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THE WORLD IS LIKE GRAINS OF SAND IN A VAST VACUUM OCEAN

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A physical vacuum is an omnipresent, all-penetrating, energetically minimized environment that does not contain material particles, which fills the entire boundless space, i.e. everything that is inside and outside of it.

The idea of vacuum as emptiness is intuitively inherent in every person. In science, it arose in ancient times. Among the historical monuments that have come down to us, the first mention of it is found in the book of the Torah “Breshit”. Here we read:

«At the beginning of the creation of heaven and earth, when the earth was empty and disorderly, and darkness was over the abyss…» [1].

It is clear that by “earth” the author means the entire Universe known at that time.

The idea of a vacuum has been the subject of debate since the times of ancient Greek and Roman philosophers. People first started talking about vacuum around 500 BC. Leucipus. Democritus (about 450 BC) and Epicurus (about 350 BC) understood vacuum as the void in which atoms and things made up of them float. They believed that without a vacuum there would be no movement.

Empedocles and Aristotle (450-350 BC), on the contrary, proceeded from the fact that “nature abhors a vacuum” (horror vacui).

The empirical study of vacuum began during the Renaissance in the 16th – 17th centuries. The founders of natural science, incl. Galileo and Newton did not yet distinguish between technical and cosmic vacuum and considered vacuum as a highly rarefied gas, paying special attention to the problems of its use in practice. Therefore, they abandoned Aristotle's formula from the very beginning.

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Einstein had the courage to admit he was wrong, which cannot be said about many modern proponents of alternative, untested ideas. So, for example, hiding behind the name of Einstein, academicians A.E. At the end of the last century, Akimov and G.I. Shipov vigorously promoted the theory of torsion fields they developed. Based on Shipov’s false theory of vacuum [3], they attributed to him enormous energy, which could supposedly be taken from him and used for practical purposes. These fantastic speculations were expressed by Nikola Tesla 100 years ago, and Evans proposed using vacuum energy. All to no avail. This did not stop Akimov. Despite the objections and criticism of the USSR Academy of Sciences, under the influence of Akimov, the Council of Ministers and the USSR State Committee in 1989 created a huge secret scientific and technical center for the development of non-traditional technologies (later ISTC VENT), which was headed by Akimov. Soon Shipov appeared at the center as the chief theoretician. In total, according to RAS estimates, the state treasury allocated 500 million pre-reform Soviet rubles for the work of torsion bars. The result is zero.

Modern quantum physics has come closest to understanding the nature of vacuum. The concept of ether as a kind of equivalent of vacuum, i.e. the environment that fills the voids are completely rejected by it, since, in principle, no voids exist in the real world. At the same time, quantum field theory recognizes the fundamental importance of vacuum in the origin and functioning of the stellar-galactic Universe.

In it, the vacuum, like everything that exists, is considered as a quantum object, as a medium in which there are no material particles, i.e. particles of matter and fields, but is not a void. This, from the point of view of quantum field theory, means that vacuum is a field whose particles are located in the ground, i.e. lowest energy quantum state with the lowest possible energy. It constantly fluctuates, i.e. performs zero oscillations [4].

They often talk about vacuum as a material object that is in a special state. From my point of view, this is an erroneous interpretation of vacuum.

Indeed, today we adhere to two definitions of matter - philosophical and natural-scientific, which complement each other and characterize matter from different sides.

Matter, in its scientific content, is the building material of the Universe, which is formed by material fundamental particles folded in different orders and combinations and particles of fundamental fields connecting them. From a philosophical point of view, matter is what is given to us as a sensation. But sensations arise as a result of the interaction of material particles and fields with our sense organs and the devices that replace them, or, more precisely, the interaction of material particles with each other.

A vacuum has neither one nor the other. It does not consist of material particles, but is populated by particles that are not given to us into sensation. In it, apart from periodically repeating fluctuations that are inaccessible to observation, nothing happens. Therefore, it is not described by physical quantities or quantum numbers known to us - mass, momentum, metric, time, temperature, etc. There are no material bodies and reference systems in it, therefore there are no movements in the broad sense of the word. In order to understand what is happening to it and connect it with our world, we conditionally attribute to it all the indicated characteristics.

Like any quantum object, the vacuum is subject to an uncertainty relation that causes its symmetry to spontaneously break, and it therefore fluctuates. These fluctuations boil down to the birth and disappearance of virtual particles.

This happens as follows. At the beginning of each period, the vacuum energy, according to the uncertainty relation, reaches a maximum. As a result, the vacuum jumps to a higher quantum energy level. This is equivalent to the birth of a virtual particle. But according to the principle of charge symmetry, its antiparticle is born along with it. The couple annihilates. The result of annihilation is, in accordance with the same uncertainty relation, the return of the vacuum to the main energy level, which is equivalent to the disappearance of the virtual particle. Then the process is repeated.

In other words, vacuum fluctuations lead to the periodically repeated birth and disappearance of virtual particles, differing in their charges, spins, and various indefinite masses, which, when given energy from the outside, can turn into real photons, electrons, neutrinos, quarks and their antiparticles. It depends on the amount of energy they acquire

Many of these provisions of field theory have found experimental confirmation. For example, the Casimir effect and the Lamb shift of atomic levels of hydrogen and hydrogen-like elements are explained by zero-point oscillations of the electromagnetic field in the physical vacuum. The Casimir effect is that, for example, two parallel conducting uncharged plates placed in a vacuum at a fairly close distance (about 10 nm) attract each other. This is explained by the fact that virtual particles born between the plates press on each plate with a force less than 2 times than the same number of photons outside. Here it is assumed that virtual particles born in a vacuum are realized under the influence of energy emitted by the plates. The Lamb shift is a shift in the levels of the outer electron of hydrogen-like atoms relative to the calculated one under the influence of zero-point vibrations of the vacuum.

Since the vacuum energy cannot be less than the minimum value, i.e. it cannot be spent, then nothing else happens in it, except for fluctuations that periodically repeat. Particles born in the process of fluctuations are virtual in the sense that they are short-lived and, in principle, unobservable. Energy pulsates inside the vacuum, being born and disappearing in it without dissipation. An observer, even if he were present, could not see this process. After all, energy is completely consumed in the process itself, and there is no material carrier to which part of the vacuum energy could go, and which could bring information about it to an imaginary observer, in the vacuum. It is also easy to understand that on average the law of conservation of energy and the symmetry of the vacuum are not violated, and its average energy, although non-zero, is the minimum possible, i.e. In a vacuum, on average nothing happens. But only on average. In reality, its energy is always different from zero, its symmetry is always spontaneously broken, and it continuously fluctuates, virtual particles are continuously born and disappeared in it. These particles seem to periodically fall from the top of the potential barrier to the bottom of the potential well and, under ideal conditions (no influence of external factors), they again climb to the top of the barrier due to the kinetic energy accumulated during the fall. This resembles the periodic process of a ball rolling in the absence of friction and air resistance from the top of an inclined hill to the bottom of a hole, which serves as the beginning of the next similar hill, to the top of which, moving under the influence of accumulated kinetic energy, the ball climbs. This process can ideally be repeated periodically without interruption.

A clear analogy for vacuum is the ocean. The only difference between them is that the ocean of our earthly home is located on a twodimensional sphere of the globe and, therefore, in contact with the third dimension, is subject to constant influence of external factors. As for the vacuum, it is logical to assume that it meets the conditions of the Poincaré-Perelman theorem, and is located on a three-dimensional sphere, is limitless and omnipresent and is not subject to any external influences. There is, of course, a question. Does the vacuum really meet the conditions of the Poincaré-Perelman topological theorem?

Let me remind you that Poincare formulated his hypothesis more than 100 years ago. She sounded like this. Every simply connected three-dimensional compact manifold without boundary is homeomorphic to a three-dimensional sphere.

A variety is an ordinary set without special points. For example: a cylinder, a sphere, the surface of a torus, an ellipsoid, a plane, a straight line – these are manifolds. Any polyhedron, cone, etc. is not a variety, because their vertices are singular points. A manifold is called simply connected if, roughly speaking, it has no continuous holes. For example, a sphere and the surface of an ellipsoid are simply connected manifolds. And the surface of a torus and a pretzel are multiply connected manifolds. Further. A straight line, a plane, an interval, a circle, a sphere are manifolds without an edge. Manifolds without an edge often include closed lines or surfaces, beyond which one cannot go without going to another dimension. A manifold without an edge can be compact, such as a circle, a sphere, as opposed to an interval, a straight line or a plane. A ball is a manifold with an edge, and its spherical surface is a manifold without an edge.

From my point of view, a vacuum can be considered as a three-dimensional simply connected compact manifold without boundary. In this case, it is located on the surface of a three-dimensional sphere. Looking at space or vacuum, it seems to us that we live inside a vacuum ball. We think that, moving in space in the same direction, we, if it is finite, will reach its edge. Therefore, a natural question arises for us. And what is beyond our space? The inevitable answer follows that we live in infinite space, and therefore in infinite time. However, logically, it is in principle impossible to jump from an infinite world to a finite one and vice versa.

It takes some imagination to imagine a three-dimensional surface. However, it's not that difficult. Let's imagine that our three-dimensional space, although finite, is limitless. In other words, no matter how long we move in one direction, we will not be able to go beyond it, we will not be able to leave it, but we will end up at the same starting point. Since, from our point of view, space cannot have more than three dimensions, it is omnipresent. Likewise, vacuum is omnipresent, i.e. nothing exists except vacuum [5].

Let's go back to the ocean. Let us assume that there is ideal calm. The sky is uniformly gray. Temperature, humidity, pressure are constant. Our ship is designed in such a way that it does not cause disturbances to the water in the ocean during its movement. Let's look at the ocean. It appears to us in the form of identical small ripples everywhere, although there is no reason for its existence. This ripple is the same irremovable fluctuation that exists in the absence of external factors for the simple reason that absolute peace does not exist. You can, of course, refer to certain initial conditions. But the initial conditions themselves may turn out to be causeless fluctuations in nature. The same is true for vacuum. Constantly fluctuates in the absence of any external disturbing factors.

Meanwhile, spontaneous symmetry violations are not identical and can, therefore, with a certain probability lead to a violation of the homogeneity of fluctuations and the emergence of a number of minima located above the main one. This process leads to vacuum degeneration, i.e. to the appearance of a spectrum of local minima in it. These minima are called false vacuums in contrast to the main, true vacuum.

With this approach, the big bang can be hypothetically considered as a process of spontaneous breaking of vacuum symmetry and the transformation of virtual vacuum particles into real particles. To do this, it is enough to assume the possibility of transferring energy from a higher level of false vacuum to particles of true vacuum.

The question arises: how do virtual particles of false vacuums get out of the potential holes in which they are located? After all, being in a false vacuum is like a ball stuck in a hole on a hillside. An obstacle (hill) prevents the ball from rolling down onto a flat clearing (see Fig. 1).

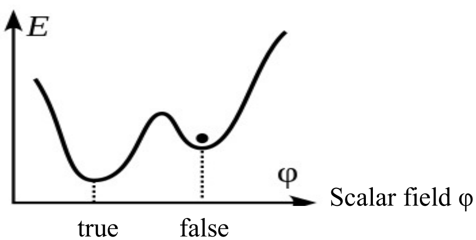

Fig. 1

To roll down, the ball must get out of the depression and overcome the hill. The ball cannot do this on its own. To do this, he needs to impart energy from the outside.

The quantum field, being at the bottom of the false vacuum, is also inactive, because it is also vacuum and cannot consume energy. However, quantum objects, as is known, unlike macro objects, have the property of overcoming a potential barrier by tunneling through it. This process also takes place without violating the law of conservation of energy on average, so it is not prohibited. This property can be considered as a manifestation of a certain conscious principle that can direct blind nature into a rational direction.

According to the vacuum model, the author of which is the Soviet American cosmologist A. Vilenkin, before the big bang the quantum field was in a state of false vacuum, i.e. it corresponded to a higher minimum possible energy level, the ground energy state of the hypothetical virtual quantum field. Having leaked through the barrier, the energy of this field realized particles of true vacuum, which became the cause of the big explosion.

A commonly asked question is how long does it take for the quantum field of the false vacuum to leak through the barrier and lead to the big bang? Why did our Universe arise as a result of the big bang exactly 13.8 billion years ago, no later and no earlier?

When it comes to a probabilistic process, such a question is illegitimate. Moreover, here we are talking not just about probability, but about conditional probability, the value of which is unknown to us, because we basically cannot know it. First of all, we do not know with what probability false vacuums arise in an infinite vacuum, what is the width of their spectrum and which of them are able to collapse and when this happens. We only know that the probability of a quantum object leaking through a barrier is determined by the height of the barrier and the amount of energy of the object, and that for the formation of our Universe they turned out to be huge. Even when we know the magnitude of this probability, we still cannot predict when it will happen or whether it will happen at all.

Let's imagine that we have a radioactive substance with a half-life known to us, equal to, for example, 10 years. Let's choose one of the atoms of this substance and ask ourselves a question. When will it explode? It is clear that we cannot answer this question. It could explode in a second, an hour, a year, 10 years, a billion years, or never explode at all.

Based on the vacuum model we have considered, we can say that many false vacuum can form in it, but whether all of them are able to lead to a big explosion and the emergence of real particles of matter and field, and with what probability this can happen, we cannot say.

There is one more important question. Can any Universe, having arisen, be realized? Paradoxical as it may seem, if the hypotheses about dark matter and energy are confirmed, then the emergence and development of our star-galactic Universe looks like a big accident. After all, 95.1% of the real particles formed turned out to be inactive; they did not create atomic matter. Why, besides them, did other particles endowed with the necessary properties arise? After all, we already see today that if, along with inactive particles, not quarks, not photons and not electrons, but some slightly different particles were formed, then protons could not arise, there would be no nucleosynthesis, there would be no would be atoms, etc. Now they say that these particles already potentially existed, in the form of virtual particles in a vacuum. Why them? We can already understand why virtual particles are formed as a result of vacuum fluctuations, but what exactly gives these particles the necessary properties is incomprehensible. Moreover, this contradicts the uncertainty principle. It seems that Nature does not act in accordance with fatal laws, but purposefully and taking into account expediency and fine tuning.

The vacuum model we have considered allows us to answer other questions that are also often asked, but do not know the answer. The first one. Why is the Universe expanding?

The Universe is made up of stars, the distances between which are much larger than their sizes. In this sense, it resembles a gas in which all its particles (stars) and their aggregates (galaxies) are very weakly interconnected by gravity. The density of this gas is small, but it is still significantly greater than the density of vacuum, and their gradient is balanced by the average gravity. If, as a result of fluctuations, the Universe increases slightly, then the average value of gravity will decrease, and the density gradient will remain practically unchanged. This will lead to a further increase in the size of the Universe, etc. Many stars behave in exactly the same way. Our Sun, for example, in 2 billion years will expand to the current size of the Solar System. For stars with a mass of 1.4 solar masses or more, this expansion process is so intense that they explode like supernovae.

The considered model, from my point of view, also answers another question: does dark energy exist, which is the cause of the accelerated expansion of the Universe. The answer is obvious. Most likely not, because... Over time, the average gravity decreases, and the density gradient remains almost unchanged. Consequently, the rate of expansion increases over time, although the acceleration decreases and there is a possibility that it will pass through a maximum. Vacuum fluctuations are currently being tried to explain the emergence of the Higgs field. After all, false vacuum are accompanied not only by minima, but also by maxima, and they exactly resemble the Higgs field [6].

The vacuum model is thus quite productive, and it is this model that may allow us to answer questions that so far exist only as hypotheses.

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