction of the concept of "goal" for the evolution of the universe.

There are many physical laws (for example, the laws of classical mechanics), which, being deterministic, are not related to the purpose of the movement.

6. Big bounce, topology and directed evolution of life. Universe as a living system

Thus, the analysis of the Big Bang models showed that the presence of the "beginning of time" associated with the singularity is also connected with the conceptual difficulties in explaining the basic properties of the universe. These difficulties are also reflected in models of the further evolution of life. It is most natural to assume that the universe existed before the Big Bang, and the properties of the universe and life in it depend on its previous states.

The creation of a complete theory of a big bounce and the evolution of life in such a universe is a separate task. Nevertheless, it seems important to discuss the basic properties of such a model.

First, we must ask ourselves where the pure state of the universe comes from in the early stages of its expansion (most models now assume that this is a hot superdense state). To do this, we turn to analogues in other fields of physics, in particular, to the theory of condensed states. In a number of substances, so-called quantum phase transitions that are not associated with thermal fluctuations are known (see, for example, [33]). In this case, the structure of the quantum system is rearranged, for which quantum fluctuations are responsible. This reorganization occurs under the influence of external parameters, such as pressure. It can be assumed that under a strong compression of the universe, a similar process occurs - it is ordered, passing into a pure quantum state. As a result, such a state can no longer be described on the basis of thermodynamic parameters, but only on the basis of the wave function. Therefore, it makes no sense to talk about such a superdense state as about hot.

As already noted above, a big bounce can be interpreted as scattering, in which the conservation laws are satisfied. In scattering, other quantities can also be conserved. In nature, many phenomena of this type are known: scattering of elementary particles (elastic and inelastic), explosions directed inward, chemical reactions and other phenomena. In all these cases, the state of the system after scattering is determined by its state before it.

Second, one can notice a deep connection between the theory of information transfer and the scattering of the universe. The states before and after scattering can be interpreted as the original and received messages. In this case, the transmission process may be accompanied by noise. One of the tasks of coding theory is the transfer of information without loss, for which the codes correcting errors are used. Thus, the information contained in the universe before the Big Bounce can be transferred to the state of the universe with or without losses, after the big bounce. For example, topological quantum computers, whose algorithms have been discussed repeatedly, are robust to errors (see, for example, [34-36]). These ideas can also be used to model the evolution of the universe.

Third, as analysis of the interaction between biologically important molecules has shown, their topological properties are fundamentally important for the effective operation of molecular machines. For example, when considering the generalized Levintal's paradox [37], it is the topological properties of molecules that do not allow solving the paradox within the framework of classical mechanics. Topology is also important in the modeling of directed evolution in the control of DNA operations [4, 5]. To solve the generalized Levintal paradox, a quantum model of the interaction of biologically important molecules is constructed in papers [37, 38]. According to this model, we can write the following:

$$i\hbar\frac{\partial\psi}{\partial t}=\hat{H}\psi+\varphi\psi\,, \tag{3}$$

$$\frac{\partial \varphi}{\partial t} = g\left(\varphi, \psi\right) . \tag{4}$$

The first equation of the system contains the potential φ, which is responsible for the collective interaction of the particles. The second is the equation of motion of the potential φ. It is the presence of the multi-particle potential that substantially limits the interaction between biologically important molecules so that most of the "wrong" reactions turn out to be forbidden.

The most significant moments of this model are the long-range interaction and collective character of the operator φ. The latter implies that the superposition principle does not hold for φ:

$$\varphi_{\Sigma} \neq \sum_{i} \varphi_{i} . \tag{5}$$

These and other properties allow us to assume that topology plays a fundamental role in the scattering of the universe and the coding of information in it.

The model proposed above (3, 4) is an extension of quantum mechanics. This is expressed in the fact that, for example, in a non-Archimedean space, distances acquire a different meaning. Moreover, the importance of the topological properties of a quantum system noted above requires concretization. From a mathematical point of view, topological operations are more general than operations on wave functions in a metric space. First, the metric space itself is a special case of a topological space, since one can dispense with the concept of proximity of points without the notion of distance (see, for example, [39]). Second, dynamics in a metric space can be generalized using the concept of "mapping". In particular, in the topology the special case of the mapping plays an important role - the homeomorphism. According to [39] the mapping of a set X into a set Y is a triplet composed of X and Y and a rule that assigns to each element of the set X an element of the set Y:

$$f : X \to Y.$$

Such a mapping can be interpreted from a dynamic point of view as the transformation of a set at the next instant of time:

$$f : X(t) \to X(t+\tau). \qquad (6)$$

Such a homeomorphic transformation is more general than a unitary evolution. If we consider the wave function as a set, then the unitary transformation

$$\Psi(t+\tau) = \hat{U}\Psi(t) \qquad (7)$$

will always be a homeomorphism, but the converse is not true.

For unitary evolution in quantum mechanics, the purity of the state is an invariant. If we consider the wave function as a topological object, then the more general properties of the wave function, such as the connectivity or the number of dimensions, can be invariants.

As shown by the analysis of the interaction between biologically important molecules, *in some sense*, the distance between them is not important. This is expressed in the fact that rather distant particles are bound, rather than necessarily neighboring ones. This also means that the dynamics of biologically important molecules occurs, generally speaking, in topological space. It is natural to assume that an analogous property holds also for a big bounce (scattering) of the universe.

If in a superdense quantum state of the universe the metric space does not play a role (but only a topological one), then there is no sense in talking about the quantization of gravity. As already suggested, gravity is either not quantized at all or the conditions for its quantization are not achieved. This eliminates the problem of divergences in the theory of quantum gravity.

The foregoing allows us to assume that the interaction between the particles of the early universe is determined by homeomorphic transformations of the type (6), in which the wave function appears as the set. In this sense, the application and further development of topological quantum field theory seems promising. Nodes and other topological defects within the framework of such a theory can be used to encode information about the future states of the universe.

As suggested in the works [22, 42], the superdense state of the universe could be accompanied by a transition to non-Archimedean dynamics. Such dynamics could occur with respect to the pure state of the universe - quantum scattering. Earlier (see, for example, [43]) quantum mechanics was generalized to the field of p-adic numbers. In this sense, the state of the universe before a big bounce can be considered as encoded on the basis of p-adic numbers.

The wave function in the framework of non-Archimedean dynamics may have additional properties (degrees of freedom). In this case, the same energy can be associated with a set of parameters based on p-adic coding.

Thus, a Big Bounce can be treated as scattering, as a result of which several universes might arise (Fig. 1).

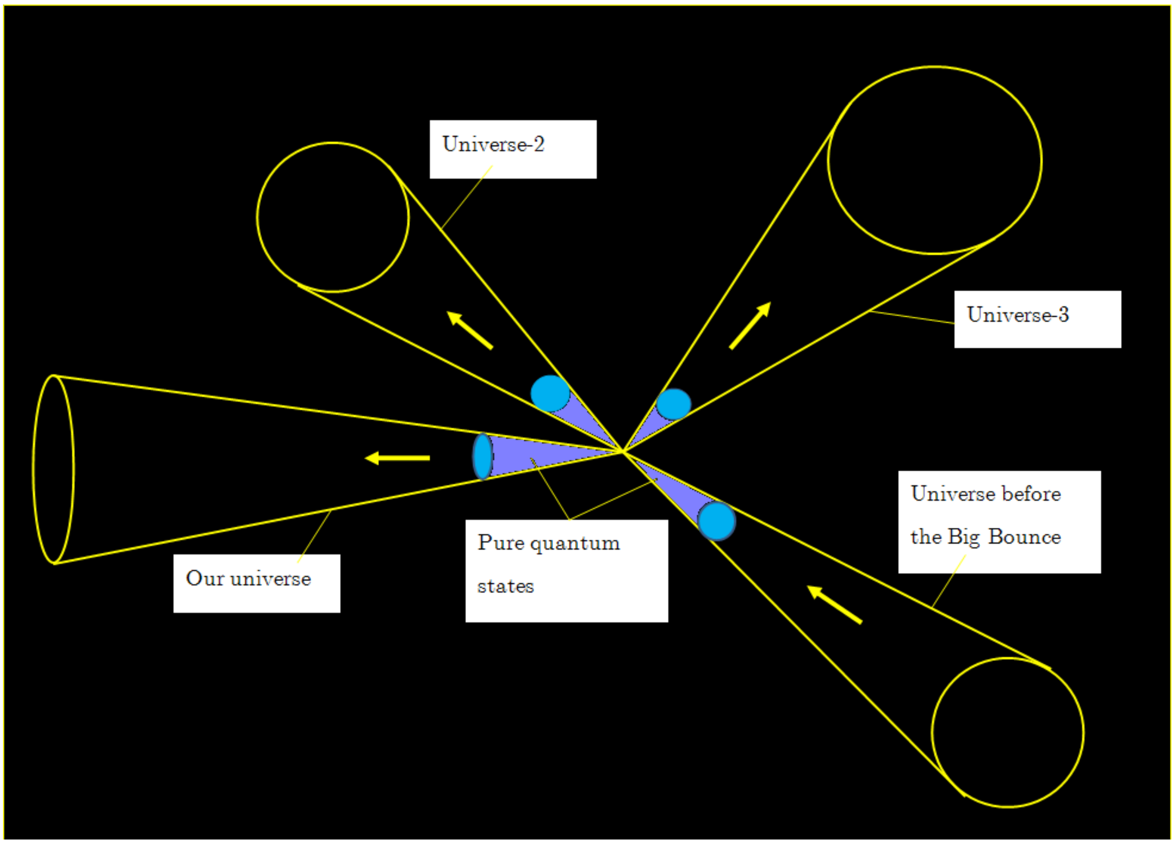

Fig. 1.

In this case, (and for particles in a similar situation), different universes can be entangled with each other in terms of a number of properties. That is, when after the phase of the initial pure quantum expansion the universe goes into a mixed state, it may turn out that some of its subsystems remain in the pure state for quite a long time. This also applies to other universes. That is, the universes remain connected to each other, no matter how far they are located.

On the other hand, as noted above, the fact that the universe is now practically flat requires that it be flat at the very first moments of its expansion. However, this is only a necessary, but not sufficient, condition. For the universe to be flat at the present time, it is still necessary that the value of the cosmological constant $\Lambda(t)$ be quite certain. This can be attempted to explain with the help of a weak anthropic principle, however, as noted above, the formulation in the form of a physical law is preferable. In this sense, we can draw an analogy between the universe and the organism, which is not accidental. In this sense, a certain value (or dependence on time) of a cosmological constant can simply represent a mechanism for the "growth" of the universe (by analogy with the growth of an organ, tissue, organism).

The nature of the cosmological constant is currently unknown, but it can be assumed that it is a nonlocal long-range field through which different universes are connected and that controls the rate of their expansion. Another option would be to control the composition of dark matter by converting its particles into particles with another (quite definite) mass that can lead to a change in the average density of the universe. Such control can be observed as a manifestation of the hidden order of the universe, consonant with Bohm's ideas (see, for example, [44]).

Earlier interaction with the help of nonlocal multiparticle fields was used to simulate the dynamics of biologically important molecules, the formation of organs and directed evolution [4, 23, 37]. This property can be considered a manifestation of similarity at different levels of the hierarchy of matter. In this case, and in many others, the distance *in some sense* does not matter.

On the basis of what has been said above, the hypothesis of a directed evolution of life in the universe can be formulated in the form of the following provisions:

1. Before the big bounce, the universe was in a pure quantum state. In this state, the properties of the universe after scattering (world constants, particle masses, etc.) are encoded. This very state arose by the mechanism of a quantum phase transition. In this case, a big bounce can also be regarded as quantum scattering.
2. In the initial stage of expansion, the universe was also in a pure quantum state; as a result of decay (decoherence), it became hot and acquired other thermodynamic parameters. At the same time, some of its subsystems, which interact weakly with others, could for a long time remain in a pure quantum state.

3. Further expansion of the universe was controlled by the changes in the parameters of dark energy (dark matter). Certain values of the constants and fields have led to the fact that the macroparameters of the universe evolved such that stars and galaxies subsequently formed, in addition to other parameters of the universe that created the necessary conditions for the emergence of life in later stages.
4. At a certain stage, in the presence of these necessary conditions, after the appearance of atoms and molecules in certain systems, quantum laws began to play an important role, governing both the spatial structure and the evolution of replicators. These laws are also ultimately conditioned by the state of the universe before a Big Bounce (scattering).
5. In the future, such a partially directed evolution was going in the direction of increasing complexity of organisms and their increasing adaptation to various environmental conditions. The laws of partially directed evolution are a consequence of the laws of physics and the initial conditions that characterize the universe.

The proposed model of the evolution of the universe and the further appearance of life in it demonstrates a great similarity of the universe with the organism. Similarities and differences between the universe and living systems are summarized in Table 1 (see also [31]).

Table 1.

Universe	Cell, organ, organism
Billions of years.	Seconds, hours, years.
Properties encoded in the past states of the universe?	The state encoded in genes, however, environment also plays an important role.
The lifetime of the universe is limited ($\Lambda(t)$)?	The lifetime of an organism is limited. Lifetime is largely controlled by genes.

Life in the universe arose at a certain stage of its expansion.	Some organs and tissues appear at later stages and are not present at birth.
Compensatory mechanisms must exist to ensure that the evolution of life in the universe occurs when there is destruction of life in some parts of the universe. There must be alternative life forms for extreme conditions.	There are compensatory mechanisms that begin to work when environmental properties deviate from optimal values.
Long-range interaction and nonlocality take place.	Long-range interaction and nonlocality take place.
Topology is important	Topology is important

Such a similarity of the universe with living organisms in many respects is not accidental and suggests that the universe itself can be classed as a living system. All existing forms of life in this case can be considered as endosymbionts in relation to the universe as a superorganism. Previously, such an idea was put forward by Lovelock in relation to the Earth [45].

The process of a bounce (scattering of the universe) turns out to be largely deterministic (predictable). In this sense, it is in many respects similar to the exchange of genes between living organisms or cell division. As was shown earlier (see, for example, [5]), the exchange of genes is largely a deterministic process, in which randomness plays a secondary role and mutations are controlled.

In the light of what has been said above, it is not surprising that the initial state of the universe is very special. For any living organism, the initial state is also very special and extremely unlikely, if one tries to obtain it through enumeration of variants.

As already noted above, a number of authors have previously proposed models according to which selection can occur among the Universes [46] within the framework of the multiverse. In the light of the theory of directed evolution, this idea can be reformulated as follows: the evolution of the universe is directed and controlled, i.e., is determined by physical laws. As a result of compression and further bounces (scattering), other universes are formed. In this process, randomness occurs but plays a secondary role. This is the role it also plays in our biosphere, for which, within the framework of the theory of directed evolution [6], it is shown that selection and random mutations cannot play an essential role in the creation of species. As Berg wrote [47], "selection protects the norm." These statements remain true also in relation to the universe.

Thus, the forms of life known to us today are largely programmed before the big bounce of the universe. This applies not only to organisms and ecosystems but also to processes of thinking. In works [38, 48], it is shown that the acquisition of knowledge is contradictory, since for the adequate use of new concepts, they must exist before they are created, which is impossible. As a result, it was concluded that a priori correct judgments are possible because they are correct *innately*. As a result of training, only a choice of appropriate behavioral programs occurs, in which all “new” concepts, generalizations, and other properties are already included a priori. The innate nature of all behavioral programs, in addition to thinking as such, fully fits into the concept of the directed evolution of the universe.

Thus, all processes of thinking are also largely programmed in the states of the universe before the Big Bounce.

Conclusions

The universe in the early stages was not hot but rather in a pure quantum state. This assumption allows solving the basic problems of cosmology from a unified standpoint: flatness and homogeneity of the universe, in addition to the predominance of matter over antimatter and the absence of monopoles. A pure quantum state was formed due to large compression as a result of a quantum phase transition. In this case, a Big Bounce can be treated as quantum scattering, as a result of which more than one universe can form. The properties of the universe, on the basis of which life arose in it, were encoded in topological states before a big bounce (scattering). Later life evolved directly. Dark matter and dark energy can be used to control the lifetime of the universe. The universe itself can be considered as a superorganism.

References

1. Davies P (2007) Cosmic Jackpot, Why Our Universe Is Just Right for Life. New York, NY, Orion Publications, 2007.

2. Rees MJ (1999) Just Six Numbers, Harper Collins Publishers.

3. Morison I (2013) Introduction to astronomy and cosmology. Hoboken, N.J., Wiley.

4. Melkikh AV, Khrennikov A (2017). Quantum-like model of partially directed evolution. Progress in Biophysics and Molecular Biology 125: 36-51.

5. Melkikh AV, Khrennikov A (2017) Molecular recognition of the environment and mechanisms of the origin of species in quantum-like modeling of evolution. Progress in Biophysics and Molecular Biology V. 130, Part A: 61-79.

6. Melkikh AV (2014) Quantum information and the problem of mechanisms of biological evolution. BioSystems 115: 33-45.

7. Melkikh AV (2015) Paradoxes of early stages of evolution of life and biological complexity. Origins of Life and Evolution of Biospheres V. 45, issue 1: 163-171.

8. Weinberg S (2008) Cosmology. Oxford University Press, Oxford.

9. Starobinskii AA (1980) A new type of isotropic cosmological models without singularity. Physics Letters B 1: 99-102.

10. Guth AH (1981) Inflationary universe: A possible solution to the horizon and flatness problems. Phys. Rev. D 23: 347-356.

11. Albrecht A, Steinhardt PJ (1982) Cosmology for grand unified theories with radiatively induces symmetry breaking, Phys. Rev. Lett. 48: 1220-1223.

12. Linde AD (1982) A new inflationary universe scenario: a possible solution of the horizon, flatness, homogeneity, isotropy and primordial monopole problems, Phys. Lett. B. V. 108, issue 6: 389-393.

13. Linde AD (1983) Chaotic Inflation, Phys. Lett. B. V. 129, issues 3-4: 177-181.

14. Melkikh AV (2018) A pure quantum universe as an alternative to inflation. http://vixra.org/pdf/1803.0632v1.pdf.

15. Feynman RP, Morinigo FB, Wagner WG (1962) Feynman lectures on gravitation. CRC Press. Taylor and Francis group.

16. Batterfeald D, Peter P (2015) A critical review of classical bouncing cosmologies. Physics Reports. V.571: 1-66.

17. Penrose R (2011) Cycles of time, an extraordinary new view of the universe. New York, Knopf.

18. Levin Y, Pakter R, Rizatto FB, Teles TN, Benetti FCP (2014) Nonequilibrium statistical mechanics of systems with long-range interaction, Physics Reports. 535: 1-60.

19. Campa A, Dauxois T, Ruffo S (2009) Statistical mechanics and dynamics of solvable models with long-range interactions, Physics Reports. 480: 57-159.

20. Arnold VI, Kozlov VV, Neishtadt Al (1988) Mathematical Aspects of Classical and Celestial Mechanics; Springer, New York, Encyclopedia of

Mathematical Sciences, Vol. III, ed. V.1. Arnold (originally published in Moscow, (1985)).

21. Melkikh AV, Melkikh EA (2017) Can we use thermodynamics in the systems with gravity? Modern Physics Letters B, V. 31, No.29, 1750272.

22. Dragovich B, Khrennikov AYu, Kozyrev SV, Volovich IV, Zelenov EI (2017) p-Adic Mathematical Physics: The First 30 Years. P-Adic numbers, ultrametric analysis and applications. V.9, issue 2: 87-121.

23. Melkikh AV, Khrennikov, A (2018) Mechanisms of directed evolution of morphological structures and the problems of morphogenesis. Biosystems. 168: 26-44.

24. Waltham D (2011) Testing anthropic selection, a climate change example. Astrobiology 11(2): 105-114.

25. Iorio L (2010) Anthropic constraints on the cosmological constant from the Sun’s motion through the Milky Way. Monthly Notices of the Royal Astronomical Society 403(3): 1469-1473.

26. Freivogel B (2010) Anthropic explanation of the dark matter abundance. Journal of Cosmology and Astroparticle Physics 03, 021.

27. Randall L (2015) Dark matter and the dinosaurs. Harper Collins, Ecco Press.

28. Mack KJ (2011) Axions, inflation and the anthropic Principle. Journal of Cosmology and Astroparticle Physics 07, 021.

29. Kizek M (2012) Dark energy and the anthropic principle. New Astronomy 17: 1-7.

30. Drake F (1962) Intelligent Life in Space. MacMillan, New York.

31. Melkikh AV, Mahecha DS (2017) On the Broader Sense of Life and Evolution: Its Mechanisms, Origin and Probability across the Universe. Journal of Astrobiology & Outreach. V.5, issue 3: 1-13.

32. Zackrisson E, Cassilendorf P, Gonzalez J, Benson A, Johansen A, et al. (2016) Terrestrial planets across space and time. The Astrophysical Journal V.833, no. 2: 1-12.

33. Sachdev S (2011) Quantum Phase Transitions. Cambridge University Press. (2nd ed.).

34. Trebst S, Troyer M, Wang Z, Ludwig AWW (2008) A short introduction to Fibonacci anyon models. Progress of Theoretical Physics Supplement, V.176: 384–407.

35. Wootton JR, Burri J, Iblisdir S, Loss D (2014) Error correction for non-Abelian topological quantum computation. Phys. Rev. X 4, 011051.

36. Nigg D, Muller M, Martinez EA, Schindler P et al (2014) Quantum computations on a topologically encoded qubit. Science 345: 302–305.

37. Melkikh AV, Meijer DKF (2018) On a generalized Levinthal's paradox: the role of long- and short range interactions in complex bio-molecular reactions, including protein and DNA folding. Progress in Biophysics and Molecular Biology 132: 57-79.

38. Melkikh AV (2014) Congenital programs of the behavior and nontrivial quantum effects in the neurons work. BioSystems 119: 10-19.

39. Viro OYa, Ivanov OA, Netsvetaev NYu, Kharlamov VM (2008) Elementary topology. American Mathematical Society.

40. Khrennikov A (2004) Information dynamics in cognitive, psychological, social, and anomalous phenomena. Ser.: Fundamental Theories of Physics, Kluwer, Dordreht.

41. Khrennikov A (2004) Probabilistic pathway representation of cognitive information. J. Theor. Biology 231: 597-613.

42. Aref'eva IYa, Dragovich B, Frampton PH, Volovich IV (1991) The wave function of the Universe and p-adic gravity, Int. J. Mod. Phys. A 6: 4341–4358.

43. Vladimirov VS, Volovich IV (1989) p-Adic quantum mechanics, Comm. Math. Phys. 123: 659–676.

44. Bohm, D (2005) Wholeness and implicate order. Taylor and Francis.

45. Lovelock J (1979) Gaia: A new look at life on earth. Oxford University Press, Oxford.

46. Smolin L (2006) The status of cosmological natural selection. arXiv,hepth/0612185v1.

47. Berg LS (1969) Nomogenesis or evolution determined by law. 1926. Reprint. Cambridge, Mass.: MIT Press.

48. Melkikh AV (2014) The No Free Lunch Theorem and hypothesis of instinctive animal behavior. Artificial Intelligence Research V.3, No 4: 43-63.