Why Cannot the Theory of the Infinite Universe be Realized?

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Resumen. *¿Por qué no puede realizarse la teoría del universo infinito?*

El presente trabajo demuestra que todas las teorías cosmológicas obedecen a una relación epistemológica: todos los pasos que hace la cosmología orientados a la adquisición de la condición de la ciencia natural es inversamente proporcional a sus pasos en la dirección de permitir valores infinitos de características cosmológicas. Analíticamente, la cosmología topó por primera vez con el problema del infinito cuando trató de explicar la rotación de la Tierra en los modelos antiguos. Un intento de introducir el infinito en la descripción del Universo según el modelo de Newton, dio lugar a las paradojas de la fotometría y la gravedad. La cosmología relativista, para eliminar las paradojas, ha tenido que otorgar una vez más características infinito del universo. La misma dificultad es típica de los escenarios inflacionarios y caóticos.

Palabras clave: teorías cosmológicas, la epistemología, infinito, universo, Newton, paradojas.

Abstract

The present work demonstrates that all cosmological theories obey an epistemological relation: all steps cosmology makes in the direction of acquiring the status of a natural science are inversely proportional to its steps in the direction of allowing infinite values of cosmological features. Analytically, cosmology first encountered the problem of infinity when it tried to explain the rotation of the Earth in ancient models. An attempt to introduce infinity into the Universe description by the Newtonian model, resulted in the photometric and gravitational paradoxes. To eliminate the paradoxes, relativistic cosmology had to introduce once more the infinite characteristics of the Universe. The same difficulty is typical of the inflationary and chaotic scenarios.

Key words: cosmological theories, epistemology, infinity, Universe, Newton, paradoxes.

Problem Statement

The question "What is the world around us like?" might be really answered in a great variety of ways and mostly within the scope of natural science. However, if we put the question in a more specific form – "Is the world around us finite or infinite?" – we shall have to admit that there is only one *natural* science able to offer a more or less sound answer. This unique science is cosmology. Why? Because viewing this natural world as an *integral whole* has always been its prerogative. Its subject is usually defined as "the physical and geometrical properties of *the Universe as a whole*".

Of course, the subject of cosmology is essentially different for us now from what it had once been for ancient Greeks, but the question whether this visible world is finite or infinite, has always aroused warmest interest. In this work we see our task as demonstrating *the epistemological unrealizability of the infinite Universe theory*. With this aim in view, we shall have to make some preliminary assumptions:

1) We shall discuss here only European cosmology, *ancient* and *modern* preferably.
2) The expression "to be realized" is used here not as equipollent to the expression "to be constructed".

It is obvious that, in a sense, "any" theory may be "constructed", yet not at all every theory is likely to prove realizable, that is, capable of being verified by observation or experiment. For this reason, it seems of interest to examine what kind of theories – those of the finite (limited) Universe or those of the infinite (unlimited) one – prove most realizable; and not only that, but, speaking more strictly, *principally* realizable. Might not it happen that *infinite values* as such are indicative of their unreal essence and, hence, of their unrealizability?

Of course, many attempts can be found in the ancient as well as in the new-time and the modern cosmologies, to construct a theory that would concede infinite values of such characteristics as space, time etc.. However, all such attempts inevitably met with serious difficulties. In the ancient cosmology the difficulties were of rather *methodological kind*, manifest in the discrepancy between the stated assertions and the observable Cosmos: such were the difficulties associated with the so-called "retrograde motion" of planets, the inequality of seasons and so on. In the new-time and in the contemporary cosmologies they are mostly difficulties of *logical and mathematical kind*, manifest in diverging integrals, zero or infinitely large values of such physical quantities as time, density, pressure etc..

And yet, quite naturally, all investigators at all times have always been yearning to "expand the limits" of the observable world. Did it really lead to the discovery of the infinite Universe? Let's start our discussion from the attempts made in the antiquity.

Difficulties in Ancient Cosmology Related to Infinity

Thomas Kuhn, for example, associates the birth of "scientific cosmology" with that of the "two-sphere model of the Universe"(Kuhn,1985,p.28). He is speaking of the idea of Anaximander of Miletus who developed a spherical model of the Cosmos with the Earth resting in the centre.

Only a few cases are known when ancient cosmology postulated, metaphysically, the infinity of the world. Such were the models of Leucippus and Democritus, who considered worlds to be infinitely many (Alfieri,1936,p.2), commencing and dying in the boundless (infinite) void. A distinctive feature of the atomistic tradition is the lack of logical elaboration, and the infinite set of worlds is merely *postulated* here.

But most cosmological theories of the ancient period (those of Pythagoras, Plato, Aristotle, Ptolemy and others) *rejected the concept of infinity* when describing the Cosmos. Why? Most probably, it was intuitively obvious for the ancient scientific tradition that "unlimited things" could not be made objects of cognition. Consequently, a cosmological maxima was formulated: *the Cosmos is finite* [1].

However, though Pythagoreans and Plato postulated the finiteness of Cosmos metaphysically, they made also a number of steps to encourage objective discussion of its dimensions, thus introducing the problem of its "finiteness-infiniteness" into the scope of philosophy and science – on an *analytical*, and not merely postulating level, as it had been for Leucippus and Democritus. Those steps were connected with the discussion of the Earth rotating round its axis by Plato2, or round the central body (Hestia) by the Pythagoreans (*Diels*,1903), or the Cosmos as a whole – round the sun, by Aristarchus of Samos (*Archimedes*,1962,p.358).

Their infringing upon the principles of the Earth's immobility and central position in the Cosmos is known to have provoked Aristotle, ironically enough, into making – with the aim to refute Plato and Pythagoreans – such statements that were to be eventually used as verification of their theses. His arguments Aristotle expressed in the book "On the Heavens", Book II, Ch.14 296 b1-7:

> Again, everything that moves with the circular movement, except the first sphere, is observed to be passed, and to move with more than one motion. The earth, then, also, whether it moves about the centre or as stationary at it, must necessarily move with two motions. But if this were so, there would have to be passings and turnings of the fixed stars. Yet no such thing is observed. The same stars always rise and set in the same parts of the earth.

1. See: Plato in "Timeus",28b-c; 38b.
2. See: Plato, "Timeus" (40 c).

Today we call such movements *parallaxes* (diurnal and annual)3. What was the main Aristotle's argument? That those *movements (parallaxes) are unobservable by regular vision*. But why are parallaxes invisible for the naked eye? Because of the enormous distance between the stars and the observer.

The problem of parallaxes was, of course, repeatedly discussed after Aristotle, too.

a) Thus, Aristarchus of Samos beats Aristotle's argument by the suggestion that the distance between the Earth and the Sun is *infinitesimally small* as compared to the distance between the Earth and the sphere of the fixed stars (Archimedes,p.358-359).
b) Then Ptolemy in "Almagest", Ch. I.§ 2 says: "…The Earth also looks as a sphere if taken in the whole set of its parts. As for its position, it is situated in the middle of heavens, as if being its centre. As for its magnitude and distance from the sphere of the fixed stars, it looks like a point, subject to no motion that might change its place".

So, we can make some preliminary conclusions about the ideas of finite or infinite nature of the Universe in ancient cosmology.

1) Ancient thinkers touched upon the problem of "the infinite world" when trying to explain the "double motion" of the Earth. Its solution was connected with the assumption that "there should be some motion of the fixed stars, which is invisible because of the *huge distance* between the Earth and their sphere".
2) It was one of the first paradoxes related to infinity – there exists some *motion* of the *fixed stars*, though *invisible* – in ancient cosmology.

An Attempt to Realize the Infinite Universe Theory in Newtonian Paradigm

With the development of mechanics and gravitational theory the so-called Newton cosmological paradigm came forth and established itself from the 17th century on, till the end of the 19th c. Its distinctive feature was – as compared to, let's say, the Copernican one – its aiming at the *physical* explanation of the Universe in the frames of the observable bodies of the solar system. At the bottom of such explanation there lay some implicitly presupposed concepts that were never formulated explicitly: 1) The Universe is *infinite*, hence, it cannot be something *whole* ; 2) Any changes in the infinite Universe are *local*; 3) *The World* – looked upon as *everything* that exists (the Universe) – is *changeless* as a whole.

3. E.g., diurnal parallax is about 0′′,00004/~100 M.p.; annual parallax is about 0′′,01/~100 M.p. Annual parallax was discovered and calculated only in 1837-38.

In other words, the 17th–19th-century physical cosmology was not counted among exact sciences, as having no object of its own described by cosmological equations, but was merely a part of astronomy. Two attempts were made in the 19th century to specify theoretically the object of cosmology – that is, to extrapolate from the Newtonian cosmological view of the world to the infinite Universe. Both led to cosmological paradoxes.

The Olbers Photometric Paradox (1826)

The essence of the photometric paradox, usually attributed Heinrich Olbers (1758 – 1840), was formulated as follows. Suppose, Newton is right in his idea of the infinite Universe. Then let's make a mental experiment. Imagine that the Earth is surrounded by a huge sphere (of a very big radius). Inside this sphere there must be found a certain number of stars, imparting to the sphere some brightness. Now, let's double the sphere's radius. If we assume that all stars are equally bright and evenly distributed in the space, then doubling of the radius should increase the luminosity of the night sky. Of course, the brightness of the farthest stars will become 4 times less, for it depends on distance as $1/r^2$, but as the number of the stars is directly proportional to the sphere volume, that is r^3, the general luminosity of night sky will nevertheless increase. And if we continue to do so, we shall, in the end, have to admit that night sky has to be as bright as the Sun! Such was the contradiction (paradox) between the data of the observable night sky and Olbers' conclusion, founded on the assumption of reliability of the Newtonian view of the Universe.

The Seeliger Gravitational Paradox (1895)

The gravitational theory created by Newton explained rather precisely the planets motion round the Sun under Kepler laws. Here we shouldn't fail to mention that applying the Newton gravitational theory to the problem of celestial bodies motion within the Solar system gave outstanding scientific results: e.g., the existence of Neptune was predicted.

This general success, however, did not secure Newtonian paradigm against the following difficulty: if we assume that everything in the *infinite* Universe, filled with the *infinite* quantity of matter, is subject to the gravitational law – we cannot help coming to a very strange conclusion, noticed by Hugo von Seeliger. If the *infinite* Universe hypothesis is true, and the assumption of the infinite quantity of matter in it is true, too, then all matter in the Universe must have gathered, under the gravitational power, according to Newton law, in its centre – where its density would have become enormous, whereas moving towards infinity the density of matter would have been approaching zero. Mathematically, this could be shown as follows:

In the Newton theory of gravitation, the gravitational potential *j* obeys Poisson's equation Dj = 4pGr, where G – gravitational constant, r– the density of matter. Its solution is of the form:

j = G ò rdV/r + C,

where *r* – the distance between the volume *dV* and the point where potential *j* is determined; *C* – an arbitrary constant. If we assume that *r* tends to infinity and the density of matter decreases faster than $1/r^2$, then the integral tallies, and the potential *is determinable*. But if, as the distance increases, the density of matter decreases slower than $1/r^2$ – and this must be exactly the case with the infinite homogeneous Universe filled with the infinite quantity of matter – then the integral diverges and the potential *is undeterminable*. A kind of solution is only found when the average density of matter in the Universe *r = 0.*

However, it is not so. Hence, Seeliger concluded, *either the Universe is not infinite, or matter is not distributed evenly in it, or else, neither of the two is true.* Seeliger tried to save the situation suggesting that maybe the power of gravitation lessens faster than $1/r^2$, as is predicted by Newton law. It would be unjust to forget that Newton himself, being a discerning and earnest scientist, could not have failed to notice the problem. In a letter to Richard Bentley he commented on a similar difficulty (Hoskin, 2008, p.252).

Early in the twentieth century, Charlier made an attempt to overcome the paradox of Newtonian "infinite Universe", by the assumption that "the density of stars is the lesser the father away in the space they are" (Charlier,1914,p.5) and that "though matter in the Universe is infinite, its average density tends at the same time to zero in the farthest parts from the centre" (Charlier,1914,p.5). This proposition does not at all follow from Newton gravitational theory, being a mere *ad hoc* assumption, aimed at saving the "Newton law" from gravitational paradox.

The artificial character of such assumptions, unverified by any kind of observation, was, in fact, an impetus to seek after alternative explanations able to solve the problem in a natural way, as a direct consequence of solvable equations.

Solution of the paradoxes of Newtonian cosmology

As we know well today, the solution of the mentioned paradoxes required a principally new theoretical basis, which was provided by the new gravitational theory (1915-1917) of A. Einstein. It introduced absolutely new concepts of space, time and matter. World characteristics were described by Einstein cosmological equation:

$$R_{ik} - ½\ g_{ik} R = k/c^2\ T_{ik} + g_{ik} L$$

where R_{ik} – Ricci tensor, R – its track, (they both are functions of g_{ik}) , T_{ik} - energy-momentum tensor of matter, L – parameter, equivalent to the complementary term in the energy-momentum tensor. There were some peculiarities in solving this equation[4]:

1) When the equation is solved, the scale factor is equal to zero, because *da/dt* = 0. In other words, the Universe, according to this equation, proved to be non-evolvable – *static*.

2) For the first time in the new-time history of cosmology, a cosmological equation described *the whole Universe*, that is, embraced *all* matter and radiation filling it.
Such static world inevitably turned out *to be closed*.

A complementary parameter *L* was introduced into the equation, though important only on the scale of the entire Universe. For this reason it got the name of "cosmological constant".

Extragalactic observations reduce *L* to the negligible quantity of the order êL ê£ 10^{-55} cm^{-2}. Which meant, no laboratorial observation was possible. However, as contemporary models develop, taking into consideration the impact of "obscure" matter and "obscure" energy, the cosmological constant is acquiring considerable importance.
Why did Einstein have to introduce the *L* parameter? Zeldovich notes that Einstein was seeking for a *static solution and with the closed geometry of the three-dimensional world (*Zeldovich,Novikov,p.126-127*.)*. The reasons for this might have been as follows:

1) It was believed that the independence of time (static character) corresponds to the greater age of celestial bodies (it had already been calculated that the Earth was about several milliards years old).
2) A closed model was preferable as meeting better Mach's principle. A closed model contained some finite quantity of matter, which allowed to presuppose: this matter forms in a way a local inertial reference system. According to Mach, a body's inertia depends on its interaction with the complete surrounding matter, which was acceptable only in case the quantity of matter was *finite*.

The created model of a static Universe with the described above properties – static nature, spatial closure, finite radius and volume, finite quantity of matter – was the first allowing to regard it as an integral whole that may become the subject of exact science.
The other thing was that the Universe static character provided a solution to Seeliger gravitational paradox. As Einstein himself pointed out (Einstein,1965,p.583-587), the quantity of matter in a closed spherical world is *finite*, though immense, and the radius of such world is *finite*, too. According to Einstein's theory, *such Universe is boundless, but not infinite.*

4. For more detail see: (Zeldovich, Novikov, 1975. P. 129-130).

When, in 1922-24, Friedmann's nonstatic solutions of cosmological equations appeared, it added to the described properties another one – *the evolution*, that is, changing of the Universe physical-geometrical characteristics in time.

Friedman's theory surmised three possible scenarios for the world's behaviour and state: expansion, static nature, and compression. Geometrical properties of the space in this model depend on the existence of matter, its density and motion: if $\rho > \rho_c$, the curvature of space is positive. Hence, the Universe is closed and *finite* (though boundless); if $\rho = \rho_c$, then the curvature of space is equal to zero, and the Universe is flat. If $\rho < \rho_c$, the curvature of space is negative; then the Universe is opened and *infinite*. The modern measured value of critical density is - $\rho_c \sim 10^{-30}$ g/cm^3.

Observations, carried out by E. Hubble (1928-29), established the red-shift effect, which was a verification of the expansion scenario. Friedman Universe expands according the Hubble law $v = Hr$, where v is the speed of an object (a galaxy or a cluster of galaxies) moving away from the observer, H is Hubble constant, of the order » 75 km/sec·Mps ; r – the distance to the object moving away. The law shows that the speed is directly proportional to the distance. In other words, the farther and object is from the observer, the greater the speed is at which it is moving away. The velocities of the objects on the border of seeing approach that of light. Hence, the objects whose light does not reach us are beyond the limits of our seeing – beyond the *light horizon.* Thus the Olbers photometric paradox got its solution.

To sum it all up, what were the results of tackling the question whether the Universe is finite or infinite, in the frames of relativistic cosmology? They are as follows:

1) The general solution of the Newtonian Universe difficulties was associated with the construction of a principally new model, based on the general relativity theory.
2) Solving the mentioned paradoxes went together with giving up the view of an *infinite* Universe and developing a theory that views the Universe size as *finite*. A model of *boundless*, but *not infinite* Universe was constructed.

So, the problems of Newtonian cosmology found their solution, but *at what price*, indeed? As we can see, the "challenge of infinity" of the Newtonian paradigm was overcome at a price of a principally new conception of the Universe physical-geometrical structure:

1) the non-Euclidean geometry was applied*;*
2) The Friedmann–Gamov theory maintains such feature of the Universe as *its finite size*.

However, these and some other assumptions of relativistic cosmology led, in their turn, to new difficulties, the "problem of singularity" being one of the most complicated among them.

Really, what did the introduction of the "singular point" notion mean for cosmology? It meant, according to Friedmann's equations in the nonstatic case, that the *time* and the *space* tended to zero, turning infinitesimal, and that the pressure and density of matter became infinitely big. *And this, from the methodological point of view, meant the "end" of modern physics as an empirical science*. In other words, such theory of the Universe could not be realized.

The Solution of Friedmann Cosmology Problems in the Inflationary Universe Model

Here it should be recalled that the idea of an inflationary scenario was first expressed in A.A. Starobinsky's work (Starobinsky, 1979,p.719). In 1981, Alan Guth found a way to use "inflation" (Guth,1981,p.347) to solve some of the problems implied in Friedmann's theory. In 1982, there appeared new scenarios by A. Albrecht, P. Steinhardt, A.D. Linde, and finally, the chaotic scenario by A.D. Linde (1983). It was for their solution that an essential change in the proper and epistemological foundations of cosmological views was required (Pavlenko,1994). It was, actually, the "price" necessary to pay for the "acquisition" of new foundations. *And what became a measure for such a price, were a local observer's dominating ideas about the physical-geometrical Universe structure*. The cosmology of the eighties was turning into the quantum theory, whereas physical vacuum was becoming the foundation of all theoretical schemes.

In this context, it is interesting to ascertain the basic statements of the inflationary theory (IT) and the chaotic scenarios, and to examine these in respect of their realizability as a basis of the "infinite Universe theory".

The Inflationary Theory (IT) proper foundations

With no claim for exhaustiveness, the following specific basic traits of the theory may be singled out:

1. *The IT introduces the "inflation" concept, to describe the exponentially rapid growth of the Universe volume, while in a vacuum-like condition*. The pressure (p) and density of the vacuum energy (ρ) are related as $p = -\rho$ (Glinner's equation). If we correlate the state equation with the law of conservation of energy

$$\rho a\ 3 + 3\ (\rho + p)\ a^2\ a = 0$$

we shall see that the velocity of the Universe growth (at the stage of inflation) is by many digits higher than the light velocity in vacuum: $a(t) \approx a_0 e^{Ht}$, where the scale factor $a(t)$ grows exponentially. The Universe radius, at the stage of inflation in the IT, grows, in about a 10^{-43}–10^{-35} -second time, from the Plank dimension of 10^{-33} cm to the fabulous dimension of $10^{10(7)}$ - $10^{10(14)}$ cm.

2. *Vacuum is looked upon as the most fundamental form of all physical forms of matter existence*. The IT presupposes the birth of an observable Metagalaxy (mini-Universe) as a result of *vacuum fluctuation*.

3. *The space is independent of matter and radiation at the early stages of the Universe evolution.* The stage of inflation in the Universe evolution takes place without any presence of matter and radiation. In other words, it is the "empty" space that inflates, – filled only with scalar field.

4. *In 2001 – 2002, the IT gets its first empirical verification* with the use of the COBE (Cosmic Background Explorer) satellite and anisotropy of the cosmic microwave background radiation. *(*Smoot, G. F. et al., 1992).

The IT epistemological foundations.

Here the following may belong:

1. *The range of objects described by the theory is essentially broadened.* The observable part of the Universe (10^{28} cm) becomes just a *local area*. If there used to be, at the time of the evaluative Universe theory prevalence, the question of validity of extrapolation from the local space-time properties to the large-scale structure of the Universe, now there arose another one: *the question of validity of extrapolation from the properties of the observable realm to those of the basically unobservable area*. The reason for such extrapolation is manifold: the problem of causality horizon, that of the light horizon, etc..

2. *The IT solves most of the evolutionary theory problems (those of flatness, horizon, three-dimensionality, etc.) at the price of such broadening of its theoretical basis that made Einsteinian description of physical world "classical".* In various scenarios, its theoretical basis includes: the GUT, the theory of supergravitation, the theory of superstrings, describing such physical objects and space-time properties, some of which can never be detected by an earthly observer in the foreseeable future or even in principle.
3. *The IT not only questioned the validity and status of mediated observations, but postulated that some of the facts it predicts are unobservable in principle.* A few examples will make it clear. The IT predicts that as a result of vacuum fluctuation, there are "bubbles"-domains born, with dense walls in the form of large-scale

> inhomogeneities. The size of these walls is of the order of $10^{10(7)}$ -$10^{10(14)}$ cm, whereas the observable realm of the Universe is approximately 10^{28} cm. And, though contemporary observational astrophysics offers various "exotic" ways to check the existence of the domain walls, real verification of this predications remains "beyond the limits" of our present possibilities.

The so-called problem of "light horizon" may serve as one more example. It is as follows. The Universe in the stage of inflation was expanding as "pure space" with no matter or radiance. These commence not before *the Universe gains the size of the order of $10^{10(7)}$ cm.* As a result of the phase transition of the vacuum from the state of negative density of energy to the state of positive energy density, light particles – photons – are being born, that is, there appears the predicted by G. Gamov "ultra-relativistic photonic gas". But velocity of photons cannot, according to SRT, rise beyond a certain finite value. So, scores of milliards years is the time needed for light to "run" the way from the domain border $10^{10(7)}$ cm to the realm observable for an earthly investigator 10^{28} cm. But this means that a contemporary earthly observer is, in fact, "cut off forever" from the rest of the world of his own Universe. The information from the outer world simply does not reach him. Hence, any observations of the "closed areas" are at present not possible at any rate, in the very principle.

Such are, grosso mode, the proper and epistemological foundations of the Inflationary theory on the whole. Basing upon them, we are going now to study the principal suggestions of the chaotic scenario.

The Chaotic Scenario Basic Suggestions

In 2008, it was exactly twenty five years since the first Linde's work appeared (Linde,1983,p.177), offering the "chaotic scenario" of the Universe origin. Let us examine its basic statements.

The specific assumptions of the chaotic scenario suggested by Andrew Linde in 1983-85.

1. As distinct from preceding inflationary scenarios, the chaotic scenario is based on the assumption that scalar field filling the space is distributed chaotically. A representative example is the simplest case of the theory of scalar field ϕ with Lagrangian

$$L = {}^1/_2\, \partial_\mu \phi \partial^\mu \phi - V(\phi)$$

It is also supposed that the potential $V(\phi)$ when $\phi \geq M_p$ grows more slowly than $\exp(6\phi/M_p)$.

This condition is satisfied by any potential that grows, when $\phi \geq M_p$, exponentially:

$V(\phi) = \lambda\, \phi^n/n\ M_p^{n-4}$

where $n > 0$, $0 < \lambda \ll 1$.

Such feature as the density of energy in vacuum ρ can be defined here only to within the Planckian limitation *0* (M^4_p), due to the quantum-mechanical principle of indeterminacy. (Linde, 1990,p.40). Hence, the values of scalar field may be any ones permitted by the theory. This field's fluctuations may have positive sign, and then the field is *increasing*, or negative sign, in which case the field is *decreasing* approaching its minimum. The probability of the field's increasing (in general case) is ½, so one half of the volume of the inflating Universe will be filled with increasing scalar field, whereas the second half of it will be filled with decreasing field.

So, the main trait of the chaotic scenario defined here is that the *scalar field* presupposed by it *is distributed in a chaotic way.*

2. Scalar field in the chaotic scenario *is capable of producing, in a chaotic manner, new areas filled with the same field.* The thing is that in the areas where vacuum fluctuations become less than a certain critical value, inflation finally stops. But in areas with nondecreasing field, new inflating areas are still being produced anew. This process is not going to end and, as the author of the theory views it, might have had no beginning. This, in its turn, brings about three fundamental consequences:
   a) The Universe *as a whole*, if the chaotic scenario is true, will never collapse (will not come to singularity, as is the case with Friedmann's theory of the evolving Universe). *There is not going to be any death of the Universe as a whole.* Externally, this allows of admitting the possibility of the Universe's eternal existence "in future". This may be interpreted in the way that *in the chaotic scenario, the factor of "time" assumes "in future" an infinite value.*
   b) The Universe *as a whole* – the Multiverse – consists of a huge number (about 10^5) of domains, similar to the Universe we live in. Since there exist "simultaneously" about 10^5 domains, appearing and dying, their number throughout the entire existence duration of the "maternal scalar field" – having neither "beginning" nor "end" – also must tend to infinity.
   c) The Universe *as a whole* might have had no original cosmological *singularity* at all (Linde,1990,p.58). This may be interpreted in such a way that *the factor of "time" acquires an infinite value also in "the past"*. Thus, the chaotic scenario solves the most complicated problem of the relativistic cosmology – singularity. But at what price?

The price of this solution of the problems of relativistic cosmology and those of prime inflationary scenarios proved enormous: the chaotic scenario had to broaden the range of objects described by it, in such a way that the very idea of the Universe was radically transformed, turning into the Multiverse. Elimination of *the infinite values* of *physical* and *geometrical features* became possible only because the idea of "quasi-infinite" size of the maternal Universe itself, the Multiverse, was introduced. This, in its turn, is sending us back to the question whether cosmology as such belongs to natural sciences, that is, whether its consequences are testable in principle (Hempel,1998,p.32).

Conclusion

Let us try to sum it all up. Throughout the entire history of European cosmology, there seems to be obvious a steady tendency: cosmology in its development, assuming the form of a natural-science theory of the Universe, tends, as long as it exists, to eliminate the infinite values of such characteristics of the Universe as its size, time, density and so on. This is why the answer I am ready to give for the question formulated in the title: "Why cannot the theory of the infinite Universe be realized?" is such: "Because when *infinite values* of physical and cosmological features are introduced into the cosmological theory of the Universe, this, objectively, brings about the invalidation of cosmology as a natural science".

In other words, all steps cosmology has made in the direction of acquiring the status of a natural science are *inversely proportional* to its steps in the direction of allowing infinite values of cosmological features: the more resolutely cosmology eliminated infinite values, the more assuredly it could be looked upon as a full-fledged natural science (relativistic cosmology was the first here), and vice versa, the greater was the number of infinite values allowed by a cosmological theory, the more inevitably it fell away from the realm of "natural science" (Lakatos,1972,p.125).

Yet, it would be naive to think that the exposed difficulties would ever stop investigators from seeking for a realizable theory of the Universe . Most probably, this quest will develop further clinging to the tendency clarified here – that is, balancing between natural science and mathematized metaphysics.

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