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Crystal Universe

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Abstract

Solitons are the objects which on the one hand combines in itself the properties of particles and waves and on the other hand obeying the Lorentz invariance. These features make the soliton look like as elementary particles. It is possible to imagine the Universe to be made of solitons. This paper presents some possible features of such solitons Universe. In particular some attention has been paid to following issues: the model of expanding Universe, the energy conservation laws, the time arrow, the dark energy, the vacuum media, the Universe inside the black hole and so on.

Keywords: Science; Physics; Chromodynamics; Earth

Introduction

The revival of the ether and "accursed" questions of physics

By its 125th anniversary the famous journal Science published a list of the greatest mysteries facing modern science. Most of them are vital concerns of mankind, but in the foreground remains the eternal philosophical questions. So, a list of the greatest scientific mysteries of the journal science [1] is:

- What is the Universe?
- Is it possible to unify all the laws of physics?
- Are there any “brothers in mind” at the Universe?
- When and where originated the earthly life?
- Does God play in the bone? Whether is there the deeper meaning in a quantum uncertainty principle and nonlocality?

Vitaly Ginzburg [2] published their list of pressing problems in physics, some of which are listed below:

- The spectrum of masses. Quarks and gluons. Quantum chromodynamics.
- Grand unification. Superunification. Proton decay. Neutrino mass. Magnetic monopoles.
- The fundamental length. The interaction of particles at high and superhigh energies.
- Non-conservation of CP.
- The cosmological problem. Inflation. lambda term. Connection between cosmology and high-energy physics
- Black Holes.
- Nonlinear phenomena in vacuum and in ultrahigh magnetic fields. Phase transitions in vacuum.
- The problem of dark matter (hidden mass).
- Origin of cosmic rays of ultrahigh energy.

The experimentalists of the LHC added a list of other relevant issues:

- What is mass?
- Are there hidden space dimensions in our world and supersymmetry particles?
- What is a dark matter?
- Why our world is made of matter, and it does not of antimatter?
- What was when the Universe was still not the substance?

The enunciation of such a broad range of unresolved problems on the most vital topics can justify the most daring flight of fantasy and putting forward of the most exotic ideas, if they can shed any light on the ways to resolve at least some of these "accursed" questions.

At the end of XIX-early XX centuries the nature of the ether-the all-pervading medium has been extensively discussed. The ether was supposed to play the role of the light carrier on analogy with sound in solids. The introduction of ether seemed reasonable from the standpoint of common sense, but faced with the challenge of "ether wind": because due to the Earth's motion relative to ether the speed of light should depend on the direction of motion of the Earth through the ether. To detect the "ether wind" a numerous ingenious experiments has been carry out. For example, the famous Michelson-Morley experiment on the interference of light beams running through the transit base in the forward and backward direction, had to register a relative change in velocity in one direction at the level of accuracy of 10^{-5}. Despite this record for that time sensitivity, the ether wind was not detected! Nor it was discovered and later through more subtle and sensitive experiments [3].

The fate of the ether was doomed. But someone still was trying to save the ether. Outstanding Dutch physicist Hendrik Lorentz found that the ether can be saved, if we assume that the size x of moving bodies are reduced, and the time t' for them to slow down according to Lorentz relations. However, experimentally verify the reduction in size and delay time up to now not feasible. Following the theory of relativity, it became clear that the assumption of the existence of the ether is not necessary. However, the creator of the theory of relativity and the "main offender" of ether Albert Einstein still recognized that "... in theoretical physics, we cannot manage without ether, i.e., continuum, endowed with physical properties, because

the general relativity... excludes direct long-range, and each short-range theory assumes continuous fields, and hence the existence of the ether "[4]. Thus, contrary to popular belief, that the concept of ether contradicts the results of experiments, "decline" of the ether was due to doubts about his "creative" potential of new ideas. In addition, the "shrinking" of sizes and slower clocks seemed totally incompatible with the concept of ether.

The following will attempt to dispel doubts about the creative potential of solid vacuum, and show that in addition to new ideas, this concept allows to find solid footing and clear guidance on the thorny path of knowledge. The inclusion of the soliton-the real Lorentz-invariant waves-particles on the “surface” of the crystalline vacuum could reconcile the concept of the solid vacuum with the principles of relativity and quantum mechanics. The identification of solitons with real elementary particles will construct all the matter from the Lorentz-invariant elements-solitons, which automatically accounts for the absence of the ether wind, "shrinking of the size", time dilation in moving frames of reference and other paradoxical challenges of 20th century physics.

Experimental

Solitons and the Lorentz-invariance in the "crystalline" vacuum

Ironically, in 1834, just when fierce fighting supporters and opponents of the ether, John Scott Russell discovered the solitary stable waves-solitons on the water surface [5]. The stability of the soliton explained by the combined effect of nonlinearity and dispersion factors. According to well-known Fourier theorem, non-sinusoidal wave of any form can be presented as a set of simple sinusoidal components with different frequencies (wavelengths) and amplitudes. The rate of nonlinear wave depends on its amplitude, so the short-wave peak of the hump will be moving faster than its long-wave base, which creates a tendency to "capsizing" of the wave. Dispersion, on the contrary, "forces" the long-wavelength components to "run" at a higher rate than short-wave, which reduces the steepness of the leading edge. When the balance of these two factors happens, the soliton form remains unchanged as it moves, and its size at the direction of travel depends on the speed in accordance with the Lorentz relations! It was later revealed that the solitons occur not only in water but also in the crystal in the form of dislocations [6], which not only obey the Lorentz relations, but also satisfy relativistic Einstein relation. Namely, the dependence of the dislocation energy E on the speed V is the same as the dependence of the energy on the velocity of a particle with mass m_0, which follows from the special theory of relativity:

$$E = \frac{m_0 v_0^2}{\sqrt{1-\left(\frac{v}{v_0}\right)^2}} \qquad (1)$$

where V_0 is the limit propagation velocity in medium that is the speed of light C in vacuum and the speed of sound in solid state.

The dislocations behave like particles: they are not destroyed when interacting with one another and divide, keeping its structure intact. This is not the only similarity with the elementary particles. Dislocations have also a kind of "charge"-dislocation and anti-dislocation attracted, and two of similar dislocations repel each other. A similar charge was named topological, which can be simplified expressed in one-dimensional case as the difference between the amplitudes of the

soliton wave at ± ∞. This "geometric" definition of the charge has sufficient completeness and generality for explanation of "real" the electric and weak charges.

Dislocations are an example of one-dimensional solitons. The existence of three-dimensional solitons has also recently been presented [7], paving the way for the construction of soliton models of real elementary particles.

Does this mean that elementary particles can be regarded as solitons? Strictly speaking, no, because this need to "rewrite" the whole current theory on the "soliton" language and make sure that nowhere on the way there is no conflict with other well-established facts, find an explanation for many of the "accursed" questions from the above list, for example, to explain the mass spectrum of elementary particles. Nevertheless, the above arguments show that the "soliton" model reflects the most important properties of elementary particles, so there is reason to use the above analogy as a starting point for further thinking. The reasons for the striking similarity of phenomena in two seemingly so distant from each other by areas of solid state physics and the physics of elementary particles, as well as the possible consequences of such an analogy, allowing to identify approaches to the solution of many vital problems of modern physics, we discuss in detail below. However, before we immerse themselves in the problems of physics is necessary to dwell on the concept of reciprocal or impulse space, which, as we shall see below, is important not only in the theory of crystalline solids, but also in this approach.

Reciprocal space

Considering the elementary particles as collective excitations of the "vacuum" crystal, we inevitably will be forced to admit that these particles are "live" in "another" space in relation to the space lattice. If this were not the case, these particles, material objects, which are composed from them, and we ourselves would be constantly faced with the atoms of crystal lattice, and would experience "ethereal wind", which is not really happening. Indeed, phonons in solids are not faced with the atoms of the crystal lattice! The thing is that the collective excitations such as solitons, which are completely determined by its momentum and energy, which belong to a special "impulse" or reciprocal space. Distance in reciprocal space has a dimension of inverse length. This metric is very peculiar: the convergence of objects in direct space corresponds to their mutual removal in the reciprocal space. All fairness, it is possible to enter the time intervals in reciprocal space also. This can be done by analogy with the theory of relativity, where the combination ct speed of light c and the time interval t is introduced as a fourth coordinate. The introduction of the "reverse" time, at first glance, appears to be too abstract; however, in addition to "a tribute of justice" such a step opens the door to new theoretical constructs that may be useful corollaries. For example, the small intervals of time in direct space correspond to large time intervals in reciprocal space and vice versa, which could lead to changes in rates of processes in the two spaces. Obviously, in the case of re-treatment, we again find ourselves in direct space. Thus, the direct and reciprocal space is independent of each other, and besides them there are no other existing spaces.

Results and Discussion

Difficulties in the standard model of expanding Universe

In 1912, Vesto Slipher firstly discovered that distant galaxies the emission spectra are shifted toward lower energies, compared with the spectra of stationary objects. This phenomenon is called "red shift" by analogy with the spectrum of

visible light, which increases the wavelength corresponds to a shift toward red. Slipher and Hubble discovered that the farther away a galaxy is, the more speed it moves away. The phenomenon of centrifugal "divergence" of the visible Universe with increasing speed as the distance from the local point of observation increases was called Hubble's Law.
Mathematically, it is stated very simply:

$$v=Hr, \qquad (2)$$

where v – is the rate of removal of the galaxy from us, r-the distance to it, and H-the so-called Hubble constant. The latter is determined experimentally, and today is estimated as 70 km/(sec Mpc) (km per second per Mpc, 1 Mpc is approximately 3.3 million light years). This means that a galaxy away from us at a distance of 10 Mpc, runs away from us at a speed of 700 km/sec.

Extrapolation of the expansion to the initial point in time leads to the conclusion that the billions of years ago, all matter in the Universe was originally concentrated in a very small volume, which suddenly began to grow rapidly, forcing all objects mutually move away, relative to each other. As a result, a theory of the Big Bang was developed. "Pointlike " or, as they say, the singularity of matter at the time of the Big Bang led to the problem of standard Big Bang theory. These problems are resolve itself into, first, to the presence of the cause-disconnected regions in the early Universe, which were to remain isolated from each other under further expansion, and, secondly, the fact that our Universe has a density very close to the critical, that is, essentially, is flat, it's hard to explain in the standard model.

To overcome the problems of standard Big Bang model the inflation model was put forward, which assumes a period of accelerated expansion in comparison with the standard model of the Universe (over a time ~ 10 sec-35 sec) from the so-called "Planck's" (10 cm-33 cm) to its current size. It is clear that inflation was to take place at speeds of billions upon billions of times greater than the speed of light. In order to "blow up" such "shock" rate the Universe at the singularity point should be filled with some kind of substance that produces a negative pressure, which recently became known as "dark energy", details about it, we will discuss below. This, beyond measure, "an increase in the entity" does not promote confidence in the scientific community, some of whose members are called the inflationary model of the "humanitarian section of physics."

Do we live in reciprocal space?

Against the background of the problems of standard models of the dynamics of the Universe concept of the crystalline vacuum gives a new food for thought and could potentially help to resolve some "accursed" questions. Moreover, there is reason to believe that we live in reciprocal space. In fact, in this space solitons are formed, which have, as noted above, all the properties of elementary particles from which it is possible to form atoms, and "build" all material objects of our world, as well as you and I. Let no one be afraid of the term "reciprocal space" in which distances are measured in "inverse meters" and time-in "inverse seconds"-it is nothing more than the subject of the agreement! You can rename the space in the direct opposite, and "inverse meters and seconds" to "direct" and vice versa-the essence of the processes will not change. A study showed earlier review [8-11] that if the vacuum is a crystal, then the grid should have a characteristic parameter of 10 m-25 m. The size of the reciprocal lattice cell for it is 1025 m^{-1}. If we make the above-mentioned "redesignation", then 1025 m

coincides on the order of magnitude with the distance to the current horizon of the Universe, i.e., the distance that the light has passed from the birth of the Universe to date. That is the whole of our Universe corresponds to only one – a single cell of a crystal with a vacuum of 10 m-25 m! This compact "package" could be the envy of even the Aladdin and his lamp! As an added bonus, this interpretation can explain the high homogeneity of the Universe, and to abandon the unnatural scenario of inflation, which causes complaints from the scientific community.

The energy conservation law and the "arrow of time"

Another important feature of the crystalline vacuum is a restriction on the execution of the laws of conservation of momentum and energy. In fact that under interaction of the particles being the excitations of the crystal, part of their energy or momentum is transferred to crystal lattice as a whole. Because of the periodicity of the structure increasing the momentum k of the particle on the value of the so-called reciprocal lattice vector G does not change the value of k, i.e., values of k and k+G are equivalent. This turn of events, at first glance might seem very "harmful". In fact, imagine that you put into your brand new car a pretty girl and decided to ride her "with the breeze". You put her pedal to the floor; your chances of success are growing with increasing speed. Suddenly, when the speed reaches the "magic" value it drops abruptly by 50%! The sad thing is repeated with the inevitable law of nature! Needless to say, not too pleasant! However, not all is so sad. If the value of the reciprocal lattice momentum is large compared with the achievable particle momentum, then no one will find the violation of conservation laws!

Apparently, this happens in our world. However, there is a very energetic process in the Universe that can make secretly violation of conservation laws to be evident. For example, cosmic rays have maximum threshold energy [12,13], whose origin remains a mystery. However, it may be due to transfer of energy to "mega lattice" [8-11], i.e., it is the maximum possible amount of energy, above which the energy abruptly transferred to the lattice of the crystalline vacuum. "Relevance" of power transmission to lattice can be manifested in the fact that all high-energy direction of flow (wave) perturbations in the Universe is rapidly damped due to "friction" of the "mega lattice", i.e., due to absorption of energy in each collision event by the lattice. The above-mentioned phenomena cause cooling and create irreversible processes in the Universe that can explain the emergence of a strict orientation of all processes over time or so called, “time arrow” on mega scales.

Thermal expansion explains the paradox of "dark energy"

On the basis of the end of the 1990s, observations of type Ia supernovae, it was concluded that the expansion of the Universe is accelerating with time. This development of events is fundamentally contrary to the expectations of the uniformity or even slowing down the expansion of the Universe over time due to the mutual attraction of matter. To explain this contradiction it has been introduced hypothetical "dark energy" – a substance which has negative pressure and evenly fills the entire space. According to general relativity, gravity depends not only on the masses, but also on the pressure and negative pressure should rise to repulsion, anti-gravity. Dark energy should also be a significant part of the so-called hidden mass in the Universe.

By analogy with crystalline solids, we must note such the important features as thermal expansion. As it is known, solids increase its size when heated, and reduce it under their cooling. We can expect that something similar happens in "mega crystal" of our Universe. Due to the nature of the reciprocal space, mentioned above, cooling of the direct space associated with a decrease in size causes a corresponding increase in the size of the reciprocal lattice. In this case the rate of these

processes-are inversely proportional to each other. To illustrate, it is possible to use a very popular thought experiment with observers. We place first observer in a direct, and the second-in the reciprocal space. Then, when the crystal is cooled first observer noted a reduction in the lattice parameter that corresponds to compression of the crystal, while the second observer in the reciprocal, i.e., our space, notices the expansion of the Universe. Such a process is able to explain the current accelerated expansion of the Universe without invoking the "mysterious" dark energy. Since the change dl of body size l due to thermal heating is expressed by the relation:

$$dl=\alpha l dT, \qquad (3)$$

where α-coefficient of thermal expansion, dT-change in temperature. Differentiating the left and right sides of (3) with respect to time, we get:

$$Vex=al dT/dt, \qquad (4)$$

where Vex-the rate of expansion of the body in the direction of l, dT/dt-rate of heating of the body. The structure of (2) and (4) coincide if we set H ~ adT/dt. Let us try to estimate at least on an order of magnitude the right side of expression (4). Although the Hubble's "constant" changes over time (as evidenced by the recently discovered accelerating expansion of the Universe) today $H=2.10^{-18}$ sec^{-1}. As it is known, a increases with increasing temperature, its typical value at room temperature lie in the range between 10^{-6} to 10^{-4} deg^{-1}. In accordance with the modern theory of the Universe hot expansion, its temperature at the point of singularity reached 1027 degrees, and after 400, 000 years at the time of separation of radiation from matter dropped to 4000 degrees. At the moment the temperature of the Universe determined from the spectrum of the background radiation is 2.7 degrees. The initial energy of the Big Bang, according to Einstein's formula $E=mc^2$, was almost completely transformed into a "light" and "dark" matter. And only a small portion was spent on "heating" in the form of radiation. The temperature change dT of the Universe for the period between the "birth of the world" and this point is 4,000 degrees. This change in temperature occurred over time dt ~ 10 billion years. The ratio of $dT/dt \sim 4\ 10^{-14}$, if we take the value of $a=510^{-5}$, we get just the value of the Hubble's constant at the moment. Of course, this is only a rough estimate of the heating rate and the coefficient of thermal expansion, which depend on the time and temperature, thereby determining the fact of different rates of expansion of the Universe at different epochs.

What "made" a vacuum?

The nature of the vacuum "material" may be the most complex and intriguing problem. Therefore, here it is possible to give only the most common reasons that stimulate thinking in this direction. First, vacuum crystal, as follows from the logic of the entire preceding discussion should be located outside of our space, i.e., in the "direct" space. Do we know at the moment at least some objects "falling out" of our world, but, nevertheless, "given to us in sensations"? Yes, there are such objects. These are the so-called "dark matter" and black holes that manifest themselves in our world through the gravitational interaction. Since the nature of dark matter is still not clear, as a candidate for the role of the vacuum matter can be considered a black hole. In fact, the black hole is a product of the ultimate compression of the stars at the end of the thermonuclear reactions in its interior. The gravitational attraction of the black hole is so strong that even light cannot come off their surface, to bring us

at least some information about the processes in its vicinity. We can never reach the black hole to touch her, because, according to the theory of relativity, while the "flight" time to her is infinitely. i.e., black hole is completely unavailable for communication with our world, except for gravity. Since the object is not available for connection, this means that it is not lie in our, but in a different space. However, the other space different from the reciprocal space, as we saw above, does not exist! Thus, the black hole can be considered as a structural material of vacuum crystal. In this case, the "atoms" of the vacuum would be entirely linked by gravitational forces. What is the distance between the “atoms” in a black hole? Can the "lattice constant" a black hole to be about 10 m-25 m? Of course, the compression degree of a black hole matter has not been established up to now. And how it can be done? On the other hand it is hard to imagine a contraction of the black hole in the singular "point".

In "black hole" concept primary compression of the vacuum crystal due to collapse causes rapid expansion in the reciprocal space, this can be roughly compared with the stage of inflation in the standard model. Compression energy is converted into the matter of the future Universe and radiation, which causes a cooling of the vacuum crystal and its subsequent contraction, albeit at a much slower rate than at the stage of inflation. This phase corresponds to the expansion of the Universe that is observed at present. The acceleration of the Universe's expansion may be associated with a decrease in the coefficient of thermal expansion in (4) when the temperature of the vacuum crystal decreases.

Thus, the presented concept could explain the observed nonstationary expansion of the Universe, the formation of matter, radiation, and their subsequent cooling through a process of compression of black hole matter. The compactness of the black hole is not an obstacle for the "spacing" the Universe in it, because, as we saw above, our entire Universe may be "packaged" in the volume of reciprocal space corresponding to one cell of the vacuum crystal lattice with the size of 10 m-25 m.

The Universe inside a black hole

The hypothesis of "black hole" nature of the vacuum crystal suggests that the "atoms" of the vacuum can be connected only by gravitational forces, because of the four known only the gravitational interaction allows to detect a black hole. Apparently, all the rest interactions are the derivatives of the gravitation-linked crystal structure. "Prominence" of gravity manifests itself in the fact that everything body around the black hole are attracted to it. But it seems "unjustly" in relation to, for example, the electromagnetic interaction. It is known that an electromagnetic wave, according to Einstein's formula $E=mc^2$ “has a weight”, and cannot leave the environs of a black hole. According to modern concepts, the gravitational interaction is also transferred by waves, which have "attracted" to the black hole! Einstein's general theory of relativity assumes that force gravitational interaction take place due to deformation of the space-time continuum, which is described by the equations which are similar to that of mechanics of a solid continuum. This approach may be some indication of a solid crystalline structure of the vacuum. According to the Einstein himself’s quote [5], it is well understood, but in a dramatic attempt to reconcile the Lorentz-invariance with solid ether, he was forced to get rid of the latter. As shown above, a solid vacuum with soliton excitations-the particles obeying Lorentz-invariance, is quite acceptable embodiment of the space-time continuum of Einstein. The equations of stress-deformed state solid continuum admit the existence of nonstationary wave deformations that can be associated with gravity waves, i.e., gravitational waves "must" exist! And the later experiments unequivocally confirm the existence of gravitational waves [14].

The existence of black holes seems to be certain. Moreover, the idea of them becomes a part of the fabric of scientific constructs. The existence of massive black holes in the center of our galaxy there is assumed. If inside of any black hole exists a world we are considering the type, is it possible in any way to contact him? Since the only currently known method of communication is electromagnetic waves, the Universe inside a black hole is isolated from the rest of the world. The only way of communication between the inner world of the black hole and the external environment could be the exchange by gravitational waves, which may be emitted from a black hole.

If we live in a black hole, then, at first glance, every material body will be very strongly attracted by its superdense matter and will "fall" into its very depths womb. In fact, it is not. Even Newton had proved the assertion that if the body is immersed in a thin homogeneous material sphere, inside it all the gravity cancels out each other and outside the material sphere the attraction will be such as if the entire mass was concentrated at its center, i.e., particles inside the black hole will experience an attraction only to its "uncompensated" mass. As shown earlier, the soliton can be represented in the form of dislocations in the crystal. Under formation of the dislocation only a small fraction of crystal atoms are shifted, causing a small asymmetry of its mass. Hence the attraction of solitons to the black hole matter and, consequently, their weight is limited.

Imaginary experience of Universe creation

Anyone who has ever had in his hands a quartz crystal, knows how it is pleasant to look inside and admire the play of light! And what if we imagine in the hands of "mega crystal" of our Universe? It is not nonsense, according to our estimates this crystal is quite small, if our entire Universe is "situated" in just one cell of the direct space with the size of 10 m-25 m. Person holding it in his hands can see everything that happens inside it in its direct space and, if desired, and in reciprocal space. Moreover, this person can be the creator of this world and stake out for its evolution and subsequent dying! What could be more entertaining? To "launch" the evolution in this world the creator has to say only the “word”. After all, says: "In the beginning was the word”. Indeed, the word-is a sound wave, which at the relevant voice power of the creator and the lattice rigidity can cause vibrations of the atoms of “mega crystal". These variations initially cause some heat and expansion of direct space due to its inevitable anharmonicity, which leads to compression of the reciprocal space with energy release, part of which is transformed into elementary particles. It is possible that the reciprocal space will shrink strong enough to talk about the singularity, but this is optional. Later on the cooling of crystal take place, for example, by heat exchange on its surface. This will lead, on the one hand, to compression of direct space and to corresponding accelerating with time expansion of the reciprocal lattice, but, on the other hand, to condensation of particles in the nuclei and atoms, and further on clearly defined schedule of evolution. Is it appropriate in this context to talk about our true Creator and to draw analogies with his deeds? From a purely scientific point of view, this analogy is appropriate.

Conclusion

From the Bible we know that "the Lord’s one day is as our thousand years, and our thousand years as His one day". Therefore, the time for the creation and contemplation of the kaleidoscope events inside the "crystal ball" is more than enough. Supernatural entity is quite capable to handle with crystal in the form of a "piece" of a black hole, despite its huge mass in our understanding.

Under scenario described it is possible to ask such questions as: What is the Universe? When and where life on earth did was born? Are there in the Universe our brothers in mind? What happened when the Universe was not yet the substance? What happened before the Big Bang? What is dark energy? And it seems it is possible to get some answers, even at the moment and it is strange.

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