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Dimensionality of Absolute Space ≈3.096433

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Abstract

The dimensionality of the Absolute Space $D_{AS} \approx 3.096433$ and the space of the Universe $D_U = 3$ are determined. The physical meaning of fractional dimensionality is discussed. A variant of the hypothesis about the fractality of the Universe is proposed, taking into account the possibility of the existence of matter with negative mass. The states of the Universe without Absolute Space are considered.

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Introduction

In the fundamental theoretical physics of the 20th century, the central place was occupied by the consideration of the nature and properties of three physical categories: space-time, matter and fields of interaction carriers, which gives the right to classify all theories with such an understanding of categories as a trialistic metaphysical paradigm. By combining two of these categories into one generalized one and taking the remaining category as the second, we can obtain three types of physical theories based on an already dualistic paradigm or three worldviews of the same physical reality from different angles.

There have always been two approaches to reality in science: holism, based on the dominance of the whole as preceding its parts, and reductionism, in which the whole is split into more primary parts preceding the whole. The dominance of reductionism manifested itself in the identification of the above-mentioned categories, which in the trialistic paradigm have the status of independent entities. The ideas of holism were of particular importance in the 20th century, which manifested itself in the attempts of theorists to unite known types of physical interactions, to build a unified field theory and to geometrize all of physics. Therefore, the tendency to transition from the trialistic paradigm, through dualistic paradigms to the monistic paradigm, prevailed. The well-known definition of matter as an objective reality given to us in sensations [1] formally allows us to consider empty absolute space also as a certain objective reality given to us in the form of a kind of "zero" sensation. It follows from this that space is merely a kind of matter. And since space exists always and everywhere, even if there is some object in it consisting of another kind of matter, then matter, at least in the form of space, cannot but exist. Space, being only one of the types of matter, is obviously capable of transforming into other types of matter and back under certain circumstances. If these conclusions were not true, then the very existence of matter, and therefore the Universe itself, would have no cause. Thus, space may be a contender for the role of the primary entity (proto-matter) that forms the Universe. And it is precisely this, accordingly, that could form the basis for the monistic paradigm. As a result of the evolution of the Universe, objects may arise in its various local areas, the dimensions of space in which may be very different, but the global dimension of the space of the Universe will always be determined by the dimension of the Absolute Space (AS). AS is also understood as that part of the Universe that remains after all its contents are removed from it.

In modern physics, the prevailing opinion is that the basic form of matter is the physical vacuum [2], capable of generating all other types of matter [3]. However, G.I. Shipov [4] managed to substantiate a hypothetical scenario of the birth of matter from a state preceding the vacuum – Absolute "Nothing", according to which the synthesis of the physical vacuum is first carried out either directly from the Absolute "Nothing", or through an intermediate stage of the primary torsion field. Further evolution follows the scheme: vacuum – elementary particles – gas – liquid – solid [5-9]. From this scheme it follows that the Absolute "Nothing" is the progenitor of the current Universe and coexists simultaneously with it at each of its points. The Absolute "Nothing" is a container in which the Universe created by it is immersed. This capacity is the space of Absolute "Nothing", which is either infinite or, on the contrary, has zero extension. If it has zero extension, then the remaining part will have infinite extension and it should be attributed to Absolute "Nothing", according to its logical meaning, as denying the existence of "Neganothing" - and this is already "Something", i.e. it is already a substance, a type of matter. And since the synthesis of matter occurs from the Absolute "Nothing", the space of the Absolute "Nothing" has an infinite extension. The space of the Absolute "Nothing" is the Absolute Space (AS), in which the Universe generated by it is immersed. The purpose of this work is to find the value of the dimensionality of the Absolute Space.

Absolute Space

The first logically substantiated characteristic of Absolute Space was given by Isaac Newton [10] "Absolute Space, by its very essence, without regard to anything external, remains always the same and motionless. Relative space is its measure or some limited moving part, which is determined by our senses by its position relative to some bodies." The following axiomatic propositions follow from this definition [11].

- The points in the AS where material objects are located are identical to each other.
- AS has its own internal, inherent congruence, the existence of which is completely independent of the existence of material objects.
- The points and intervals of the AS determine the location of material objects and events, but physical bodies and events do not determine the points and intervals of the AS.
- AS is not connected with matter and consists of a set of points, each of which is devoid of structure.
- Points are eternal and unchanging. Changes can only consist in the fact that points are occupied by some physical objects and exist independently of the objects.
- The AS must have infinite extension in any direction, the number of which is determined by its dimension. It follows that the AS has zero curvature and is Euclidean.

Considering the Category of Absolute Infinity [12-16] and Transferring the Properties of Absolute Infinity to Space, it can be Argued that Absolute Space must Exist [11], and the Following Properties must be Added to Its Characteristics:

- The essence of AS is identical with its being, since AS is being itself, and relative spaces possess only being.

- AS is infinite, unlimited, it does not even limit itself, it has no parts, no beginning, no end.
- AS is amorphous. To exist means to have an image, but AS does not have an image, because an image must have a form or shape.
- AS is dimensionless, because form and appearance imply limitations and dimensions, but AS has no form or appearance.
- AS is motionless.
- AS has no gradients with respect to any of its properties, it is scalar.
- AS exists in a single copy, it is one and simple. From this simplicity comes complexity.
- On the one hand, the AS is outside of time. It has no past or future, since its past, present and future coincide. On the other hand, this coincidence does not mean that the AS is indifferent to the course of Absolute Time. Absolute Time flows independently of the existence of the Universe and the AS itself. The mechanism of the influence of Absolute Time on the AS is unknown to us, but the result of this influence is, apparently, that no significant changes occur in the AS.
- AS has no mass, electrical, gravitational or any other charge and therefore does not have a state of weightlessness and is not subject to the influence of any fields.
- AS is not a mind, it does not think, does not contemplate, does not perform any actions of rationality.
- AS is a topological space, it is continuous, and cannot be divided into transfinite infinities. It cannot exist divided into parts.
- AS is not substantial.
- S is homogeneous.
- AS is isotropic.

Despite the complete absence in the AS of concepts familiar to us, such as temperature, mass, viscosity, electromagnetism, etc., the existence of the AS is justified by the fact that, in essence, precisely due to the absence of the above- mentioned attributes, it is equivalent to its non-existence. Therefore, we can think of it, perceive it as a completely abstract idea, devoid of any content, through the abstracting action of thinking over all objects surrounding us. This is possible only in the case when other spaces and sets, when investigating their essence, being, cause of origin and quality, include in their composition or consist of AS and exist in AS, being in motion. On this basis, Chizhov E.B. gave an updated definition of Absolute Space: "Absolute space is a logically conceivable primary substance that does not have quantitative and qualitative categories, from which pure quantitative and qualitative spaces consist, as well as an environment in which certain quantitative and qualitative extensions are realized and relative spaces exist [11]." Generally speaking, AS could not be defined, since it, being the primary substance of "All that exists", is defined through itself and the only axioms of its essence and being will be the axioms of proposition:

- There is AS.
- AS exists.

Based on the definition of AS and the axioms of proposition, we can say that AS is the first cause of the possibility of the existence of quantitative and qualitative differences in all that exists. The existence of AS explains the existence of the Universe, AS is the first cause of the existence of the entire Universe.

The eighteenth attribute of AS has a special significance. In a certain sense, it is controversial. On the one hand, if AS is not substantial, then the evolution of AS into a physical vacuum, and, moreover, into matter, becomes doubtful or even impossible. If we assume that AS is substantial, then, as is done in etheric vortex theories, for example, [6, 7], the formation of material particles can be fully substantiated. However, it is not possible to substantiate the substantiality of AS itself, and, consequently, the very existence of matter in general. Therefore, at the current moment, the eighteenth attribute exists in the following variants: 1). AS is non-substantial; and 2). AS is substantial! This means that, until any data appears that would allow a more unambiguous choice to be made, both mutually exclusive variants have the right to exist. However, since in the present discourse we are, first of all, investigating the properties of space, and not of some environment filling this space, it should be considered that it is preferable to consider space itself non- substantial.

In [17] it is shown that the value of the speed of light is an extremely slowly decreasing function of its frequency, so that in the frequency range from 1 to 10^{22} s^{-1}, i.e. from the hardest γ-rays to ultra-long radio waves, the difference in the value of the speed of light exceeds the accuracy of modern methods for determining the speed of light. However, at frequencies less than one hertz, the speed of light begins to decrease sharply, and at a frequency equal to 4.6· 10^{-21} s^{-1} the speed of light becomes equal to zero. Such light is already at rest particles - photonics with a mass of 3.4· 10^{-71} кg, forming "standing light", which over time fills the space of the Universe, thus being able to serve as the Absolute Reference System.

In the non-substantial AS, standing light fills it and can be, in a certain situation, a source and generator of matter in various forms, including substance. In the variant of substantial AS, such a source and generator of matter can be the Absolute Space itself.

Topological dimensionalities.

Definition of a topological space [16 – 21]. Let X be an arbitrary set, and τ={U:U⊂X}- be some set of subsets of X. The set τ is called a topology on the set X, and the pair (X,τ) is called a topological space if: 1). ∅∈τ and X∈τ, where ∅ is the empty set. 2) The union of an arbitrary finite or countable subset of elements of τ belongs to τ. 3). The intersection of an arbitrary finite subset of elements of τ belongs to τ.

Subsets {U⊂X: U∈τ } are called open subsets. The complement F=X\U of an arbitrary open set U⊂τ is called closed. The empty set ∅ and the set X itself are both open and closed. The topology τ defined above is called the open topology on the set X.

The most natural way to determine the dimensionality of an object is the geometric method [22]. "the topological dimensionality of space Geom.X is the minimum number of independent parameters (the minimum number of coordinates) that are necessary to describe the space or the location of a point in space, primarily in order to distinguish points in space from each other" [23, 24]. Such a definition of the dimension of space formally coincides with the definition of the order (quantity) of integrals or derivatives of any function. As it turns out, if the number of parameters of a topological space, according to the generally accepted opinion, can only be integer, then the order can be fractional [25, 26].

In the First Book of Euclid's Elements, the Basic Concepts are Defined [27, 28]

- A point is a figure that has no parts;
- A line is a figure that has length but no width;
- The ends of a line are points;
- A surface is a figure that has only length and width;
- The ends of a surface are lines.

If we Add to this Classification of Euclid

Volume is a figure with length, width and height; The ends of the volume are surfaces; Hypervolume is a figure with n lengths, where n > 3; The ends of the hypervolume are hypersurfaces with $m = n - 1$ lengths,

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- Volume is a figure with length, width and height;
- The ends of the volume are surfaces;
- Hypervolume is a figure with n lengths, where n > 3;
- The ends of the hypervolume are hypersurfaces with $m = n - 1$ lengths,

then for these objects we can define the topological dimension Evklid.X, namely, for a point – 0, a line – 1, a surface – 2, a volume – 3, a hypersurface – m and a hypervolume – n. From these values of dimensions we can conclude that Euclidean dimensions are integers.

Close in meaning are two dynamic, symplectic and cubic definitions of topological dimension:
Din.X: a point is a zero-dimensional unit, the initial element of physical reality; continuous movement of a point generates a line of dimension 1, movement of a segment generates a surface of dimension 2, movement of a surface generates a volume of dimension 3, movement of a volume, accordingly, gives a hypervolume with the corresponding dimension [29];

din.X: if an object located in a topological space X has the ability to move in n different directions (in both directions), perpendicular to each other and cannot move in more than n directions, then the space X has dimension n. On the other hand, this dimension determines the number of independent degrees of freedom of the studied physicochemical system. If we consider the phase diagram of such a system, then the figurative point on it shows the possibility of being shifted in one direction or another without changing the qualitative phase composition corresponding to this figurative point [30].

Sim.X: If a simplex with n vertices fits into a space X (a simplex is an n- dimensional generalization of a triangle [31]), and it is not possible to fit a simplex with more than n vertices into it, then the topological dimension of such a space is equal to n – 1.

Cub.X: If a hypercube with m vertices fits into space X and it is not possible to fit a hypercube with a larger number of vertices into it, due to the fact that the number of vertices in a hypercube is $m = 2^n$ [31], then the topological dimension of $Cub.X = n = log_2\ m$.

P.S. Urysohn and K. Menger based their topological theory of dimension [24, 32, 33], now called the small inductive dimension i*nd.X,* on the definition: A space *X* is called n-dimensional at a point *p* if the point *p* has arbitrarily small neighborhoods whose boundaries have dimensions no greater than $n – 1$, but does not have arbitrarily small neighborhoods whose boundaries have dimensions less than $n – 1$. The initial point of the inductive chain forms an empty set ∅, which is assigned the dimension Ind.∅=-1.

The large inductive dimension Ind.X defines the dimension of a topological space X to be equal to n if between any two closed disjoint sets in X there is a partition of dimension $n – 1$, and Ind.∅=-1 [24, 33].

The topological dimension dim.X is defined using the concept of a covering, a finite set of open sets whose union gives the whole of X. A covering ω' is inscribed in a covering ω if any set on ω' is contained entirely in some set on ω. The multiplicity of a covering is the maximum number of sets in a covering that have a common point. The dimension dim.X is found as the smallest number n such that any covering of *X* can be inscribed with a covering of multiplicity $n + 1$. The dimensionalities Ind.*X*, ind.*X* and dim.*X* are integer and coincide in a wide class of topological spaces, in particular, for *n* −dimensional Euclidean space $Ind.E^n=ind.E^n=dim.E^n=n$ [21, 24, 33].

Dimensionality of Absolute Space D_{AS}

Let us assume that the *n*-dimensional topological space, which is Absolute Space, is packed in a regular manner by *n*-dimensional balls of radius R. Then between these balls there will remain voids (holes), which we will call negaspheres of the same radius R. Obviously, when this radius decreases, the volumes of spheres and negaspheres in the limit at R → 0 will become zero, so they can be conditionally called points (dots) and negapoints (negadots), respectively (the prefix nega means that in this place there is no spatial point, and instead of a point, there is a negapoint. And since the volumes of dots and negadots are zero, the dots and negadots themselves will not differ significantly from each other. The only type of packing of spheres of the same radius in n-dimensional space, such that the volumes of dots and negadots are the same in any part of the packing, as well as their relative positions from each other, are simple cubic packings. This type of packing is characteristic of the equilibrium state of the system and is possible in Euclidean spaces of any dimension [31, 34]. A packing of this type is most easily represented as an n- dimensional Euclidean space, densely packed with n-dimensional cubes in such a way that the vertices of the contacting cubes coincide, and a sphere with a diameter of 2R, equal to the side of the cube, is inscribed in each cube. The centers of the inscribed spheres coincide with the centers of the cubes, and the centers of the voids, which are negaspheres, coincide with the vertices of the cubes. It is easy to verify that the ratios of the volumes of the packed spheres and negaspheres do not depend on the size of their radii, and therefore will coincide for the corresponding limit ratios of points and negapoints. When passing to these limits, the shapes of points and negapoints, if their volumes are equal, will cease to differ. Absolute space must obviously have the dimension of such a space in which the volume of each sphere or, accordingly, in the limit, each point, is equal to the volume of the corresponding negasphere, and in the limit, the negasphere. It follows from this that the ratio of these volumes, as well as the ratio of the limits of the volume *n* of an n-dimensional sphere to the volume W_n of an n-dimensional negasphere must be equal to one, i.e.:

$$V_n = W_n \qquad (1)$$

The volume of a negasphere is equal to the difference between the volume B_n of an n-dimensional cube and V_n:

$$W_n = B_n - V_n \qquad (2)$$

since the spheres are inscribed in the corresponding cubes, the sides of these cubes are twice as large as the radii of the spheres. The volume of an n-dimensional equal to [31, 34], respectively:

$B_n = 2^n R^n$ (3)

$$V_n = \frac{\pi^{n/2} R^n}{(n/2)!} \quad (4)$$

Substituting the formulas for volumes (2-4) into equality (1), we obtain:

$$(n/2)!\, 2^{n-1} = \pi^{n/2} \quad (5)$$

Having solved equation (5) for n, we find that the dimensionality of Absolute Space

$n = D_{AS} \approx 3{,}096433$ (6)

Discussion of Results

Since Absolute Space is a topological set, and the spheres that it was packed with were also topological sets, then the most probable dimensionality of D_{AS} that was found must obviously be topological. However, as was said above, the topological dimensionality for all known topological sets is expressed by integers. In the case of AS, this dimensionality turned out to be fractional. This fact can be given various interpretations and hypothetical explanations.

Nihilist Hypotheses

- AS does not consist of any points, it is indivisible, and therefore it is impossible to pack points that do not exist in reality, to make any coverings or cuts in AS. It follows that the problem does not exist. But the problem remains if we assume that AS consists of non-substantial points.
- Due to the fact that the obtained dimensionality of the AS turned out to be fractional, and such, in accordance with the theory of topological dimensionality, cannot be, then, consequently, such Absolute Space, in principle, is impossible. In addition, it is not at all necessary that all voids have the same volume in the AS, or that spheres are packed in a cubic packing. In this case, the criterion of the absoluteness of space could be completely different. However, such a criterion is not known, and therefore the choice of the optimal dimensionality of the AS is based on the equality of the volumes of the sphere and negasphere in the densest packings of points in multidimensional spaces.
- Since, based on known facts, fractional topological dimensions cannot exist, it can be assumed that the AS points, not finding the possibility to pack in a fractional dimension, due to the absence of the corresponding space in nature, are forced to pack in a space whose dimension is closest to the nearest integer. In this case, the volumes of the points and negativity will be unequal to each other, but the difference in their numerical values will be minimal. Then the optimal dimension for the AS will be equal to 3.

Hypothesis of Substantiality of AP Points

If the AS is substantial, then the points of the AS will either be attracted to each other, or repel each other, or not react with each other at all.

- Points of the AP attracting each other. If the points of the non-substantial AS are packed into the most symmetric simple cubic lattice possible in topological spaces of any dimensionality, then the points attracting each other must be packed into the most closely adjacent, densest packings possible in a given space. Until recently, the highest density of packings of spheres was known only for space dimensionalities 1 (tight packing, packing coefficient $\Delta_1 = 1$), space dimensionality 2 (triangular lattice, $\Delta_2 = \pi/\sqrt{12} \approx 0{,}9069$), space dimensionality 3 (face-centered cubic lattice $\Delta_3 = \pi/\sqrt{12} \approx 0{,}74048$) [34]. I. Kepler In 1611 he put forward the hypothesis that in three-dimensional space, any regular or irregular lattice cannot have a density greater than Δ_3 [35]. In 1998, Thomas Hales managed to prove Kepler's conjecture [36, 37]. The monograph (34) presents data on the densities of various packings up to the dimension of space equal to 1048584. For dimensions $n \leq 48$, a graph of the dependence of the packing density of regular lattices on the dimension of space is constructed. From this graph, two packings of spheres are discovered, one in eight- dimensional space, called the E_8 lattice, and the other in twenty-four dimensions - the Leech lattice Λ_{24}, as well as unexpectedly dense, very symmetrical lattices with many remarkable and mysterious properties. In 2016, the Ukrainian Mathematician Marina Vyazovskaya solved the problem of the densest packing of spheres in such spaces – eight-dimensional [38] and, in collaboration, in 24-dimensional [39]. In order to identify the most probable dimension of the AS from the point of view of the equality essary that these volumes are equal in the densest packing. Therefore, the density of the closest packing should be equal to 0.5. From the data [34] we find a suitable range of packing density values: $\Delta_3 \approx 0.74048$; $\Delta_4 \approx 0.6185$; $\Delta_5 \approx 0.4652$. Extrapolating this dependence to the value $\Delta_n = 0.5$, we find $n \approx 4.7485$. This result means that if the points of Absolute Space were attracted to each other, then the AS would have a dimensionality ≈ 4.75, which is very different from the expected dimensionality of 3.

- The points of the AS repel each other. Due to the substantiality of the points, they will behave in the same way as particles of matter with negative mass, and such particles are not attracted to each other, but, as shown in [40], repel each other. Therefore, they, flying apart in different directions, will leave the AS, and the remaining space will become empty, i.e. will be an empty set $\varnothing$ with dimensionelity –1 [32]. From the calculated values of the packing density of points in multidimensional spaces, up to dimensionality $n \leq 48$ [34], it follows that the packing density of spheres is the smaller, the greater the dimension of the space. For simple cubic lattices, from equalities (3, 4) it follows that the packing density $\Delta\infty$ in the ∞-dimensional AS will be equal to:

$$\Delta_\infty = \lim_{n\to\infty} \frac{V_n}{B_n} = \lim_{n\to\infty} \frac{\pi^{n/2}}{(n/2)!2^n} = 0, \quad (7)$$

so that in a space with infinite dimensionality the packing density will be zero in general.

- The AS points are indifferent to each other. Since such points do not influence each other in any way, they should be packed in the same way as non-substantial points with the formation of an AS of the same dimensionality (6), and the substance of such points can be "standing light" in the form of photonics [17].

Geometric Hypotheses of AS

In non-Euclidean (elliptic and hyperbolic) [41] and Finsler [42] spaces, which the space of the Universe may turn out to be, the above reasoning about packings of points in space is impossible, but this may mean that the Universe, obeying the laws of these spaces, is still immersed in an AS with fractional dimension D_{AS}. The same can be said about spaces with compactified dimensionalities [43]. Fractional dimensionality, it would seem, can be associated with the curvature of space or with

the value of a right angle. But despite the fact that the value of π in these spaces is different, the absolute value of a right angle remains equal to π/2, since a right angle in these spaces is defined as the intersection of the corresponding tangents to the intersecting curves. If we imagine a Euclidean space, which we will conventionally call a meta-Euclidean space, in which the value of a right angle, as an adjacent angle between intersecting lines, with the formation of four equal angles, will differ from π/2, then this makes it possible to estimate the dimension of such a Euclidean space as a fractional one, the value of which depends on the degree of deviation of the value of a right angle in such a space from π/2. If meta-Euclidean spaces exist, then we can expect that there will also be meta-non-Euclidean spaces.

In addition to the assumption of a possible discrepancy between the value of a right angle and π/2 in meta-Euclidean spaces, one can formally assume the existence of spaces in which individual dimensions, both cyclic and non-cyclic, can have a finite length, which would correspond to the fractional dimension of such spaces.

Fractional Topological Dimensionality Hypothesis of AS

In the work a hypothesis is presented of packing the space of the Universe with cubic Planck cells with an edge length equal to the minimum Planck length [44].

$$l_p = 1.61605(10)\cdot 10^{-35} \text{ м}. \quad (8)$$

.

The first variant of the hypothesis suggests that the AP can also be packed with the corresponding Planck cells if the dimensionality of the fourth dimension is fractional and equal to

$$n_4 = D_{AS} - 3 \approx 0.096433 < 1 \quad (9)$$

To find the length x of the fourth edge in such a cell, consider a parallelepiped with sides $l_1=l_2=l_3=l_p=l$ *and* x. The volume of such a parallelepiped will be equal to:

$$V_p = xl^3 = l^{3.096433} = l_p^{3.096433}, \quad (10)$$

from where the length of the fourth edge is equal to

$$x = l^{0.096433} = l_p^{0.096433} = 0.0004415163\,м \quad (11)$$

From equalities (10, 13) it is evident that the length of the fourth edge in a 4-cell is many orders of magnitude greater than the length of edges (8) in three-dimensional cells. As a result, the space is packed with parallelepipeds with three sides *lp* and *x* strongly elongated toward the fourth axis.

In another variant, it is assumed that all packing cells are of the same size, their lengths are equal to *y*, the elementary length in this 4-space, then the volume of the elementary cell in it will be equal to:

$$V_p = y^4 = l_p^{3.096433}, \quad (12)$$

from where, taking into account (8), we obtain:

$$y = \sqrt[4]{l_p^{3.096433}} \approx l_p^{0.774108} \approx 1.1684 \cdot 10^{-27} м \quad (13)$$

Equality (13) indicates that in this variant the AS is four-dimensional, but the dimensionality of each dimension is fractional, less than 1 and equal to ≈0.774108. However, most likely, the third variant is more realistic, when the elementary Planck length is the same in all Euclidean topological spaces, then the volumes of Planck cells in three-dimensional and four-dimensional spaces, respectively, are equal to:

$$V_3 = l^3_p \quad (14)$$

$$V_4 = l^4_p \quad (15)$$

and the quantitative relationship Z of these cells in the structure of space is determined from the proportion:

$$1 - (D_{AS} - 3) \;\text{———}\; D_{AS} - 3$$

$$Z \;\text{———}\; 1 \quad ,$$

$$Z = \frac{4-N}{Д-3} \approx 9.367 \quad (16)$$

Reduced to integers, it follows that for every 75 three-dimensional Planck cells (14) there are 8 four-dimensional Planck cells (15). Since the dimensionality of the AS found above is topological, then to satisfy the condition of the topologicality of the AS it is necessary to take the limit for the lengths

$$V_3 = \lim_{l\to 0} l^3 = 0 = \lim_{l\to 0} l^4 = V_4 \quad (17)$$

Equalities (16, 17) mean that the AS is packed with cells of two types and, although in the limit, these cells have zero dimensionalities, they are nevertheless different in dimension, and the fact that the number of three-dimensional cells in the packing is not a multiple of the number of four-dimensional packings indicates that these cells are not strictly regularly distributed in the AS. Since there are almost 10 times more three-dimensional cells in the packing than four-dimensional ones, the AS will naturally be perceived as three-dimensional.

Dynamic Hypothesis

The antipode of the third variant described above is the "dynamic variant", when periodic oscillations between three-dimensional and four-dimensional spaces occur in Absolute Space, so that every 75 t_p (t_p = 5.39056 · 10−44 s – Planck time) AS is three-dimensional, and the next 8 t_p it is four-dimensional. The dimensionality of such space will also be equal to $D_{AS} \approx$ 3.096433 (6). Such transitions can be associated with the flow of Absolute Time, the course of which is accompanied by the emission of a quantum of action on points of space, possibly equal to Planck's constant *h* = 6,6260755 · 10−34 J·s, forcing them to rebuild from one dimensionality to another. And since this change of dimensionality occurs too often, we, as subjects of the three-dimensional World, do not notice it, especially since in the state of four- dimensionality we simply do not exist.

In turn, subjects and objects of the four-dimensional World do not exist in the state of three-dimensionality either. However, the causal connection and interaction between these Worlds takes place. Since in the four-dimensional World we exist in a "split state", the influence of the processes of this World on our three-dimensional World can be perceived by us as the impact of causeless "otherworldly forces".

On the other hand, it is not at all necessary to correlate with the Planck time, the time of the Universe's stay in spaces of different dimensionalities can be any, even arbitrarily large, as long as the ratio of the times of stay of the AP in the corresponding dimensionality is 75:8. Therefore, if our Universe is currently in three-dimensional space, then this can continue, for billion years, then this cycle will be repeated many times.

Fundamental Differences in Types and Methods of Obtaining Fractals

Let us recall important definitions that allow us to estimate the fractal dimensions of sets [21].

Self-similar sets are sets that can be composed of several of their copies, reduced by the same number N times. A bounded set P is self-similar if it can be represented as a union of pairwise disjoint subsets, each of which is congruent to the set P. Two sets are congruent if one is obtained from the other by parallel compression, expansion, translation, or rotation. For example, a segment, a square, an n- dimensional hypercube with a side *a* are self-similar sets. The measure of such sets is their volume

$$V = a^n \quad (18)$$

and their self-similarity dimensionality is determined from (18):

$$n = dim_s P = \log_a V = \frac{\ln V}{\ln a} \quad (19)$$

Since many discrete sets also turned out to be self-similar, their self-similarity dimensionality can be found using formula (19). In accordance with this, it was proposed [21] to call a fractal such a self-similar set whose dimensionality is fractional. A natural generalization of the self-similarity dimensionality is the Minkowski dimensionality.

The Minkowski Dimension of a set G is Called the Finite Limit

$$dim_M G = \lim_{\delta\to 0} \log_{1/\delta} n_\delta(G) = \lim_{\delta\to 0} \frac{\ln n_\delta(G)}{\ln 1/\delta} = \lim_{\delta\to 0} \frac{\ln n_\delta(G)}{-\ln \delta}, \quad (20)$$

where δ is the diameter of the δ-sphere the union of which completely covers the set G; $n\delta(G)$ is the minimum required number of δ-sphere that could cover G. As a rule, as δ decreases, the number $n\delta(G)$ increases. The idea of the Minkowski dimensionality is to compare the growth rate of $n\delta(G)$ depending on the decrease of δ. Since the Minkowski dimensionality can be calculated not only for self-similar sets, then a fractal should be understood as a set whose Minkowski dimensionality is fractional [21].

The refinement of the concept of dimensionality according to Minkowski led to the definition of the Hausdorff-Besicovitch dimensionality (sometimes simply called the Hausdorff dimensionality) [21, 22, 28]. Consider covering the set of interest with d-dimensional "cubes" with the edge length of the i-th cube ε_i. We define the measure ("volume") $V_d(\varepsilon)$ of this set by the expression

$$V_d(\varepsilon)=\inf\sum_i \varepsilon_i^d, \quad (21)$$

where the lower bound is taken over all possible coverings satisfying the condition $\varepsilon_i \le \varepsilon$, then

$$V_d = \lim_{\varepsilon\to 0} V_d(\varepsilon) \quad (22)$$

The Hausdorff-Besicovitch dimensionality is defined by the critical value $d = d_{krit}$, above which the measure is 0, and below which it is ∞. Methods for practical calculation of d_{krit} are described in [28].

In definition (21, 22), different measuring "cubes" are used. If we consider the "cubes" to be the same, we arrive at the dimension *D*, sometimes called the capacity

$$V_d \approx \sum_i \varepsilon^D = M(\varepsilon)\,\varepsilon^D, \quad (23)$$

where $M(\varepsilon)$ is the number of cubes. Normalizing the measure of the set by 1, we obtain

$$1 \approx M(\varepsilon)\varepsilon^D, \quad (24)$$

from where we find the dimensionality of the set:

$$D = D_e = \lim_{\varepsilon\to 0} \frac{\ln M(\varepsilon)}{\ln(1/\varepsilon)} \approx \frac{\ln M(\varepsilon)}{\ln(1/\varepsilon)} \quad (25)$$

As shown above, the topological dimensionality of all known topological spaces, except for AS, is integer. However, the fractal dimensionalitys of topological spaces also turned out to be integer [21, 22, 28]. For classification purposes, in order to make the concept of a fractal more specific, B.B. Mandelbrot changed the definition of a fractal: “A fractal is a set whose Hausdorff-Besicovitch dimensionality is strictly greater than its topological dimension” [21, 22, 45]. Thus, he defined a fractal as a set for which the inequality holds:

$$D > D_T, \quad (26)$$

where *D* is the Hausdorff-Besicovitch dimension and D_T is the topological dimensionality. However, this definition turned out to be defective, since sets were found in which inequality (26) was not satisfied. In this regard, a new definition was proposed [22]: "A fractal is a set with its OWN FRACTIONAL dimension", which did not cover all fractals, since the OWN dimensionality of some of them is expressed by an integer [21, 22, 28]. On the other hand, Mandelbrot concluded that, in general, D can also take integer values, but always $D < E$, where E is the dimensionality of the embedding of the set in the space with such a minimal dimension in which the given fractal can still be embedded, but is strictly greater than D_T [45]. Thus, a characteristic of the fractality of an object is the presence of its own dimensionality, which is not equal to the dimensionality of the embedding space [46]. The updated definition of fractality of an object is the Spielrain inequality [22, 47]:

$$D \geq D_T \qquad (27)$$

However, fractal sets have been discovered that obey the opposite anti-Spielrein inequality [22]:

$$D \leq D_T \qquad (28)$$

In the work [48] fractals are divided into ideal and non-ideal. Ideal fractals are fractals that retain their fractality, described by certain mathematical dependencies, and system hierarchy with infinite penetration into the structure. Non-ideal fractals are fractals that retain system hierarchy only in a finite range of scales. Of all natural fractals, which represent material structures that exist in reality, only the Universe can be ideal due to its possible infinity. All other natural fractals are obviously non- ideal. In [22], based on the analysis of the dimensions of known fractals, it is concluded that if both equalities (27) and (28) can be true for non-ideal fractals, then only the anti-Spielrain inequality (28) is true for ideal fractals.

Since the fractal dimension can also take on integer values equal to the corresponding topological dimension, it immediately follows that the topological dimension is only a special case of the fractal dimension!

Physical Meaning of Fractional Dimensionality

After it became clear that the topological dimensionality is a special case of the fractal dimensionality, it is natural to conclude that all topological spaces are also fractals! However, for the sake of convenience and decision-making, we will single out the concept of "fractals" as sets with only fractional (fractional-dimensional, fractional-numerical) dimensionality. Sets with integer dimensionality, which are not topological, will be called parafractals. Such are the Peano curve, Hilbert curve, Gosper curve, dragon curve, etc. [22, 28], obeying the Spielrain condition (27). The topological dimensionality of these curves is 1, and the embedding dimensionality and fractal dimension are 2.

Since a line and a square have the same power, equal to the power of the continuum, a one-to-one correspondence is possible between them [49], for example, like this: we divide a square into an uncountable number of lines; we divide a fractal curve into an uncountable number of intervals, each of which contains an uncountable number of points. Then each interval can be assigned a one-to-one correspondence with a line of the square, and each point of the interval can be assigned a one-to-one correspondence with a point of the corresponding line. Thus, the presence of a homeomorphism between a topological set and a fractal with an integer dimensionality allows us to conclude that they are identical. If, however, any differences are found in sets with the same dimensionality, such sets will be isomers.

The fractal dimensionality of a set can obey both the Shpilrain inequality and the opposite anti-Shpilrain inequality. A set can be everywhere non-dense and contain negapoints (holes), to which fractals should be attributed, and, in the limiting case, everywhere dense, which topological spaces are. Obviously, any non-dense set can be obtained from an everywhere dense set by replacing points with negapoints or by simply removing some points from an everywhere dense set (the point removal method). Therefore, topological spaces can serve as an embedding space, i.e. a space with the smallest dimensionality E in which a given fractal can be embedded, but under the condition that the size (radius) of such an embedding space is not less than the size of the embedded space. With this method of obtaining fractals, the fractal dimensionality of objects will be less than the topological one, therefore the anti- Shpilrain inequality (28) is satisfied for them.

But another method of obtaining fractals is also possible – replacing the negatives with points, which corresponds to adding points to the original topological space, which are an everywhere dense D_T-dimensional set, which no longer fit into this topological space (the point addition method). Additional points are forced to be located in a space with a higher dimensionality D, which can be fractional, and the space itself will be the desired fractal. From the above, it is clear that in the set obtained in this way, the Shpilrain inequality (27) will be fulfilled. Let us demonstrate the effect of these methods using the example of the Sierpinski carpet (square) (Figure 1):

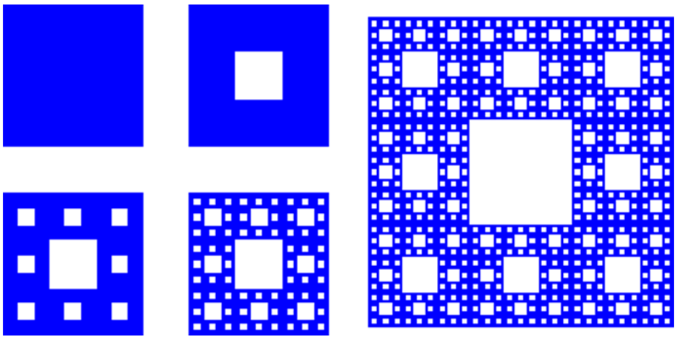

Figure 1: Construction of the Sierpinski Carpet.

To construct the Sierpinski carpet, we divide the square Q_0 by lines parallel to its sides into 9 equal squares, from which the central one is removed. Doing the same with the remaining 8 squares of the first rank, we obtain the set Q_1. Continuing this process ad infinitum, we obtain the sets Q_1, Q_2, Q_3, … . The Sierpinski carpet Q is the intersection of all Q_n. From the construction it is clear that the set Q_n consists of $M = 8n$ square elements (each without the central part) with the edge length 3^{-n}. Substituting these expressions into formula (25), we obtain that the fractal dimensionality of the Sierpinski carpet is equal to [45, 46, 49]:

$$D = \lim_{n\to\infty} \frac{\ln 8^n}{\ln 3^n} = \frac{\ln 8}{\ln 3} \approx 1.8928 \qquad (29)$$

The Sierpinski carpet is a set of isolated points arranged in a certain order on a limited section of the plane. To fix the position of an arbitrary point of this set in space, two coordinates are needed, so the topological dimensionality of the Sierpinski carpet is 2, which ensures the validity of the anti-Shpilrain inequality (28).

To construct a square Sierpinski carpet by the point-removal method, we use a black square, which is a square densely filled with an uncountable number of points everywhere (Figure 2), or a negasquare, which is densely filled with an uncountable number of nega-dots everywhere (Figure 3).

Figure 2: Black Square.

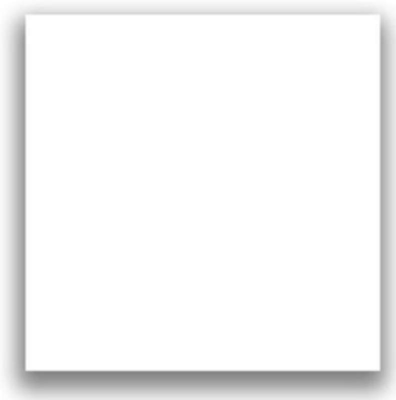

Figure 3: Negative Square.

From the construction of the Sierpinski carpet we already know the locations of the dots and nega-dots on it in Fig. 1. Therefore, using the appropriate calculation program, we find the location of the nega-dots (white squares) in Fig. 1 and remove them from the black square in Fig. 2 (or, what is the same, we replace these points with nega-points). After removing the extra points in Fig. 2, only those points remain that are part of the Sierpinski carpet and the nega-points that were formed after removing the corresponding points. The Sierpinski carpet is constructed.

To construct the Sierpinski carpet by adding points, we use a nega-square consisting of nega-dots. Using the appropriate calculation program, we find the location of the points related to the Sierpinski carpet in Fig. 1 and insert such points into the corresponding place of the nega-square. After all the points of the carpet are inserted into the nega-square, the Sierpinski carpet will be constructed.

In passing, we can estimate the dimensionality of the Sierpinski "nega-carpet", which is a set of nega-dots on the Sierpinski carpet (Figure 1). Considering that the length of the carpet side is 3, we find the area *S* of the Sierpinski carpet (which plays the role of volume):

$$S = 3^{1,8928} = 8,0000. \quad (30)$$

The Area of the Black Square, based on the Procedure for Constructing the Carpet Described Above, is Equal to

$$S_{\blacksquare} = 3^2 = 9. \quad (31)$$

The area of the negative carpet will be equal to

$$S_{\square} = S_{\blacksquare} - S = 1, \quad (32)$$

and from (19, 25) it follows

$$3^x = 1, \quad (33)$$

from which we obtain that the fractal dimensionality of the Sierpinski nega-carpet, which is the complementary set to the Sierpinski carpet to the topological space of the black square ($D_T = 2$), which is the embedding space for the Sierpinski nega- carpet

$$x = 0. \quad (34)$$

It follows that the Sierpinski nega-carpet also obeys the anti-Spielstein inequality. From the given examples of constructing fractals, the physical meaning of the fractional dimensionality of space (set, subset) and a separate fractional dimension of space becomes clear, namely: the fractional dimensionality of a set shows what part of the points of the embedding space remains after the points that are redundant for the desired fractal have been removed.

The embedding space of the AS can obviously be a 4-dimensional Euclidean space, and since $D_{AS} < 4$, the anti-Shpilrain inequality is satisfied for the AS. On the other hand, the fractional dimensionality of the Absolute Space has a completely different nature than the dimensionality of the known fractal sets. The dimensionality of the AS was determined as optimal from among the possible topological dimensionalities of spaces based on the equality of the volumes of points and negatives in these spaces. That is why the obtained value of the AS dimensionality, equal to ≈ 3.096433, is topological.
On the other hand, since D_{AS} is a fractional value, then, by definition, the dimensionality of the AS is, at the same time, also fractal. But then the fractal dimension of the AS turns out to be equal to the topological one:

$$D = D_T = D_{AS}, \quad (35)$$

thus, for the AS both conditions (27) of Spielrain and (28) of anti-Spielrain turn out to be true.

The Dimension of the Space of the Metagalaxy D_{FM}

The Carpenter-de Vaucouleurs law, obtained empirically by determining the number and mass of the average number of galaxies inside a sphere of radius *R* centered in one of the galaxies, depends on *R* according to a power law [22]:

$$M(R) = BR^D, \quad (36)$$

where *M(R)* is the mass of all galaxies included in the cluster; *B* is the proportionality coefficient; $D = 1 \div 1{,}5$ is the fractal dimensionality of the cluster in the studied range of distances R. Dividing equality (36) by the volume of the cluster V_T in the topological space

$$V_T \sim R^{D_T}, \quad (37)$$

where $D_T = 3$ is the topological dimensionality of the cluster, we obtain a formula for the density ρ of the cluster

$$\frac{M(R)}{V_T} = \rho = \frac{BR^D}{R^{D_T}} = BR^{D-D_T} = BR^{D-3}. \quad (38)$$

Equalities (35, 37) with $D < 3$, assuming their validity at any scale of consideration, served as the basis for the hypothesis of the fractal structure of the Universe [46, 49]. It is easy to see that under such an assumption the density of matter of an infinitely sized Universe tends to zero.

$$\rho = \lim_{R\to\infty} BR^{D-3} = 0. \quad (39)$$

Based on the fact that the volume of our Metagalaxy V_M, obtained using the fractal dimensionality of the object will be equal to

$$V_M = \frac{4}{3}\pi R_M^3 \sim R_M^{D_{FM}}, \quad (40)$$

where R_M is the radius of the Metagalaxy, we find the fractal dimensionality of the Metagalaxy

$$D_{FM} \sim \frac{\ln V_M}{\ln R_M} \quad (41)$$

Substituting into (41) the values of the radius of the Metagalaxy

$$R_M \approx 1.3 \cdot 10^{26} M, \quad (42)$$

and the volume of the Metagalaxy $VM \approx 9.2 \cdot 10^{78}$ m_3 [17], we find from (41) the dimensionality of the space of the Metagalaxy equal to $D_{FM} \approx 3.0238$. The obtained result allows us to specify equalities (36, 38) for our Metagalaxy

$$M(R) = BR^{3.0238} \quad (43)$$

$$\rho = \frac{M(R)}{V_T} = BR^{3.0238-3} = BR^{0.0238}, \quad (44)$$

the density of the Metagalaxy becomes equal to ∞ when $R \to \infty$, which contradicts the hypothesis of a fractal Universe stated in [22], which was based on estimates of the dimensionality of known volumetric fractal clusters, the fractal dimensionality was, as a rule, less than 3 [22, 50], in particular, in the case of porous materials, $D = 2.56 \pm 0.03$ and $D = 2.57 - 2.87$ the exact dimensionality of the Universe was considered unknown, but was assumed to be equal to $D \approx 1.23$ [22, 49]. Only in one case was a value greater than three obtained, $D = 3.04 \pm 0.05$,but this result, according to [22], was ignored due to insufficient measurement accuracy. In the present version of the theory of fractality of the Universe, the values of the dimensionalities of the Metagalaxy, galaxies, star clusters and Absolute Space, the dimensionalities of which is greater than 3, are used. Therefore, from equalities (36 – 39) equalities of the type (44) will follow, from which it follows that the density of an object, in particular, the Metagalaxy, becomes equal to ∞ when $R\to \infty$. For this, it is sufficient to write in explicit form in equalities (38, 44) the empirical coefficients

$$B = R^{D_{AS}-D_T} = R^{D_{AS}-3} \quad (45)$$

$$\rho = BR^{D-D_T} = BR^{D-3} = R^{D_{AS}-3}R^{D-3} = R^{D-D_{AS}} = R^{D-3.096433} = \frac{M(R)}{V_{AS}} \quad (46)$$

Formula (46) shows that the volume of an object must be measured not in the space of the Metagalaxy, because such a volume will not be true, but will depend on the characteristics of this particular Metagalaxy, and it must be measured in Absolute Space.

The inaccuracy of formula (41) has the disadvantage that the sought fractal dimensionality of the Metagalaxy turns out to depend not only on the size of the object under study, but also on the units of measurement of its radius. Indeed, if the radius of the Metagalaxy is measured not in meters, but, for example, in kilometers, then its fractal dimensionality will be equal to ≈3.2865. Consequently, the value of D_{FM} determined by formula (41) turns out to be tied to the unit of measurement of the radius of the Metagalaxy and is therefore conditional. Here it is necessary to distinguish between the concepts of mathematical dimensionality and physical dimensionality. Physical dimensionality is defined in units of measurement of the characteristics of the object (distance, time, speed, acceleration, mass, etc.) The mathematical dimensionality of the object include topological and fractal dimensions of sets (spaces). Mathematical dimensionalitys must be physically dimensionless and not depend on the units of measurement of the characteristics of the object. In order for equalities (36 – 44) to satisfy this requirement, it is necessary and sufficient to make an objective normalization of the dimensions (radius) of the object.

According to [22], the density of the Metagalaxy is so small that it can be considered practically empty, since the distances between stars and galaxies are many orders of magnitude greater than the sizes of these objects. Therefore, it can be considered that the density of the Metagalaxy ρM [51] is approximately equal to the density of Absolute Space ρ_{AS}:

$$\rho_M = 9{,}31 \cdot 10^{-27}\, kg/m^3 \approx 0 = \rho_{AS}, \quad (47)$$

although, in fact, ρ_M is, of course, slightly greater than 0. From this we can conclude that the presence of an insignificant amount of matter in the space of the Metagalaxy, which is immersed in the AS, does not have a significant effect on the dimensionality of the embedding space, therefore the dimensionality of the space of the Metagalaxy embedded in the AS should be approximately equal to the dimensionality of the AS:

$$D_{FM} \approx D_{AS} = 3.096433 \quad (48)$$

Due to the fact that the dimensionality of the AS does not depend on its size, the dimensionality of the space of the Metagalaxy will also not depend on the radius of the Metagalaxy, nor on the physical units of measurement in which this radius is measured.

Despite the fact that the AS is infinite and indivisible, we can assume that the space of the Metagalaxy occupies only a part of the AS and in this sense the volume of the AS involved in the insertion of the Metagalaxy is equal to V_M, so that

$$R_M = R_{AS} \quad (49)$$

From equalities (37, 40, 48, 49) and the isotropy of the space of the Metagalaxy and AS we have:

$$V_M = \frac{4}{3}\pi R_M^3 \sim \frac{4}{3}\pi R_{AS}^3 \sim R_{AS}^{D_{AS}} \sim R_{AS}^{3,096433} \quad (50)$$

$$\log\frac{4}{3}\pi + 3\log R_{AS} = 3{,}096433 \log R_{AS}, \quad (51)$$

from which we obtain the radii of the part of the AS involved in the Universe in dimensionless physical units of length L:

$$R_{AS} \sim 2825600L \sim R_M \sim 1{,}3 \cdot 10^{26} m\ , \quad (52)$$

From (50) we find the relationship between L and ordinary measures of length:

$$1\ \text{метр} \sim \frac{2825600}{1{,}3\cdot 10^{26}} \sim 2{,}17 \cdot 10^{-20} L \quad (53)$$

$$L \sim 4{,}6 \cdot 10^{19}\ m \sim 5000\ \text{световых лет} \quad (54)$$

The Dimension of the Space of the Universe is $D_U = 3$

Let us write equality (41) taking into account (40) for the fractal dimensionality D_{FM} of an object of radius R:

$$D_{FM} = \frac{\log\frac{4}{3}\pi R^3}{\log R} \approx \frac{0{,}6219}{\log R} + 3, \quad (55)$$

from which it follows that the dimensionality of the space of the Universe D_U, which has infinite dimensions in all directions, is equal to:

$$D_U = D_{FM} = \lim_{R\to\infty}\left(\frac{0{,}6219}{\log R} + 3\right) = 3 \quad (56)$$

A New Version of the Hypothesis About the Fractality of the Universe

In the monograph by S.D. Khaitun [22] a hypothesis about a fractal Universe is presented, based mainly on the assumption of zero global density of the Universe. It was suggested by considerations related to the hierarchical structure of the observable part of the Universe. The Earth is part of the Solar System, the Sun and other stars form galaxies, galaxies are structured into clusters of galaxies, clusters of galaxies – into superclusters of galaxies, etc. The distance between stars is much greater than the stars and their planetary systems, the distance between clusters of stars is much greater than the sizes of these clusters, the distances between galaxies are much greater than galaxies, the distances between clusters of galaxies are much greater than these clusters, etc., so that with the increase in the size of the cosmic system the density of its mass rapidly decreases.

The density of the Sun is 1416 $\frac{g}{cm^3}$, of galaxies – 10^{-24} $\frac{g}{cm^3}$ [52] of our metagalaxy – $9{,}31\cdot10^{-27}$ $\frac{kg}{m^3}$ [51]. Empirically, this dependence is described by the Carpenter – de Vaucouleurs law (36, 38), the extrapolation of which to infinite values of R allows us to draw the main conclusions from the hypothesis of S.D. Khaitun:

1. The global mass of the Universe is infinite;
2. The global density of the Universe is zero. Equality (36) can also be written as:

$$M \propto R^D, \quad (57)$$

where $\propto$ is the symbatic sign, indicating that for $D > 0$ the mass of an object increases with increasing distance to it (or the size of the object); equality (38) breaks down into the expressions:

$$\rho \propto R^{D-3}, \quad (58)$$

$D > 3$ and

$$\rho \beth R^{D-3}, \quad (59)$$

where $\beth$ is the antisymbatic sign, indicating that for $D < 3$ the density of the object decreases if R increases. For $D = 3$, which corresponds to the dimensionality of the space of the Universe D_U, the density of the object does not depend on the radius of the object:

$$\rho = \rho_U = const, \quad (60)$$

But

$$\rho_U \neq 0, \quad (61)$$

since it is known from experience that matter in the state of matter in the Universe exists. Since the dimensions of the Metagalaxy are quite large, its properties should largely coincide with the properties of the entire Universe, in particular, we assume that the density of the Metagalaxy is approximately equal to the density of the Universe:

$$\rho_U \cong \rho_M = 9{,}31 \cdot 10^{-27} \frac{kg}{m^3} \quad (62)$$

Equality (62) radically changes the conclusion of the theory about the equality of the global density of the Universe to zero, to a new one, which consists in the fact that the global density of the Universe is either equal to the density of the Metagalaxy, although it differs from it, but insignificantly. This makes it possible to identify the dependence of the dimensionality of an object on its density. It is essential that a change in the global density of space can occur not only by adding or extracting matter from space, but also by compressing or expanding an object. Therefore, the resulting dependence should characterize both objects distant from us and compressing or expanding objects. The simplest approximation to the true curve of the dependence of the dimensionality of an object on its density is a straight line constructed from two points (lines 2 and 3 of Table 1):

$$D = 3{,}096433 - 1{,}036 \cdot 10^{25}\rho, \quad (63)$$

from which it follows that the "point density", for which, by definition, $D = 0$, is equal to $\rho_0 = 2{,}99 \cdot 10^{-25}\,\frac{kg}{m^3}$. And if we load the AS with matter, then with an increase in its density from 0 to ρ_U the dimensionality of space first decreases from 3.096433 to 3, and then with a decrease in dimensionality to zero, the density increases to the point density ρ_0. This point is the singularity. However, its density ρ_0 turned out to be very small, although it was assumed that it should be infinitely large in accordance with the Big Bang theory. In accordance with the assumption that the density at the singular point should be equal to ∞, the relevant curve was constructed using three points (Table 1).

Table 1: Dependence of the Object's Dimensionality on Its Density at Base Points

D	ρ
3,096433	0
3	$9{,}31 \cdot 10^{-27}$ *kg/m*^{3}
0	∞

It follows from this dependence that with an increase in the density of an object with the matter in it, the dimensionality of the object decreases. On the other hand, at the limit point of infinite density, the dimensionality of the object becomes equal to zero. This indicates that the true curve of the desired dependence is a hyperbola:

$$D = \frac{a}{\rho + b}, \quad (64)$$

$$a = \frac{3\rho_M D_{AS}}{D_{AS} - D_U} = bD_{AS} = 8{,}9682 \cdot 10^{-25} \quad (65)$$

$$b = \frac{3\rho_M}{D_{AS} - D_U} = 2{,}8963 \cdot 10^{-25} \quad (66)$$

From (64 – 66) we find

$$D = \frac{3\rho_M D_{AS}}{3\rho_M + \rho(D_{AS} - D_U)} = \frac{1}{0{,}322 + 1{,}115 \cdot 10^{30}\rho} \quad (67)$$

$$\rho = \frac{3\rho_M (D_{AS}) - D}{(D_{AS} - D_U)D} = \frac{(8{,}9682 - 28963D) \cdot 10^{-25}}{D} \quad (68)$$

Table 2: Dependence of the object's dimension D on its density $\rho\frac{kg}{m^D}$.

D	$\rho\frac{kg}{m^D}$	D	$\rho\frac{kg}{m^D}$	D	$\rho\frac{kg}{m^D}$
0	∞	3,096433	0	-0	$-\infty$
10^{-100}	10^{70}	3,11	$-1{,}3\cdot10^{-27}$	$-0{,}5$	$-2{,}1\cdot10^{-24}$
10^{-27}	$a = 896{,}8$	4	$-6{,}5\cdot10^{-26}$	-1	$-1{,}2\cdot10^{-24}$
10^{-20}	$897\cdot10^{-7}$	5	$-1{,}1\cdot10^{-25}$	-2	$-7{,}4\cdot10^{-25}$
10^{-10}	$897\cdot10^{-17}$	6	$-1{,}4\cdot10^{-25}$	-3	$-5{,}9\cdot10^{-25}$
0,1	$607\cdot10^{-26}$	10	$-2{,}0\cdot10^{-25}$	-10	$-3{,}8\cdot10^{-25}$
1	$607\cdot10^{-27}$	1000	$-2{,}9\cdot10^{-25}$	-10^{10}	$-2{,}9\cdot10^{-25}$
2	$159\cdot10^{-27}$	10^{10}	$-2{,}9\cdot10^{-25}$	-10^{100}	$-2{,}9\cdot10^{-25}$
3	$9{,}31\cdot10^{-27}$	10^{100}	$-2{,}9\cdot10^{-25}$	-10^{1000}	$-2{,}9\cdot10^{-25}$
3,09	$6{,}03\cdot10^{-28}$	∞	$-2{,}9\cdot10^{-25}$	$-\infty$	$-b$

.

An object is understood primarily as space, a set or any material body, a star cluster, a Metagalaxy or even the Universe, placed in the embedding space. If the space is filled with any substance, then such space can be characterized by density, dimensionality and dimensions.

The main antisymbat branch of the hyperbola (the first two columns of Table 2) characterizes the following spaces with positive density:

- Absolute Space: $D_{AS} = 3{,}096433$; $\rho_{AS} = 0$. $R_{AS} = \infty$.
- Space of the Metagalaxy: $D_M = 3{,}0238$; $\rho_M \approx 9{,}31\cdot10^{-27}\ \frac{kg}{m^3}$; $R_M \approx 1{,}3\cdot 10^{26} m$.
- Space of the Universe: $D_U = 3$; $\rho_M \sim 9{,}31\cdot10^{-27}\frac{kg}{m^3}$; $R_U = \infty$.

Singular space (space at the singularity point): $D_S = 0$; $P_S \leq \infty$; $\delta \geq R_S \geq 0$, where δ is a very small value that determines the maximum radius of the singular core. With an increase in the dimensionality of space from 0 to the dimensionality of AS, the density of space decreases from ∞ to 0. This dependence continues smoothly into the region of negative density values (two middle columns of Table 2). This means that the mass of an object with a dimensionality greater than D_{AS} (i.e. in multidimensional spaces) becomes negative. The possibility of the existence of a substance with a negative mass is discussed in the review [53], and in the works [40, 44, 54, 55] it is shown that the mass of any substance becomes negative if its temperature becomes higher than the critical one, individual for each substance [54], or if the speed of the body becomes higher than ω≈ 235696.8871 km/s [40, 44]. When the temperature or speed of the body decreases, the mass of the body again becomes positive.

An essential feature of multidimensional spaces ($D \geq D_{AS}$, column 3) is that their density is, on the one hand, negative, and on the other hand, very small in absolute value (column 4). This can be explained by the fact that particles with negative mass, due to Einstein's principle of equivalence of inertial and gravitational masses, repel each other [56]. Indeed, let us consider two bodies with negative mass. Due to Newton's law of universal gravitation, they should be attracted to each other. But in accordance with Newton's second law, the force arising between them due to the negative mass of the body will be negative and directed in the opposite direction. And since this force is negative, the acceleration will also be negative, so the bodies will repel each other. Due to the scattering of particles with negative mass (negatons) in different directions, the particles move away from each other indefinitely, but the maximum density of space filled with negatons does not become zero, but becomes equal to $-2,8963 \cdot 10^{-25}$ kg/m^D, which has no explanation yet.

V. I. Kostitsyn in his monograph "Theory of Multidimensional Spaces" [57] came to the conclusion that the maximum speed of processes in two adjacent multidimensional spaces, in which the difference in the dimensionalities of the spaces is equal to 1, differs by a factor of *c,* where $c = 299792458$ $m/s \approx 3 \cdot 10^8$ m/s is the speed of light. For example, the speeds of light in 4-dimensional and 6-dimensional Euclidean spaces will be, respectively, $c_4 \approx 9 \cdot 10^{16}$ m/s and $c_6 \approx 81 \cdot 10^{32}$ m/s. If this is really so, then the possibility of moving at a speed greater than the usual speed of light is revealed. To do this, it is only necessary to accelerate the spacecraft to a speed greater than *w,* then, locally, at the location of the spacecraft, a multidimensional space will be formed, and the speed of the spacecraft can be increased almost to infinity, and it will even be possible to fly beyond the Metagalaxy. But here one problem arises: since particles of negative mass repel each other and fly apart in different directions, the spacecraft can fall apart into elementary particles. There is hope that the spacecraft will not fall apart immediately: in multidimensional spaces of not very large dimensionality, the force of negative gravity (repulsion force) may not be large compared to the strength of the spacecraft. Then it will be possible to increase the speed of the spacecraft, and along with it the multidimensionality of the local space to very large values. This process, of course, is not unlimited: at some very large speed *w* and space dimensionality D_w, the spacecraft will fall apart into elementary and subelementary particles.

But another interpretation of the obtained results is also possible. As follows from the works [40, 44,54,55], negamatter can form in our Metagalaxy at high speeds and high temperatures of the body, the space of which is three-dimensional. But based on the data of Table 3, negamatter can form in two other fundamentally different cases:

- In multidimensional spaces, with the conditions that $\infty \leq D > 3,096433$, and $-2,8963 \cdot 10^{-25} \leq \rho < 0$ (columns 3 and 4);
- In spaces with negative dimension, with the conditions: : $0 > D \geq -\infty; -\infty \leq \rho \leq -2,8963 \cdot 10^{-25}$ (columns 5 and 6).

Although the conditions for the formation of non-matter in these types of spaces are unknown to us, it may well turn out that it is precisely in multidimensional spaces or in spaces with negative dimensionality that non-matter will be the main type of matter and its existence will not require high speeds and temperatures.

In the hierarchy of space dimensionalities, negative dimensionalities come after the zero dimensionality, and the zero dimensionality characterizes the spatial point at which the singularity is realized. Therefore, a space of zero dimensionality can be called singular. The density ρ_S of such singular spaces has a positive sign and is assumed to be equal to the nuclear saturation density, which minimizes the energy density of infinite nuclear matter $\rho_\infty \approx 2,5 \cdot 10^{17}$ kg/m^3 [58, 59]. The radius R_S of singular spaces also has a positive sign and is equal to 0 in the limit. Extrapolating this hierarchy towards negative dimensionalitis $D_{SS,}$ in accordance with Table 3, we conclude that such supersingular spaces will have a negative density ρ_{SS} and a negative radius R_{SS} (columns 5 and 6). It follows that the mass of particles filling supersingular spaces will also be negative. S.N. Golubev managed to prove that the cores of elementary particles are nega-particles [60]. As follows from Table 3, the density of supersingular and multidimensional spaces is negative and very small in absolute value. This is due to the fact that nega-particles repel each other and fly apart in different directions.

The restraining factor that does not allow one to leave the core completely is, possibly, the nuclear and gravitational forces of the environment with a positive density.

Universe Without Absolute Space

The fractal Universe described in the monograph by S.D. Khaitun [22] does not take into account the possibility of the existence of AS and matter with negative mass (negamatter). In this section, we consider a model of the Universe that ignores the existence of AS, but allows for the existence of negamatter.

To construct the relevant curves that model the dependence of the dimensionality of space on its density, there are only two points: dimensionalities 0 and 3 correspond to global densities ∞ and 0. The relevant line will be a line parallel to the density axis

$$D=3, \qquad (64)$$

from which it follows that for any values of density the dimensionality of the space of the Universe will be equal to 3. The relevant curve constructed from the same two points will be a hyperbola

$$D = \frac{3}{3\rho+1} \qquad (65)$$

$$\rho = \frac{3-D}{3D} \qquad (66)$$

The results of calculating D and ρ using formulas (65, 66) are presented in Table 3.

Table 3: Dependence of the Dimensionality D of an Object on its Density $\rho\ \frac{kg}{m^D}$ in a model Ignoring the Existence of AS

D	$\rho\frac{kg}{m^D}$	D	$\rho\frac{kg}{m^D}$	D	$\rho\frac{kg}{m^D}$
0	∞	3	0	-1	$-1{,}3333$
10^{-100}	10^{100}	4	$-0{,}0833$	-2	$-0{,}8333$
0,75	1	6	$-0{,}1667$	-10	$-0{,}4333$
1	0,6667	1000	$-0{,}3333$	-1000	$-0{,}3333$
2	0,1667	∞	$-0{,}3333$	$-\infty$	$-0{,}3333$

Comparing tables 2 and 3, we see that the nature of the dependencies in table 3 is the same as in table 2, they are symbatical, but differ in that the global densities of spaces in table 3 are many orders of magnitude greater. In particular, at the points of negative singularities, the density in absolute value is very much equal to $-0{,}3333\frac{kg}{m^D}$, and according to table 2, only $-2{,}9\cdot 10^{-25}\frac{kg}{m^D}$.

In this variant, in multidimensional spaces with a dimensionality greater than 3, there is a substance with negative mass (columns 3, 4). In addition, negamatter, formally, can be formed in spaces with negative dimension (columns 5, 6). Spaces with negative dimensionality, if such can really exist, can be interpreted as spaces in "White Holes", which arise by squeezing and penetrating matter into the forming "White Hole" from the "Black Holes" of the Metagalaxy.

Conclusion

As is known, there may be up to two trillion galaxies in our Metagalaxy; there are about 200 billion stars in the galaxy, most of them similar to the Sun. There are approximately a septillion stars in the observable Universe 1027. In addition to galaxies, there are also star clusters - a visually related group of stars that have a common origin and move in the gravitational field of the galaxy as a single whole. Some star clusters also contain, in addition to stars, clouds of gas and/or dust. There are two main types of star clusters: globular and open; in June 2011, it became known about the discovery of a new class of clusters that combines the features of both globular and open clusters [61]. Globular clusters are groups of stars concentrated in a spherical or nearly spherical region with a diameter of 10 to 30 light years. They can contain from 10 thousand to severl million stars. The unit of dimensionless length L (54) probably corresponds to the size of a star cluster, which is a relatively minimal star cluster in size. The volume of such a globular cluster is ~5 · $10^{59} m^3$. Assuming the cluster density equal to the density of the Metagalaxy, we obtain the cluster mass of ~5 · $10^{33} kg$, and considering the mass of a star in a cluster equal to the mass of the Sun ~2 · $10^{30} kg$, then the number of stars in a cluster is ~2500. It has been proven that the dimensionality of the infinite-sized space of the Universe is three, which is confirmed in practice. The Universe is in the Absolute Space, the dimensionality of which is fractional and, significantly, this dimensionality is greater than the dimensionality of the space of the Universe D_{AS}~3,096433 > 3. Since ρAS is less than the density of the Metagalaxy and the Universe, the presence of matter in the Universe reduces the dimension of its space from ~3,096433 to 3. Therefore, the dimensionalities of the Metagalaxy, galaxy and star clusters will be in this range of values. An increase in density from 0 to ∞ is accompanied by a decrease in the dimensionality of space to 0. From the above and the fact that $D_{FM} < D_{AS}$ we are once again convinced that filling the Absolute Space with matter leads to a decrease in the dimensionality of space, this corresponds to the compression of the AS, and, along with it, the Metagalaxy. The density of the Metagalaxy increases with time. The reason for the expansion of the Universe is the "Big Bang" of a singular object, since the speed of the expansion of particles still overcomes the force of compression of space.

The fact that the radius of the supersingular space is negative may indicate that an object can overcome the throat between our Metagalaxy and the parallel Metagalaxy from a "White Hole" with a negative radius relative to our Metagalaxy

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