SUPPLEMENTS/AMENDMENTS TO THE COSMOLOGICAL PICTURE OF THE WORLD BASED ON THE HYPOTHESIS OF FRACTAL UNIVERSE

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The article is devoted to the changes that have occurred over the last year in the author's cosmological picture of the world. As before, the author starts from the hypothesis of fractal Universe. From this follows that since the density of such a Universe is equal to zero, Universe, as a whole, cannot either expand or contract. In the previous works the author did not realize that in the framework of the accepted hypothesis (of the fractal Universe) the processes of contraction of metagalaxies (and other cosmic macro-systems) cannot prevail over the processes of their expansion and the other way around in. And therefore, the Universe, as a whole, cannot evolve. The evolution (in the "progressive" direction) could occur only in metagalaxies taken separately on the stage of their expansion. At the stage of contraction, the results of local evolutions, including advanced forms of life, are always destroyed. As a consequence, any form of life arising in metagalaxies is unavoidably local, both — in time and space.

Wherever any form of life has appeared, it is doomed to destruction in the process of contraction of metagalaxies. Locality of hotbeds of life in the fractal Universe is aggravated by impossibility for residents of different metagalaxies to contact, because the distances between them are much larger than the metagalaxy sizes (all fractals are arranged in such a way). So a signal propagates between nearest metagalaxies during the time that is much larger than the duration of their gravitational cycles of expansion and contraction.

Keywords: Universe, the hypothesis of fractal Universe, the phenomenon of life, our Metagalaxy, expanding metagalaxies, contracting metagalaxies, universal evolution, the Boltzmann fluctuation hypothesis, entropy.

Introduction

The article [Haitun, 2014] was written just over a year ago. However, during this time the author's cosmological picture of the world has changed dramatically, making him to take up the given article. These changes are the two new consequences following from the hypothesis of fractal Universe which we now add to the eight ones, discussed in the previous article.

These new consequences are so important that it is necessary to abandon the previous idea of the Universe evolution, which played the key role in my picture of the world (and not only mine). Accordingly, the author's conception of life in Universe has changed dramatically, losing its overall optimistic character.

Before we start talking about the changes in the author's conception, let us briefly describe what it was before. At the same time, this description will be followed by the addition of new material.

Outlines of the Author's Cosmological Ex-Conception

In the center of the author's picture of the world there are two ideas: first of all, the idea of universal evolution and, secondly, the suggestion that everything in the world is fractal. Universal evolutionism, considering the evolution of inorganic, organic and social worlds as successive stages of evolution, has roots in the 19th c., it has many fathers.

The fractal picture of the world we owe to a brilliant scientist, mathematician, Benoit Mandelbrot who has committed a scientific revolution. Since 1975, he has published several monographs on the subject.

Before Mandelbrot, scientists considered material bodies as more or less homogeneous and continuous, bounded by more or less smooth surfaces. Mandelbrot showed that the observable world is populated mainly by bodies of entirely different nature — inhomogeneous, scratchy, branched, and penetrated by cavities. The description of such bodies requires a special, fractal mathematics.

Universal Autoevolutionism

In the scientific community there is still no agreement on the driving force of evolution. There are competing versions of autogenesis, Darwinism, creationism and other concepts. First of all, the author adheres to materialistic concept and also to autogenetic concept, which suggests that evolution occurs due to self-organizing processes in matter.

The observed world is woven from interactions, everything is permeated by them, and everything is moved by them. Matter consists of substance and field interactions. The substance is composed of molecules, molecules are composed of atoms, atoms — of elementary particles. Elementary particles are considered as clumps of field interactions, so that, in the end, the substance can be considered as compacted field interactions, which have acquired new properties. In other words, interactions act *as a matter* (we can say that the both terms, interactions and matter, are synonyms), i.e. interaction patterns have material nature.

Physicists say about interactions between particles composing a physical system, about interactions between physical systems. In these two cases, interactions are realized by *field* interactions (electromagnetic, gravitational, strong, and weak). In physics, there are also interaction *forms* — electromagnetic, gravitational, thermal, etc. *These forms have the quantitative measure — energy*, which can be electromagnetic, gravitational, etc. Biological and social systems are also material, so that interactions can be biological and social, that is, the concept of interactions is not only physical but also biological and social.

Not all forms of interactions can be characterized quantitatively (not all phenomena allow quantitative description and not all values have quantitative sense). For instance, *generally, the energy concept is inapplicable to biological and social interactions*. However, if we talk about the intensity of interactions the concept of interactions, in the qualitative sense, may be applied to material systems of any nature. This is true, in particular, with regard to the social systems, in which interactions may be industrial, economic, cultural etc.

Usually, processes of consumption of substance and energy by living organisms, or in other words, processes of transformation into each other different forms of substance and energy are called *metabolisms*. However, transformations of substance

and energy occur also in inorganic material systems (physical, chemical, social). This allows us to extend the concept of metabolism for material systems of any nature, understanding metabolisms as transformation processes into each other different forms of interactions. In this (universal) meaning the two concepts of interactions and metabolisms intersect — we can talk about the intensity of interactions and we can talk about the intensity of metabolisms.

Being the source of everything in this world, *interactions develop themselves, becoming the driving force of evolution, its fundamental essence*. The same we can say about matter.

The evolution of the material world occurs due to the self-development of matter (interactions) *by self-assemblies* (innovations, inventions). The concept of self-assembly was born in the 1950s, in the molecular biology, going then beyond. Today the concept of evolutionary self-assembly becomes widely accepted. The self-assemblies (innovations) *that generate the greatest possible number of other self-assemblies for the longest future are called progressive* and they are at the forefront of the evolution.

Universal evolutionism and the assumption that the observable world is fractal cross in the phenomenon of the *fractal evolution*. To understand this, let us consider a tree with its rugged structure. In textbooks we saw the drawing of the organic evolution tree. The same tree exists in the case of the universal evolution. Simplifying somewhat, we can say that evolution occurs through a cascade of branching points (verticils), in which alternative evolutionary branches are born.

To make more precise, it should be said that not all evolutionary lines have a common root. Moreover, sometimes lateral communications occur among different evolutionary lines. As a result, the tree of life is transformed "into the likeness of mangroves" [Vorontsov, 1999, p. 515].

Intelligent life, as all forms arising in the process of evolution, is a result of branching of evolutionary lines. One of these evolutionary lines is a human. A variety of forms of mind is great and most likely it is beyond our understanding.

Ideas of the fractal universal evolution save us from anthropocentric views. The man is not the main goal and the final result of evolution, but its intermediate finish. The meaning of human life, I believe, is to follow the laws of evolution. The famous maxim of Protagoras "Man is the measure of all things" must be replaced by the maxim "Evolution is the measure of all things".

The evolution does not care about human interests or about some other interests. At each time the evolution favors somebody (or something) that best meets its requirements. For a while its "favorite son" was a Neanderthal, and then he was replaced by Cro-Magnon (modern man), who tomorrow may be replaced by someone else.

The main requirement of the evolution is to follow its vector, which has several components [Haitun, 2005, p. 181–183]:

1. The increase in complexity;
2. The increase in diversity;
3. The intensification of metabolisms / interactions;
4. The intensification of cycles;
5. The growth of the structure integrity (the connectivity of "everything with everything");

6. The growth of system openness (increasing role of interaction with the environment);

7. The evolving systems become more and more fractal, and etc.

But following the vector of evolution is not enough. The evolution squeezes the maximum possible out of the specific conditions, forcing the evolving systems do it as efficiently as possible, not just follow the evolution vector. What does it mean?

In the biological evolutionism, mainly due to Aleksey Severtsov (1866–1936), there is the rooted idea, that the progressive improvements open the way to further improvements in contrast to non-progressive changes. Generalizing this idea, we come to the *evolutionary principle of minimax*: in the course of evolution the rate of metabolisms, leading to the subsequent intensification is maximized, while the rate of metabolisms, which do not lead to a further intensification is minimized.

In my opinion, the "meaning of life" of human individuals, societies and humanity in general is to follow the vector of evolution directed towards intensification of those metabolisms which lead to growing complexity, openness, diversity, and etc. for a longer possible future. If humanity ignores this vector, it will die or will be pushed to the periphery of evolution, as has repeatedly happened in the past with human societies.

As of today, evolution of the Earth is headed by humankind because people follow the vector of evolution in the best way.

Progressive self-assemblies, about which we talked above, are born rather seldom. They appear only provided very lucky circumstances. We all can observe this in our everyday life. New ideas are born not every day and not by everyone. Those persons who could generate progressive self-assemblies we call creative, and especially gifted ones we call geniuses. Everyone knows how hard to put forward really a new idea (a progressive self-assembly), and how hard life such people have. They are often poorly adapted to everyday life, and therefore are forced to sacrifice the pleasures of ordinary life. It is even more difficult to convert a model self-assembly into the final product. In the free-market countries millions of small and medium-sized enterprises are registered annually. However, within a year about 90% of them fold.

Now let us imagine that this rare event has occurred, the progressive self-assembly was born, what's next? And then the following will occur.

If a fragment of the observable world, thanks to a successful evolutionary self-assembly, has moved along the vector of evolution further than the other parts of the world, then, according to the evolutionary principle of minimax, this achievement will extend to adjacent areas. In other words, evolutionarily more advanced parts of the observable world are spreading their best practices in the neighbouring areas. The evolution happens with the *expansion of progressive self-assemblies*.

From this follows the desire of man to expand the zone of evolutionary achievements more and more. Man has "captured" the Earth, but the "law of expansion" makes him move into space in order to enlarge as widely as possible the area of evolutionary success.

Non-Physical Patterns Have Arisen From Physical Ones as a Result of Their Self-Organization

Among scientists there are polar points of view on the relationship between physical and non-physical (chemical, biological, social) phenomena. One of them

thinks that all non-physical interactions are reducible to physical, i.e. to gravitational, electromagnetic and so on. This point of view is widely spread among physicists who often say, for example, that chemistry is the physics of molecules. According to the second point of view, which is spread among biologists, non-physical interactions, say mental or biological, are not reducible to physical interactions.

The existing data make us accept the first point of view, but in a transformed form, so that the second point of view could be also fair in a sense.

The scientific literature on the *biofield* gives the following two facts. *First*, an organic cell and a multicellular structure behave as if they are guided by a "cellular" or "over-cellular" field, which, however, still no one could detect as *non-physical* essence. *Second*, it was really detected that living cells emit electromagnetic waves in a certain (the millimeter and submillimeter) range, the source of which was not possible to localize in a cell. At the same time, these electromagnetic waves exert the definite biological impact on the living cells.

The fact that the physical devices detect *physical* fields instead of biological and chemical fields says that they (physical fields) do really exist there. This is the *fundamental fact* from which we will proceed.

As mentioned above, elementary particles are woven from the physical field interactions, as their bunches. Living and non-living structures, in turn, consist of elementary particles. Thus, all substance, including biological and other non-physical structures, is woven from physical field interactions. That is why the devices, *being properly tuned*, register physical fields instead of non-physical fields.

Therefore, we have to recognize that the gravitational, electromagnetic, strong and weak physical interactions are primary, or basic (fundamental), whereas all other interactions (chemical, biological, social) are woven from them, forming multi-level structures (patterns). In my opinion, the physical interactions can even be defined as forming a substrate of all other interactions.

What is said above is confirmed by the history of the observable world (our Metagalaxy) since the Big Bang, about 13,7 billion years ago. According to modern concepts, at the beginning the observable world was filled with high-temperature plasma. Only in the course of its expansion more and more complex forms of matter began to appear (self-organizing in the course of evolution). First appeared elementary particles, then chemical elements, which under the influence of gravity, began sticking together forming stars, galaxies and other cosmic structures. Only about 4.5 billion years ago, on the Earth appeared more and more complex organic forms and later — the man with his social forms of life.

The Hypothesis of Fractal Universe and the Eight Consequences

The observable world (our Metagalaxy) was born approximately 13,7 billion years ago as a result of the Big Bang. For us the world is bounded by the apparent horizon. Since no signal can propagate faster than light, we cannot, in principle, have information about what is going on at distances exceeding 13,7 billion light years. So, about the structure of the Universe we can judge only on the basis of our knowledge concerning its small part where we live. In other words, *all our statements about the Universe are hypothetical*.

Therefore, all the statements that the Big Bang happened some time ago, that the Universe emerged from the vacuum-like state of the physical environment, that it is expanding, that today this expansion is accelerating, and etc. are hypothetical. All this has happened and/or happens with our Metagalaxy and we have no empirical data that allow us to transfer all these statements to the Universe.

Starting B. Mandelbrot [Mandelbrot, 2010], many authors have been writing about the fractal Universe. However, the fractal Universe is also only hypothesis, based on the information about our Metagalaxy It is essential, however, that if the Universe is actually fractal than *its global density is equal to zero* (this is overlooked by all authors known to me) so the Universe, as a whole, can neither expand nor contract. Hence, the observed process of cosmic expansion takes place only in a small part of the Universe, in our Metagalaxy.

The fact is that fractals have a peculiar property overlooked by many authors including Mandelbrot. More precisely, this property characterizes the "true" fractals, fractals, in the strict mathematical sense of this term, resulting in computational experiments ("on paper"), and does not characterize material structures of finite sizes.

We are talking about the measure of fractals. The measure of a set is the "volume" occupied by the points of a set after the "evaporating" gaps between them. To determine the measure, you can use the measurement "cubes" of different dimensions. And so, the measure of the "true" fractals is identically equal to zero, if it is determined by means of the measurement "cubes" of dimension equal to the dimension of the Euclid space, in which the fractals are located.

Let us illustrate this with a simple example. Imagine an infinitely thin sheet of paper. We carve out of it infinitely narrow strips, tear them into tiny pieces ("points"), and then we are trying to fill a room with these pieces. The sheet of paper is two-dimensional, its mass and density are equal to zero. It is clear that in such a way it is not possible to fill a three-dimensional volume (the room). We will get a structure of zero mass density which is "everywhere empty". This "paper" structure can serve as an image of a "true" fractal.

Material objects of finite size, located in our three-dimensional space, which now are called fractals (carbon black, trees, bronchi, galaxies, etc. etc.), do not have zero mass density. They have a fractal structure in a limited range of sizes of the measurement "cubes". Therefore, they are not "true" fractals.

What is said above does not detract the revolutionary transition to the fractal picture of the world made by Mandelbrot, because all fractals, including those which have a non-zero density, are characterized by certain fractal properties. Before Mandelbrot' era these fractal properties were practically disregarded by science:

1. Fractals are extremely heterogeneous, forming hierarchically arranged structures, penetrated by voids;

2. Fractal structures are often characterized by *scale invariance* (self-similarity), when each part is geometrically similar to the whole;

3. All fractal structures are described by hyperbolic functions and by statistical non-Gaussian distributions (the latter was discussed in the article [Haitun, 2015]);

4. When the fractal structure of a system is preserved in the limit to the infinitely small scale (the case of "true" fractals), the fractal dimension D differs from the topological dimension D_T, and $D \le D_T$ (Mandelbrot and other authors take wrongly

$D \geq D_T$). In the other case (not "true" fractals"), the dimension D (strictly speaking, it is not the fractal dimension) calculated in finite scales acts as the exponent in dependences and distributions, about which we have just talked.

Thus, the assertion that the mass density of "true" fractals is equal to zero is irrelevant to the material, finite in size structures, located in our three-dimensional space.

From this assertion, however, three important consequences arise:

1. Since the density of material fractals, located in our three-dimensional space, is different from zero, then the matter is not "empty everywhere" (in contrast to the "true" fractals) as one might think, looking at the "almost empty" atom structures.

2. Statistical physics of irreversible processes is divided into two approaches — the fractal and kinetic. These two approaches exclude and complement each other (see details in [Haitun, 1996]);

3. The Universe, because of its infinity, can be a "true" fractal. In fact, the "true" fractals have to preserve their properties when arbitrarily small measurement "cubes" are used. In the case of an infinite Universe this requirement is not an obstacle. From the point of view of an imaginary observer, the sizes of which tend to infinity (so that he could observe a infinitely large fragment of the Universe), the sizes of finite measurement "cubes", which we use in our everyday life and astronomical observations, tend to zero.

Below we will talk about the Universe in the assumption that it is fractal. Now we list briefly the eight consequences discussed in the article [Haitun, 2014] which follow from the hypothesis of fractal Universe.

Consequence 1. If the Universe is fractal in the strict sense of this term, it is infinite (not closed). Actually, the infinity of the Universe is the basis of the hypothesis because only an object of infinite size can have a "true" fractal structure.

If the Universe is indeed fractal in the strict sense of this term, it is the *only "true" fractal in the material world*.

Consequence 2. The Universe (if it is fractal in the strict sense of the term) should have zero global density, i.e. the density of any of its fragment (while tending mentally its volume to infinity) must tend to zero despite the fact that mass of the Universe is equal to infinity. This is consistent with the observation data obtained in our Metagalaxy: the average density of the material falls rapidly to a surprisingly small quantities when passing from the Sun (1.416 g/cm^3) to our Galaxy (10^{-24} g/cm^3) and then to our Metagalaxy (2×10^{-31} g/cm^3). Mentally continuing this sequence of numbers, it is natural to assume that if we tend to infinity a fragment volume the density of such a fragment must tend to zero according to a well-defined power dependence characteristic of fractal structures.

Namely, if we denote the mass of the spherical fragment of a fractal, located in the three-dimensional space, M(R), where R is its radius, this mass increases according to R^D, where D is the fractal dimension of the chosen fractal:

$$M(R) \propto R^D.$$

[Mandelbrot, 2010, p. 129]. Dividing this relation by R^3, we obtain the expression for the density:

$$\rho \propto R^{D-3}.$$

Mandelbrot says also [op. cit.] about the discovery made by an astronomer G.H. de

Vaucouleurs [Vaucouleurs, 1970] who found out that the density of cosmic fragments decreases with their increasing volumes according to this law with $D = 1.23$. To get this result he used the data of observation in the visible part of the Universe, i.e. in our Metagalaxy. Perhaps, it is the first empirical estimation of the fractal dimension of our Metagalaxy. If we extend the empirical data on the Universe, it is possible also to apply the obtained estimation to it.

The zero density of the Universe is provided by its special (fractal) structure: the larger space systems we take, the more distance between them. The distances between the planets of the solar system are much larger than the planet sizes, the distances between the stars are much larger than the star sizes, the distances between the galaxies are much larger than the galaxy sizes, etc. If the Universe is fractal, in the strict sense of the term, then the distances between metagalaxies are many times larger than the sizes of the metagalaxies.

Consequence 3. Due to the zero density of the fractal Universe, it cannot either expand or contract as a whole. Therefore, the Big Bang and all that followed it, observable now, have happened not with the Universe but only with our Metagalaxy. From this follows that a lot of statements concerning the Big Bang, the Universe expansion, the age of Universe, the model of hot Universe, etc. transferred from our Metagalaxy to the Universe are only baseless speculations. Moreover, they contradict the hypothesis of fractal Universe. There are only two opportunities: either the Universe is fractal or the Universe is expanding. It we accept the hypothesis of fractal Universe we can talk about the expansion of our Metagalaxy, the Big Bang of our Metagalaxy, etc. In this case only finite fragments of the Universe (metagalaxies and other cosmic macro-systems) can expand or contract.

Consequence 4. While we believe that the Big Bang has happened with the Universe, the lack of the center and radial gradients of explosion could be explained by the Cosmological principle, according to which the different areas and directions in the Universe are equivalent. But if we believe that the Big Bang has happened only with our Metagalaxy (Consequence 3), it is necessary to recognize that the Cosmological principle does not work there, as it does not work within the other space systems of finite size. So the lack of the center and radial gradients of explosion of our Metagalaxy requires another explanation.

The only possible explanation which is not associated with the Cosmological principle is that our Metagalaxy is an extremely rarefied black hole. The internal space of it has a finite volume but it does not have boundaries, the center and radial gradients of expansion.

As a geometric analogy of the three-dimensional, finite space without boundaries we can use a two-dimensional surface of a three-dimensional sphere (for example, take the surface of the Earth) but in our case the sphere is expanding. Let us place on such a surface a two-dimensional gas of interacting points, simulating a three-dimensional "gas" of stars and galaxies. If these interactions are like real, then, just as it does in the observable world, the points will form a fractal-like structure. Due to the symmetry of the model, the gas on the two-dimensional spherical surface will not have specific areas and directions; it will remain macro-homogeneous and isotropic. While the sphere is expanding, the gas density on its surface is decreasing, and the points are dispersing without the center and radial gradients of expansion. If the radius of the sphere is increasing at a constant rate, the points are dispersing in

accordance with the Hubble law in its two-dimensional version.

Indeed, let the sphere radius R increase at a constant speed V. Then the distance r between two points on the sphere increases with speed

$$v = V\frac{r}{R} \quad \frac{V}{R}r = \frac{1}{t}r = Hr. .$$

This is the Hubble law.

In the three-dimensional version we can observe it in our Metagalaxy.

Consequence 5. The acceleration of cosmic expansion was discovered in 1998–1999 at distances of the order of (or greater than) 1 billion light years. This phenomenon can be attributed to our Metagalaxy (Consequence 3) and it can be explained as a manifestation of opening of the black hole that began not so long ago (on space standards). In the process of expanding the black hole radius exceeded a certain critical value (called the *gravitational radius* or the *Schwarzschild radius*). Our Metagalaxy is still a black hole in a significant part of its volume (the radius is about 1 billion light years).

Our Metagalaxy is opening gradually. Nothing could happen with such a huge object an instant. In the beginning, violations of space-time geometry of the black hole appeared at the edge of it, later these violations began to seize more and more areas and penetrate deeper. Apparently, this explains the surprising fact that the density of our Metagalaxy (2×10^{-31} g/sm^3) is so close to the critical value ($(6–8)\times10^{-30}$ g/sm^3), but it is still a little lower.

Consequence 6. The discovery of the acceleration of cosmic expansion, referred to the Universe by cosmologists allowed them to believe in the existence of *dark energy*, characterized by anti-gravity. The logic leading to such a conclusion is clear: the cosmic acceleration is interpreted as the evidence of the existence of cosmic repulsion, which the usual gravitating matter, visible and dark, cannot provide. If we believe that the Universe is fractal the hypothesis of dark energy becomes unnecessary, because Consequence 5 gives less fantastic explanation for this phenomenon.

Consequence 7. Consequence 5 can be verified experimentally. Indeed, it is highly unlikely that the Earth (our Galaxy) is located exactly in the center of our Metagalaxy (because of its huge size). With probability close to unit, the Earth is displaced from this center. If this is the case, then the observed cosmic acceleration must have spherical asymmetry. The more the Earth is shifted from the center of our Metagalaxy the stronger the spherical asymmetry of cosmic acceleration. I suggest to check experimentally whether the cosmic acceleration has spherical asymmetry or not. If the result is positive, the explanation may be just what we are giving here.

Consequence 8. If the famous anthropic principle does not refer to the Universe as whole, but to metagalaxies scattered in it, it has, in our opinion, the simple, and not theological meaning. We know that life did not originate on all the planets of the Solar System. Similarly, life could originate only in some metagalaxies, not in all of them. Life can arise and evolve until the emergence of intelligent beings under certain environmental conditions (on a planet or in a metagalaxy). If the corridor of actual conditions in the Universe is narrow life in it is an extremely rare phenomenon. If the corridor is wide, life is a widespread phenomenon. Due to the infinity of the Universe, the number of life hotbeds in it is infinite.

Thus, it is not a question whether there is life in the Universe beyond the Earth or not. Definitely life exists. It is important to know how far away from each other these life hotbeds are located. If the terrestrial biosphere is the only one in our Metagalaxy, then we are doomed to cosmic solitude (perhaps this explains the failure of attempts to detect signals of extraterrestrial civilizations taken over half a century [Gindilis, 2004]). However, if there are millions of biospheres in our Metagalaxy, then our chances of meeting with neighbours are real.

2. The Two New Consequences from the Hypothesis of Fractal Universe

In his previous publications, the author light-mindedly adhered to the idea that it is possible to extend empirical data concerning the evolution of the observed world, i.e. of our Metagalaxy, to the entire Universe. In the work [Haitun, 2014] I also wrote that "nothing prevents a fractal Universe to evolve", and that evolution of "the whole Universe, in theory, should also proceed to decrease its fractal dimension. Therefore, the Universe is going away from equilibrium. If this is indeed the case, then in the course of evolution manifestations of its fractal nature are also increasing".

There is no limit to human stupidity. Or, in the words of one of the greats, scientists tend to make all conceivable and inconceivable errors. Today, as before, I am sure that the hypothesis of fractal Universe is the foundation of the cosmological picture of the world. Now, however, I realize that the hypothesis about the Universe evolution contradicts the hypothesis of fractal Universe. Since I have no reason to abandon the hypothesis of fractal Universe, I strongly reject the idea of the Universe evolution.

Thus, I add two more consequences to those eight ones discussed above.

Consequence 9. Having in mind the Big Bang theory of our Metagalaxy, let us see what happens if and when our Metagalaxy starts contracting by gravity. Upon reaching a fairly high degree of compression, all complex forms of matter (including organic and social forms of life on the Earth and, possibly, elsewhere) resulting in the previous process of expansion will disappear inside the Metagalaxy. In the end, only high-temperature plasma will remain, from which everything has started after the Big Bang.

The same is true for other contracting metagalaxies.

This does not mean that when the process of contraction starts the vector of evolution is reversed in metagalaxies. As I see it, the laws of evolution do not change in dependence of the conditions under which they operate, however, the result of their actions changes. For example, with the explosion of the Sun or Earth's collision with a large asteroid, our civilization would be destroyed in spite of the laws of evolution which continue to act. The result of external conditions will overpower the laws of evolution. Something like this is happening in huge cosmic objects at the stage of compression: gravitational collapse overpowers the results of the evolution laws, so that metagalaxies are coming back to the high-temperature plasma state, from which they began their evolution in the process of expansion.

As mentioned above (Consequence 3), a fractal Universe cannot either expand or contract. *This means that the compression and expansion processes of metagalaxies (and other space macro-systems) cannot prevail over each other*. From this we conclude that *the evolution of the fractal Universe, as a whole, is not possible*; only

its individual parts can evolve. And all the results of the local evolutions of cosmic macro-systems (metagalaxies and etc.) achieved in the process of expansion are destroyed by gravity in the local processes of compression.

Consequence 10. I suppose that an advanced life is a natural product of local evolutions occurring in expanding metagalaxies (and other cosmic macro-systems). In other words, there is life in all expanding metagalaxies, having certain parameters in a certain corridor. If this corridor is wide enough, life in the Universe is literally boiling. But if the corridor of parameter values is narrow life occurs only in some metagalaxies. However, due to the infinity of the Universe the number of expanding metagalaxies with life hotbeds is infinite.

However, and this is the central thesis of this article, life appearing in metagalaxies is always tragically local — in time and in space. Whenever life is born in some metagalaxy, it is doomed at the stage of compression. This also applies to human civilization, in spite of our cosmic expansion.

Locality of life hotbeds in the fractal Universe is compounded by the impossibility of contacts between residents of different metagalaxies. Since the distances between metagalaxies in the fractal Universe are many times greater than their sizes (Consequence 2), the propagation time of any signal between the nearest metagalaxies is many times longer than the duration of gravitational and life cycles. The answer to a signal sent to the inhabitants of the neighbouring metagalaxy will come (if it comes) only after so many cycles that the signal senders will not exists for a long time.

All this sounds, of course, quite scary, and it is in sharp contrast to the views on the phenomenon of intelligent life that follow from perceptions of the evolving Universe which I shared earlier. Well, I thought before, it is possible that the intelligent life today is a fairly rare phenomenon in the Universe. But the Universe is still evolving, therefore, the intelligent life has enough time to spread throughout the Universe, so that “all will be well”. But it turns out that, if the Universe is fractal (and it seems to be the truth), there are no grounds for such an optimistic view of the future of the intelligent life in the Universe. The intelligent life appears in some metagalaxies and later disappears. Such a process repeats again and again. So any intelligent life does not have future in the Universe, as a whole.

We all know this sad situation, in principle. Human life is finite and everyone dies in the end. Nevertheless, nothing could prevent each of us to live a life filled with ups and downs. However, there is one crucial difference. The individual has a chance to continue oneself in the offspring, making contribution to the evolution of its society, humanity, and life in a given metagalaxy. In contrast, life in a metagalaxy does not have such a chance: it just dies without leaving a trace. When life arises in a metagalaxy at the next stage of expansion, this life starts from scratch, knowing nothing about the past.

It is quite possible, a reader might argue, that the expansion of a metagalaxy is not accompanied by subsequent contraction, and this metagalaxy will continue to expand, and, in the end, it will be scattered in space between other metagalaxies. Let a number of metagalaxies with such a fate be small. Could it lead to the survival and further evolution of more and more advanced forms of life in the Universe?

I think that this is impossible, because otherwise the processes of expansion of metagalaxies would have had the advantage over the processes of contraction

(Consequence 9). The substance scattered in the Universe by metagalaxies, that "refused to" contract, is captured by others metagalaxies, returning to the mincing machine of the local compressions and expansions.

The most important for the terrestrial life: the hypothesis of fractal Universe does not negate the concepts of universal evolution provided these concepts are referred only to our Metagalaxy at the stage of its expansion, which has lasted for 13,7 billion years and which, apparently, will last for billions of years. This evolution, definitely, has a vector, and certain laws. We must follow this vector according to these laws in order not to die before the start of the gravitational collapse of our Metagalaxy. The future of terrestrial civilization is bounded by our Metagalaxy as long as it is expanding.

3. The Fractal Universe vs. the Boltzmann Universe

Note that the fractal Universe strangely reminds us the Universe under the assumption made by Ludwig Boltzmann in the late 19th c. It is the famous fluctuation hypothesis. According to this hypothesis, the Universe, as a whole, is in equilibrium (i.e. does not evolve), but some fluctuations occur in various parts of it. These fluctuations are space macroworlds in some parts of which there are processes accompanied by increasing entropy, while in other parts there are processes accompanied by decreasing [Haitun, 1996, p. 307–308; Haitun, 2005, p. 33–36]. However, it seems to me, that this similarity is purely external, our concept is quite different.

Firstly, according to Boltzmann, such worlds-fluctuations in the Universe are extremely unlikely (that is why he calls them fluctuations), while the main part of the Universe is in equilibrium, i.e. dead. The Man, according to Boltzmann, is the product of such an unlikely fluctuation, which gives him the opportunity to observe it (this fluctuation) from the inside.

In contrast, the expanding and contracting metagalaxies (and other expanding and contracting space macro-systems) in the fractal Universe are not the fluctuations at all. The entire Universe consists of them. And the advanced life is a natural product of evolution in expanding metagalaxies. Life is widely represented in the fractal (non-evolving) Universe. Another thing is that the phenomenon of life in the fractal Universe is always local (in space and time): whenever life is born, it is doomed to destruction.

Secondly, according to Boltzmann, for "the Universe, as a whole, the two directions of time are indistinguishable, as well as in the space there is no difference between the top and the bottom" [Boltzmann, 1984, p. 461]. On the contrary, in the fractal Universe, time flows only in one direction.

However, in respect of entropy, in my opinion, the fractal Universe is very similar to the Boltzmann Universe. Since the Boltzmann Universe is in equilibrium, its entropy is constant. (The entropy of any it is fragment tends to a constant value if we remove mentally its boundaries to infinity.) Respectively, some fluctuations in the Universe are growing, and their entropy is also increasing, whereas the other fluctuations are disappearing, and their entropy is decreasing. About the same can be said of the fractal Universe, but for other reasons.

The entropy of the fractal Universe, as a whole, is also constant over time, but not because the Universe is in equilibrium. In contrast, it is essentially non-equilibrium,

being composed of essentially non-equilibrium systems, of expanding and contracting metagalaxies and other space macro-systems. The entropy is constant because any change in the entropy of the Universe in a certain direction would mean its evolution, while the fractal Universe cannot evolve. If so, we make a conclusion that the *growth of entropy in expanding metagalaxies should be compensated by its decrease in contracting metagalaxies*.

Of course, this is a strange conclusion, at least for the author of these lines, because all his life he professed the law of increasing entropy as a fundamental law of nature. However, there is nothing extraordinary in this statement. In the end, the law of increasing entropy is an empirical law; its validity follows from the observations made by us only and exclusively within our expanding Metagalaxy. And what would happen if we lived in a metagalaxy contracting by gravity, in which because of the growing pressure, all more or less complex forms of matter disappear gradually, one after another? When changes occur in the direction of reducing the complexity and diversity? Apparently, then, we would have come to the conclusion that in such a world (within the contracting metagalaxy) the law of decreasing entropy acts.

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Of course, the experimental verification (Consequence 7) of Consequence 5 cannot be a justification of the hypothesis of fractal Universe. And in general, about what kind of empirical support for a hypothesis or a theory can we talk when we discuss the Universe, not observable beyond the apparent horizon of finite radius?!

Let us emphasize, however, that all the consequences given above, including Consequence 5 which substitutes the hypothesis of dark energy with its fantastic properties, follow from only one, but very believable, hypothesis — the hypothesis of fractal Universe. I think that this hypothesis is very attractive from the point of view of the principle of economy of thought. In my opinion it is more attractive than ad hoc hypotheses, which are taken to overcome some particular difficulties faced by a particular theory, and to which the hypothesis of dark energy belongs.

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