# SOLUTION TO EINSTEIN'S VACUUM EQUATION WITH A LARGE NUMBER OF LAMBDA TERMS

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2026.04.08

**ABSTRACT**

It is proposed to increase the number of positive and negative $\Lambda_j$-terms in Einstein's vacuum equation to infinity. The solution to this equation leads to a closed Universe filled with a virtually infinite number of "corpuscles" (i.e., stable convex spherical vacuum formations) and "anticorpuscles" (i.e., stable concave spherical vacuum formations) with a hierarchical discrete set of radii. These "corpuscles" and "anticorpuscles" of different scales are nested within one another like Russian dolls. Thus, they form a multitude of hierarchical chains, all beginning with the core of a single largest "corpuscle" (i.e., the mega-Universe) and culminating in a single core of the smallest "corpuscle" (i.e., the instanton). As a result, a closed Hierarchical Cosmological Model was obtained, which allows us to outline the ways of solving many problems of modern physics, such as: baryon asymmetry of the Universe, confinement of quarks, geometrization of electric charge, gravity, dark matter and energy, etc. This article is a development and refinement of the Geometrized Vacuum Physics Based on the Algebra of Signature (GVPh&AS), presented in the articles [3,4,5,6,7,8,9, 10,11,12,13,14,15,16].

**Keywords:** modifications of the general theory of relativity, cosmological model, vacuum physics, stable vacuum formations, signature algebra, geometrized physics

## INTRODUCTION

### *1 Brief Historical Background*

Many cosmological models are based on the equation of general relativity:

$$R_{ik} - \frac{1}{2} R g_{ik} = \varkappa T_{ik}, \tag{1}$$

where $g_{ik}$ are the components of the metric tensor of curved 4-dimensional space with the metric $ds^2 = g_{ik}\, dx^i dx^k$; $\varkappa$ is the proportionality coefficient;

$$R_{ik} = \frac{\partial \Gamma^l_{ik}}{\partial x^l} - \frac{\partial \Gamma^l_{il}}{\partial x^k} + \Gamma^l_{ik}\Gamma^m_{lm} - \Gamma^m_{il}\Gamma^l_{mk} \text{ is the Ricci tensor;} \tag{2}$$

$$\Gamma^\lambda_{ik} = \frac{1}{2} g^{\lambda\mu}\left(\frac{\partial g_{\mu k}}{\partial x^i} + \frac{\partial g_{i\mu}}{\partial x^k} - \frac{\partial g_{ik}}{\partial x^\mu}\right) \text{ is Christoffel symbols;} \tag{3}$$

$$T_{ik} = (p + \rho c^2) u_i u_k - p g_{ik} + \frac{1}{4\pi}\left(-F_{il}F^l_k + \frac{1}{4} g_{ik} F_{lm} F^{lm}\right) \tag{4}$$

is the energy-momentum density tensor, reflecting the inertial and dynamic properties of matter; where $\rho$ is the mass density; $u_i$ is the velocity of matter; $c = \sqrt{u_0 u_0}$ is the speed of light; $p$ is the pressure; $F_{il}$ is the electromagnetic field tensor.

Within Einstein's general theory of relativity (GR), the right-hand side of Eq. (1) is considered the source of the curvature of the space-time continuum, which is determined by the left-hand side of this equation.

Eq. (1) was derived as a result of the joint work of A. Einstein and D. Hilbert in 1915. At that time, scientific circles were confident that the Universe was stationary (i.e., did not change over time, since distant but observable stars remained practically in the same place). However, Eq. (1) allowed for the possibility of the Universe expanding or contracting depending on the magnitude of its critical mass density.

To prevent changes in the size of the Universe within GR, Einstein used the fact that the covariant derivative of the components of the metric tensor is equal to zero

$$\Lambda \nabla_j g_{ik} = \nabla_j \Lambda g_{ik} = 0, \tag{5}$$

just as the covariant derivatives of the tensors on the right and left sides of Eq. (1) are equal to zero

$$\nabla_j \left(R_{ik} - \frac{1}{2} R g_{ik}\right) = 0 \quad \text{and} \quad \varkappa \nabla_j T_{ik} = 0. \tag{6}$$

This allowed Einstein to add the Λ-term to Eq. (1) in 1917

$$R_{ik} - \frac{1}{2} g_{ik} R + g_{ik} \Lambda = \varkappa T_{ik}. \tag{7}$$

In this case, the Λ-term balanced gravity and stabilized the Universe.

In 1924, Alexander Friedmann demonstrated the transformation of the Einstein-Hilbert equation (1) if the spatial metric changes with time, and in 1929, Edwin Hubble discovered a tendency for the Doppler shift of the emission spectrum of galaxies to increase with their distance from the observation point, which is commonly interpreted as the Doppler effect due to the expansion of the Universe. After these events, the need for the Λ-term disappeared. Therefore, according to contemporaries, Einstein called the introduction of the cosmological constant Λ into Eq. (7) his "biggest blunder."

However, in the late 1990s, astronomers discovered that the expansion of the Universe is accelerating rather than decelerating (as expected). The problem is that the accelerated recession of galaxies requires a colossal energy source. To account for this phenomenon, the *Λ*-term was again required, which in this case determines the repulsive properties of "dark energy," i.e., the negative vacuum pressure.

Currently, the Lambda-Cold Dark Matter (ΛCDM) standard cosmological model dominates science. In this model, a spatially flat universe is filled, in addition to ordinary baryonic matter (~4%), with dark energy (~70%) (described by the cosmological constant *Λ* in Einstein's equation (7)) and cold dark matter (~25%), which determines the rotation speed of stars in galactic disks.

*2 Geometric meaning of the constant Λ*

In [1], Willem de Sitter showed that a 4-dimensional space can be defined as a conic section of a 5-dimensional single-strip hyperboloid, defined in 5-dimensional space by the equation

$$x_0^2 - x_1^2 - x_2^2 - x_3^2 - x_4^2 = \pm r_k^2. \tag{8}$$

Such a 4-dimensional space has a curvature tensor [1,2]

$$R^i_{mab} = \pm \frac{1}{r_k^2} \left(\delta^i_a g_{mb} - \delta^i_b g_{ma}\right). \tag{9}$$

In this case, the Ricci tensor has the form [1]

$$R_{im} = R^a_{iam} = \pm \frac{3}{r_k^2} g_{im} \quad \text{or} \quad R_{im} \mp \frac{3}{r_k^2} g_{im} = 0. \tag{10}$$

We multiply both sides of the Eq. (10) by the contravariant components of the metric tensor $g^{im}$

$$g^{im} R_{im} = \pm \frac{3}{r_k^2} g^{im} g_{im}.$$

As a result, we obtain the scalar curvature

$$R = \pm \frac{3}{r_k^2} n. \tag{11}$$

where n is the dimension of space; in the case of 4 dimensions, $n = 4$.

We use the notation

$$\Lambda_k = \pm \frac{3}{r_k^2}. \tag{12}$$

Substituting notation (12) into Ex. (11), we obtain

$$R = \pm 4 \Lambda_k = \pm \frac{12}{r_k^2}, \tag{13}$$

Eq. (10) then takes the form of Einstein's second vacuum equation with the $\Lambda_k$-term

$$R_{im} \pm g_{im}\Lambda_k = 0. \tag{14}$$

Thus, the $\Lambda_k$-term is 1/4 of the scalar curvature $R$ of a spherical 4-dimensional space.

$$\Lambda_k = \mp\frac{1}{4}R = \pm\frac{3}{r_k^2}, \tag{15}$$

For such a sphere in 4-dimensional space, the radii along the three spatial axes *XYZ* are $x_k = y_k = z_k = r_k$, and along the fourth time axis $T$, the radius is $ct_k = r_k$. That is, a time interval is associated with such a spherical space.

$$t_k = \frac{r_k}{c} = \pm\sqrt{\frac{\Lambda_k}{3c^2}}. \tag{16}$$

*3 Statement of the problem*

In this article, we ask the question: "Why should we limit ourselves to just one Λ-term?" The point is that mathematics imposes no limit on their number. Indeed, the covariant derivative of an infinite series of ±Λ-terms is also equal to zero.

$$\nabla_j(\Lambda_1\, g_{ik} + \Lambda_2 g_{ik} + \Lambda_3 g_{ik} + \ldots + \Lambda_\infty g_{ik}) = \Lambda_1\, \nabla_j g_{ik} + \Lambda_2\nabla_j g_{ik} + \ldots + \Lambda_\infty\nabla_j g_{ik} = \nabla_j g_{ik}\sum_{j=1}^{\infty} \pm\Lambda_j = 0, \tag{17}$$

where $\pm\Lambda_1$, $\pm\Lambda_2$, $\pm\Lambda_3$, $\pm\Lambda_4$, … , $\pm\Lambda_\infty$ are constants that can take positive ($\Lambda_j > 0$) or negative ($\Lambda_j < 0$) values.

Following Einstein's logic, we substitute the series $g_{ik}\sum_{j=1}^{\infty} \pm\Lambda_j$ into Eq. (1). As a result, we write the fully geometrized vacuum equation.

$$R_{ik} - \frac{1}{2}Rg_{ik} + \Lambda_1 g_{ik} + \Lambda_2 g_{ik} + \Lambda_3 g_{ik} + \ldots + \Lambda_\infty g_{ik} = 0, \tag{18}$$

or in condensed form

$$R_{ik} - \frac{1}{2}Rg_{ik} + g_{ik}\sum_{j=1}^{\infty} \pm\Lambda_j = 0, \tag{19}$$

where $\Lambda_j = 3/r_{aj}^2$ or $-3/r_{aj}^2$, where $r_{aj}$ is the radius of the $j$-th spherical formation.

We set the energy-momentum density tensor equal to zero ($T_{ik} = 0$) in equation (18) for three main reasons. First, this tensor is phenomenological in nature (i.e., it is entered manually); second, the tensor $T_{ik}$ is in principle impossible to encapsulate due to the presence of a mass density with the arbitrary dimension of kilograms; third, this tensor is associated with many problems in general relativity, such as the violation of the law of conservation of energy (see the introduction in [7]). Furthermore, Einstein's general relativity in no way explains how matter curves four-space.

When the right-hand side of Eq. (19) is zero (i.e., $T_{ik} = 0$), two significant simplifications are obtained.

First, if we multiply both sides of Eq. (19) by $g^{ik}$, we obtain

$$g^{ik}\left(R_{ik} - \frac{1}{2}Rg_{ik} + g_{ik}\sum_{j=1}^{\infty} \pm\Lambda_j\right) = R - \frac{n}{2}R + n\sum_{j=1}^{\infty} \pm\Lambda_j = 0, \tag{20}$$

where $n$ is the dimension of space, which implies

$$R = \frac{2n}{n-2}\sum_{j=1}^{\infty} \pm\Lambda_j,$$

and Eq. (19) takes the form

$$R_{ik} + \frac{2}{n-2}g_{ik}\sum_{j=1}^{\infty} \pm\Lambda_j = 0. \tag{21}$$

In the case of a 4-dimensional space: $n = 4$, then $R = 4\sum_{j=1}^{\infty} \pm\Lambda_j$, and Eq. (21) takes its simplest form:

$$R_{ik} + g_{ik}\sum_{j=1}^{\infty} \pm\Lambda_j = 0.$$

This equation can be represented as a system of two equations.

$$\begin{cases} R_{ik} + g_{ik}\sum_{m=1}^{\infty}\Lambda_m = 0, \\ R_{ik} - g_{ik}\sum_{n=1}^{\infty}\Lambda_n = 0. \end{cases} \tag{22}$$

Each of the equations in this system has the right to be applied with a probability of ½, so in what follows we will seek a solution to the averaged equation:

$$R_{ik} + ½\,(g_{ik}\sum_{m=1}^{\infty}\Lambda_m - g_{ik}\sum_{n=1}^{\infty}\Lambda_n) = 0. \tag{23}$$

where $\Lambda_m = 3/r_m^2$ (24)
are related by the positive curvature of the "corpuscles" with the radii of the cores $r_m$ (i.e., with stable spherical convexities of the corpuscular vacuum);
$\Lambda_n = 3/r_n^2$ (25)
are related by the negative curvature of the "anticorpuscles" with the radii of the cores $r_n$ (i.e., with stable spherical concavities of the corpuscular vacuum).

*In this article, "corpuscle" refers to a stable, convex, spherical vacuum structure consisting of a core and a surrounding outer shell (see Figure 6). Similarly, "anticorpuscle" refers to a stable, concave, spherical vacuum structure consisting of an anticore and a surrounding outer shell.*

Eq. (23) will be called third Einstein's vacuum equation.

Secondly, the covariant derivative of the zero on the right-hand side of Eq. (23) is equal to its ordinary derivative, which is zero (see Ex. (39) in [7]).
.

$$\nabla_j 0 = \frac{\partial 0}{\partial x^j} - \Gamma_{ij}^l 0 - \Gamma_{kj}^l 0 = \frac{\partial 0}{\partial x^j} = 0, \tag{26}$$

therefore, within the framework of tensor analysis, in this case, the covariant derivative of the tensor on the left-hand side of Eq. (23) must also be equal to its ordinary derivative, and equal to zero

$$\nabla_j (R_{ik} + g_{ik}\sum_{j=1}^{\infty}\pm\Lambda_j) = \frac{\partial\left(R_{ik} + g_{ik}\sum_{j=1}^{\infty}\pm\Lambda_j\right)}{\partial x^j} = 0, \tag{27}$$

therefore, each of the 16 vacuum equation (23) can be considered as one of the conservation laws and can be applied as an initial condition for searching for stable deformations of a corpuscular (i.e., spherically symmetric) type vacuum [7,8].

Thus, this article aims to find solutions to the vacuum equation (23) with an infinite number of $\pm\Lambda_j$-terms, which can form the basis of a metric-dynamic model of a closed mega-Universe filled with stable spherical vacuum formations (i.e., "corpuscles") of varying scales.

*The article is accompanied by fractal illustrations, which have the ability to allegorically visualize the superficial manifestations of what is hidden in Nature. In some cases, a fractal illustration can convey details of events that would otherwise require several pages of text to describe.*

**1 Possible cosmological scenarios**

Let's average Eq. (23) over the entire mega-Universe.

$$\overline{R_{ik} + ½ g_{ik}(\sum_{m=1}^{\infty}\Lambda_m - \sum_{n=1}^{\infty}\Lambda_n)} = \overline{R_{ik}} + \overline{½ g_{ik}(\sum_{m=1}^{\infty}\Lambda_m - \sum_{n=1}^{\infty}\Lambda_n)} = 0. \tag{28}$$

Based on this equation, let's consider several possible cosmological scenarios:

1] We assume that, when averaging over the entire mega-Universe, the number of "corpuscles" is equal to the number of "anticorpuscles." In this case, vacuum balance is maintained.

$$\overline{½(\sum_{m=1}^{\infty}\Lambda_m - \sum_{n=1}^{\infty}\Lambda_n)} = 0, \tag{29}$$

Then Eq. (28) takes the form of Einstein's first vacuum equation

$\overline{R_{ik}} = R_{ik} = 0$, (here it is assumed that $R_{ik}$ = constant)

which has four Schwarzschild solution metrics:

- two metrics with signature (+ – – –):

I $\quad ds_1^{(+)2} = \left(1 - \frac{r_{a1}}{r}\right) c^2 dt^2 - \frac{1}{\left(1-\frac{r_{a1}}{r}\right)} dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2,$ (30)

H $\quad ds_2^{(+)2} = \left(1 + \frac{r_{a2}}{r}\right) c^2 dt^2 - \frac{1}{\left(1+\frac{r_{a2}}{r}\right)} dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2.$ (31)

- two metrics with signature (– + + +)

H $\quad ds_1^{(-)2} = -\left(1 - \frac{r_{a1}}{r}\right) c^2 dt^2 + \frac{1}{\left(1-\frac{r_{a1}}{r}\right)} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2,$ (32)

I $\quad ds_2^{(-)2} = -\left(1 + \frac{r_{a2}}{r}\right) c^2 dt^2 + \frac{1}{\left(1+\frac{r_{a2}}{r}\right)} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2.$ (33)

*In 1916, Karl Schwarzschild obtained only metric (30). More precisely, somewhat later in 1916, Johannes Droste first wrote it down in this form. However, the remaining metrics (31) – (33) are also solutions of Eq. (29)* $R_{ik} = 0$, *and they cannot be ignored (see [7,8,9,10]).*

These solutions do not allow us to construct a metric-dynamic model of stable vacuum formation, since they contain singularities (see §2 in [7]). Only in the case $r_{a1} = r_{a2} = 0$ do metrics (20) – (33) reduce to two solution metrics

I $\quad ds_1^{(+)2} = c^2 dt^2 - dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2$ с сигнатурой (+ – – –); (34)

H $\quad ds_2^{(-)2} = -c^2 dt^2 + dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2$ с сигнатурой (– + + +), (35)

which describe the 4-strand fabric of flat space (see [3] and the Introduction in [6]).

2] Suppose, when averaging over the entire mega-Universe, the number of "corpuscles" (i.e., stable vacuum convexities) is greater than the number of "anticorpuscles" (i.e., stable vacuum concavities). In this case, the second term in Eq. (28) turns out to be equal to some value of $\Lambda_a$

$$\overline{½\left(\sum_{m=1}^{\infty} \Lambda_m - \sum_{n=1}^{\infty} \Lambda_n\right)} = \Lambda_a. \quad (36)$$

Then e Eq. (28) takes the form of Einstein's second vacuum equation with the $+\Lambda_a$ term

$$R_{ik} + g_{ik}\Lambda_a = 0. \quad (37)$$

The solutions to Eq. (37) are Kottler metrics with signature (+ – – –)

I $\quad s_a^{(+)2} = \left(1 - \frac{r_{a1}}{r} + \frac{r^2}{r_{b1}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1-\frac{r_{a1}}{r}+\frac{r^2}{r_{b1}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2),$ (38)

H $\quad ds_b^{(+)2} = \left(1 + \frac{r_{a2}}{r} - \frac{r^2}{r_{b2}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1+\frac{r_{a2}}{r}-\frac{r^2}{r_{b2}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2),$ (39)

V $\quad ds_c^{(+)2} = \left(1 - \frac{r_{a3}}{r} - \frac{r^2}{r_{b3}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1-\frac{r_{a3}}{r}-\frac{r^2}{r_{b3}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2),$ (40)

H′ $\quad ds_d^{(+)2} = \left(1 + \frac{r_{a4}}{r} + \frac{r^2}{r_{b4}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1+\frac{r_{a4}}{r}+\frac{r^2}{r_{b4}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2),$ (41)

*i* $\quad ds_{abcd}^{(+)2} = c^2 dt^2 - dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2.$ (42)

where $r_{a1}, r_{a2}, r_{a3}, r_{a4}$ and $r_{b1} = r_{b2} = r_{b3}, = r_{b4} = \sqrt{\frac{\Lambda_a}{3}}$ are integration constants (i.e., constant parameters of the metrics) with the dimension of distance.

3] Suppose that, when averaging over the entire Universe, the number of "corpuscles" is less than the number of "anti-corpuscles." In this case, the second term in Eq. (28) turns out to be equal to some value $-\Lambda_b$

$$\overline{½(\sum_{m=1}^{\infty}\Lambda_m - \dot{\sum}_{n=1}^{\infty}\Lambda_n)} = -\Lambda_b. \qquad (43)$$

Then Eq. (28) takes the form of Einstein's second vacuum equation with the $-\Lambda_b$-term

$$R_{ik} - g_{ik}\Lambda_b = 0. \qquad (44)$$

The solutions of Eq. (44) are Kotler metrics with the opposite signature (– + + +)

$$\text{I} \qquad s_a^{(-)2} = -\left(1 - \frac{r_{a1}}{r} + \frac{r^2}{r_{b1}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_{a1}}{r}+\frac{r^2}{r_{b1}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (45)$$

$$\text{H} \qquad ds_b^{(-)2} = -\left(1 + \frac{r_{a2}}{r} - \frac{r^2}{r_{b2}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_{a2}}{r}-\frac{r^2}{r_{b2}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (46)$$

$$\text{V} \qquad ds_c^{(-)2} = -\left(1 - \frac{r_{a3}}{r} - \frac{r^2}{r_{b3}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_{a3}}{r}-\frac{r^2}{r_{b3}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (47)$$

$$\text{H}' \qquad ds_d^{(-)2} = -\left(1 + \frac{r_{a4}}{r} + \frac{r^2}{r_{b4}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_{a4}}{r}+\frac{r^2}{r_{b4}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (48)$$

$$i \qquad ds_{abcd}^{(-)2} = -c^2dt^2 - dr^2 - r^2d\theta^2 - r^2\,sin^2\,\theta\, d\phi^2, \qquad (49)$$

*In 1918, Friedrich Kottler in his article [17] wrote down only one metric of the form (40). In the case: $r_a = \infty$ and $r_b \neq 0$, this metric goes over to the Schwarzschild metric (30). In the other limiting case: $r_a \neq \infty$ and $r_b = 0$, this metric goes over to the de Sitter metric*

$$ds^2_{\text{de Sitter}} = \left(1 - \frac{r^2}{r_a^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r^2}{r_a^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2). \qquad (50)$$

*Therefore, metric (47) is also called the Schwarzschild - de Sitter solution in the literature.*

4] Let, for example, $\Lambda_b = \frac{1}{2}R + D$ (where $R = g^{ik}R_{ik}$ is the scalar curvature of the Universe). In this case, equation (44) takes the form of the Einstein-Hilbert equation (1)

$$R_{ik} - \frac{1}{2}g_{ik}R = g_{ik}D \qquad (51)$$

with the source of curvature $g_{ik}D \equiv \varkappa T_{ik}$. Where, according to Ex. (43), $\Lambda_b$ is the fraction of the vanished matter.

5] Let, for example, $\Lambda_b = \frac{1}{2}R - L + D$ (where $R = g^{ik}R_{ik}$ is the scalar curvature of the Universe). In this case, Eq. (44) takes the form of Einstein's equation with the Λ-term (7)

$$R_{ik} - \frac{1}{2}g_{ik}R + g_{ik}L = g_{ik}D. \qquad (52)$$

By comparing Eqs. (7) and (52), the following correspondences can be identified: $g_{ik}D \equiv \varkappa T_{ik}$, $L \equiv \Lambda$ where $L = \frac{1}{2}R + D - \Lambda_b$ is some addition to the missing part of matter $\Lambda_b$, while

$$\Lambda_b + L = \frac{1}{2}R + D. \qquad (53)$$

6] It is possible that metric-dynamic processes (e.g., untying of topological knots) occur in a closed mega-Universe, which lead to a change in the difference between the number of "corpuscles" (i.e., stable vacuum convexities) and the number of "anticorpuscles" (i.e., stable vacuum concavities).

$$\overline{½(\sum_{m=1}^{\infty}\Lambda_m - \dot{\sum}_{n=1}^{\infty}\Lambda_n)} = \Lambda_a(t). \qquad (54)$$

Then the addition $L$ from Eq. (52) can be defined as the difference between $\Lambda_a(t)$ at different moments in time.

$$L = \Lambda_a(t_0) - \Lambda_a(t_1), \text{ then } \Lambda_a(t_1) + L = \Lambda_a(t_0), \qquad (55)$$

where $t_0$ is the initial moment in time, $t_1$ is the current moment in time.
Comparing Ex. (53) and (55), we discover that the addition of $L$ may be the result of some particles disappearing during the time interval $\tau = t_1 - t_0$ (i.e., topological knots were untied, and stable vacuum deformations were straightened out), releasing negative vacuum pressure for the accelerated expansion of the Universe.

We do not have sufficient data to determine which of the possible scenarios the Universe is developing under. However, using an infinite number of $\pm\Lambda_j$-terms in Einstein's third vacuum equation (23) allows us to consider a number of scenarios that can help us identify solutions to a number of cosmological problems. For example, the addition of $L$ may prove to be a logical analogue of dark energy.

Infinities in mathematics and physics usually lead to absurdities and insurmountable problems. But the infinite number of $\pm\Lambda_j$-terms in e Eq. (23) does not lead to deadlock situations, since the physical significance is zero or finite difference between the total sum of positive $+\Lambda_j$-terms (i.e., "corpuscles") and the total sum of negative $-\Lambda_j$-terms (i.e., "anticorpuscles").

**2 Hierarchical cosmological model**

Based on the vacuum equation with an infinite number of $\pm\Lambda_j$-terms (23)

$$R_{ik} + \tfrac{1}{2} g_{ik}\left(\sum_{m=1}^{\infty}\Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right) = 0, \quad (56)$$

the following "Hierarchical cosmological model" can be proposed.

Suppose that a closed spherical mega-universe is filled with an infinite number of:
- "corpuscles" with various core radii [8]

$$r_m = \sqrt{\frac{3}{\Lambda_m}}, \quad \text{where } m = 1,2,3,4,5,6,7,8,9,10, \ldots \quad (57)$$

- and "anticorpuscles" with core radii

$$r_n = \sqrt{\frac{3}{\Lambda_n}}, \quad \text{where } n = 1,2,3,4,5,6,7,8,9,10, \ldots$$

In this case, "corpuscles" and "anticorpuscles" with cores of various sizes are nested within one another like Russian nesting dolls (Figures 1 and 2).

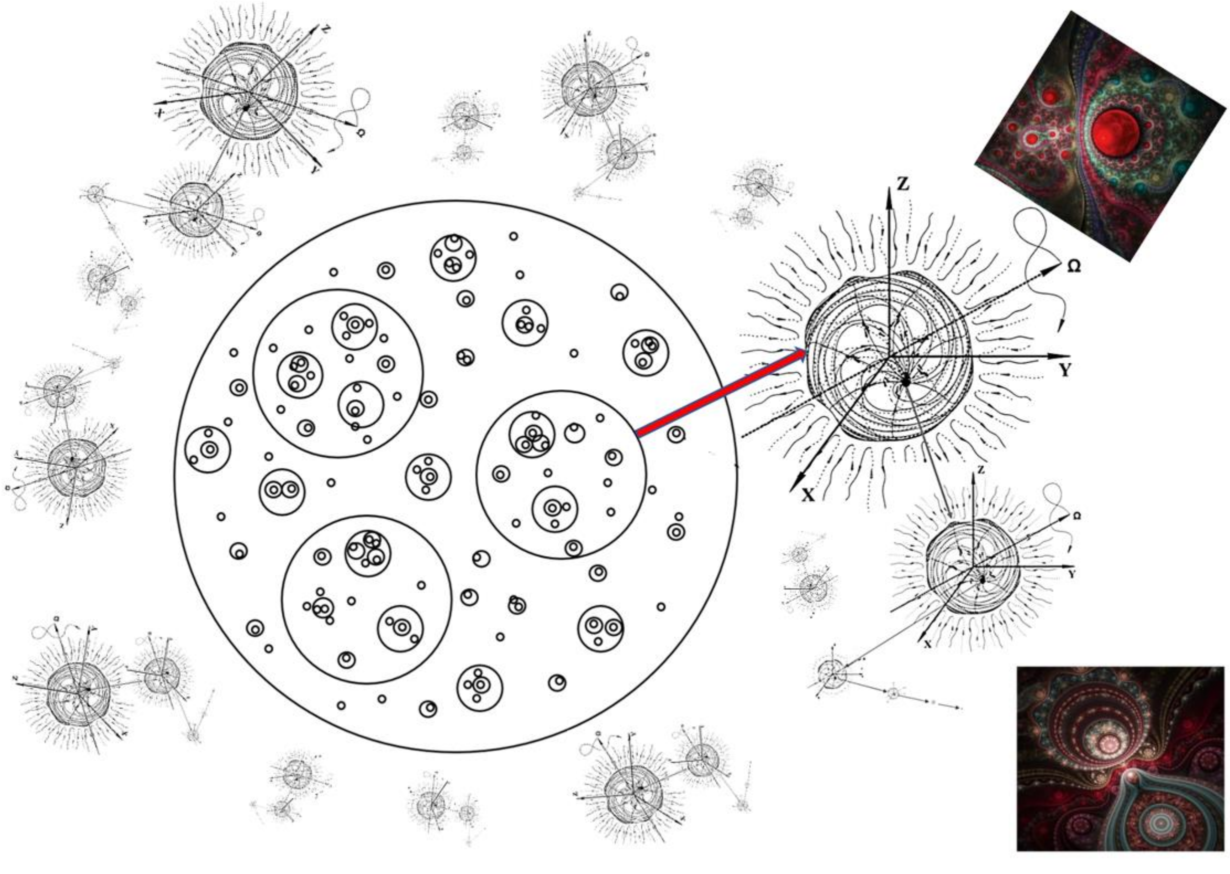



**Fig. 1:** A schematic representation of the "Hierarchical Cosmological Model," consisting of an infinite number of hierarchical chains of "corpuscles" and "anticorpuscles" of various sizes, whose cores of different scales are nested within one another like Russian nesting dolls

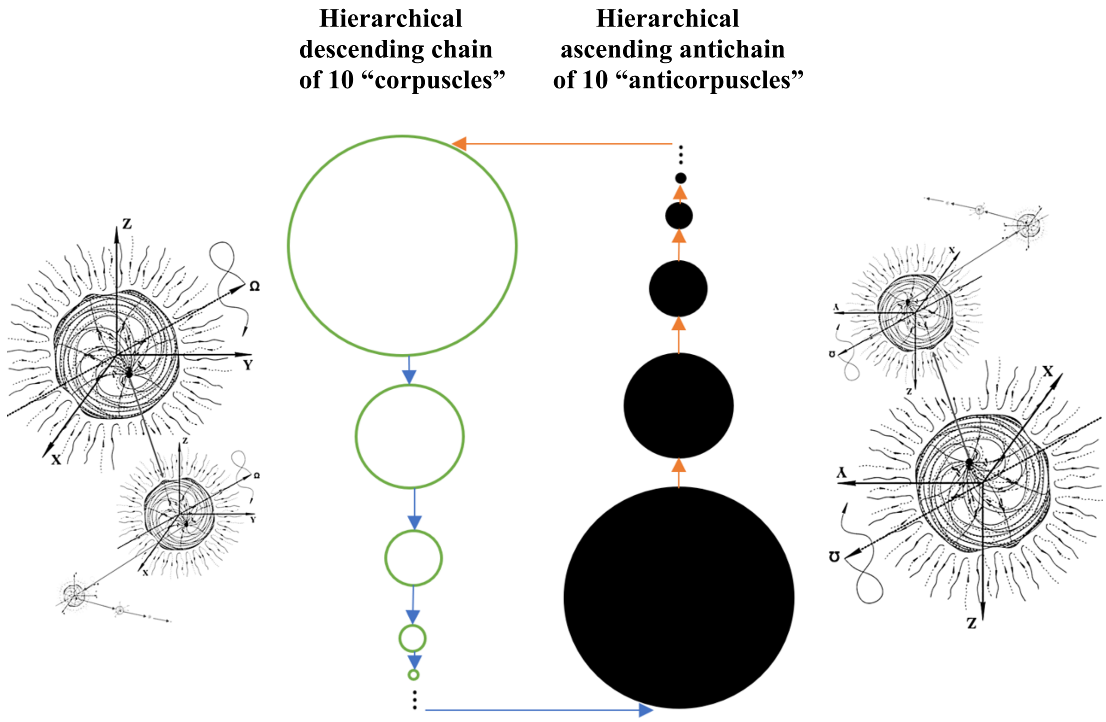



**Fig. 2:** Schematic representation of one of the closed hierarchical chains of “corpuscles” and “anticorpuscles” of various sizes (15), whose cores are nested inside one another like Russian nesting dolls

Let’s make two more assumptions. First, in the surrounding world we observe a discrete set of “corpuscles” and “anti-corpuscles” with cores of various scales: the cores of galaxies, the cores of planets and stars, the cores of biological cells, and the cores of atoms and elementary particles. Moreover, the characteristic radii of these cores are not random but correspond to a hierarchical sequence determined by an approximate heuristic recursive formula (see §3 in [8])

$$r_m \sim \frac{R_v^2}{l_v^m} = \frac{10^{50}}{(3\cdot 10^{10})^m}, \qquad (58)$$

where
$l_v \approx c\,\Delta t \approx c\cdot$1second $\approx 3\cdot 10^{10}$ cm is the distance traveled by a light beam in a vacuum during a time interval $\Delta t = 1$ s;
$R_v \approx 10^{25}$ cm – the parametric radius of the Universe (cm).

We do not know how many nested “corpuscles” or “anticorpuscles” of varying scales make up a single maximum hierarchical chain (see Figure 2). But if we assume that there are, for example, 10 of these spherical vacuum formations, then the recursive formula (58) allows us to obtain the following heuristic hierarchical sequence of the base radii of the “corpuscle” and “anticorpuscle” cores:

$r_1 \sim 10^{39}$ cm is radius commensurate with the radius of the mega-Universe; (59)
$r_2 \sim 10^{28}$ cm is radius commensurate with the radius of the observable Universe;
$r_3 \sim 10^{17}$ cm is radius commensurate with the radius of the galactic core;
$r_4 \sim 10^{7}$ cm is radius commensurate with the radius of the core of a planet or star;
$r_5 \sim 10^{-3}$ cm is radius commensurate with the radius of a biological cell;
$r_6 \sim 10^{-13}$ cm is radius commensurate with the radius of an elementary particle core;
$r_7 \sim 10^{-24}$ cm is radius commensurate with the radius of a proto-quark core;
$r_8 \sim 10^{-34}$ cm is radius commensurate with the radius of a plankton core;
$r_9 \sim 10^{-45}$ cm is radius commensurate with the radius of the proto-plankton core;
$r_{10} \sim 10^{-55}$ cm is radius commensurate with the size of the instanton core.

*The radii $r_i$ in hierarchy (59) are approximate and may be refined as research progresses. At this stage, the specific values of ri have virtually no effect on the structure of the hierarchical cosmological model under consideration. It is only important that $r_i$ differ from one another by approximately 10 orders of magnitude ($r_i \gg r_{i+1}$).*

Of this discrete hierarchical sequence, only the radii $r_2$, $r_3$, $r_4$, $r_5$, $r_6$ turned out to be close to the radii of the cores of observable spherical macroscopic and microscopic "corpuscles" and "anticorpuscles." The remaining spherical objects with radii $r_1$, $r_7$, $r_8$, $r_9$, $r_{10}$ lie far beyond the limits of modern observational capabilities. At present, we cannot state with certainty whether spherical bodies of such sizes exist or not. However, it is permissible to attempt to construct a cosmological model (as a working hypothesis) involving these hypothetical stable spherical formations.

Second, we assume that within the proposed Hierarchical Cosmological Model there is an infinite number of hierarchical chains of "corpuscles" and "anticorpuscles" of varying scales, nested within one another like matryoshka dolls (see Figures 1 and 2). In this case, a single hierarchical chain may contain from 4 to 10 corpuscular entities of varying scales. However, all hierarchical chains begin with the core of a single common, largest "corpuscle" (i.e., with the core of the mega-Universe with an approximate radius $r_1 \sim 10^{39}$ cm) and converge to a single, common, tiny "instanton" core with an approximate radius of $r_{10} \sim 10^{-55}$ cm (see Figure 4).

For example, the core of a free "electron" (with a radius of $r_6 \sim 10^{-13}$ cm) may be located inside the core of the mega-Universe (see Figure 1), while inside the core of the "electron" there may be a "proto-quark," inside which lies the core of an "instanton." In this case, the hierarchical chain consists of only four "corpuscles" of different scales. It will be shown below that mathematics prohibits hierarchical chains with an odd number of cells (i.e., cores of different scales). In other words, in the hierarchical cosmological model under consideration, there are no hierarchical chains with three or five cells.
In another example, there might be 6 cells in a hierarchical chain, for instance:

- a mega-Universe with a radius $r_1 \sim 10^{39}$ cm;
- a "galaxy" core (with an approximate radius $r_3 \sim 10^{17}$ cm) may be located inside the mega-Universe;
- inside the "galaxy" core there may be a "planet" core (with an approximate radius of $r_4 \sim 10^{7}$ cm);
- inside the "planet" core there may be an "electron" core (with an approximate radius of $r_6 \sim 10^{-13}$ cm);
- inside the "electron" core there may be a "proto-quark" core (with an approximate radius $r_7 \sim 10^{-24}$ cm);
- inside the "proto-quark" core there may be an "instanton" core (with an approximate radius $r_{10} \sim 10^{-55}$ cm).

and so on.

## 3 A closed 10-level hierarchical chain of multi-scale "corpuscle" and "anticorpuscle" cores

From the infinite number of hierarchical chains with varying numbers (from 4 to 10) of cells shown in Figures 1 and 2, we will select only the single longest chain with 10 nested "corpusculars" and "anticorpusculars."

*Recall that at this stage of the research, we do not know how many links (i.e., nested "corpuscular" cores of different scales) there are in the longest hierarchical chain. In this article, we have provisionally adopted, as a working hypothesis, that the number of these links is finite and no more than 10. At the same time, the hierarchical cosmological model developed here is indifferent to any number of links in the hierarchical chain, i.e., excess links can always be removed, or missing links can always be added.*

Such a 10-level hierarchical chain is described by Einstein's vacuum equation with 10 $+\Lambda_m$-terms and 10 $-\Lambda_n$- terms.

$$R_{ik} + ½ g_{ik} \sum_{m=1}^{10} \Lambda_m + ½ g_{ik} \sum_{n=1}^{10} -\Lambda_n = 0. \quad (60)$$

Let's express this equation as a system (similar to system (22))

$$\begin{cases} R_{ik} + g_{ik} \sum_{m=1}^{10} \Lambda_m = 0, \\ R_{ik} - g_{ik} \sum_{n=1}^{10} \Lambda_n = 0. \end{cases} \quad (61)$$

We will find the solutions to Eq. (61) separately.

*3.1 One 10-level hierarchical chain of a cores of "corpuscles"*

Let the sum of the ten $\Lambda_m$-terms of the series in the first Eq. (61) be equal to a specific numerical value $\Lambda_0$

$$\sum_{m=1}^{10} \Lambda_m = \Lambda_0. \quad (62)$$

Then the first equation in system (61) takes the form of Einstein's second vacuum equation (37)

$$R_{ik} + g_{ik} \Lambda_0 = 0. \quad (63)$$

The solutions to this equation are analogous to the metric solutions (38) – (42) of Eq. (37) with the signature (+ – – –)

$$\text{I} \qquad ds_a^{(+)2} = \left(1-\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \qquad (64)$$

$$\text{H} \qquad ds_b^{(+)2} = \left(1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \qquad (65)$$

$$\text{V} \qquad ds_c^{(+)2} = \left(1-\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_0}{r}-\Lambda_0 r^2\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \qquad (66)$$

$$\text{H}' \qquad ds_d^{(+)2} = \left(1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \qquad (67)$$

$$i \qquad ds_{abcd}^{(+)2} = c^2dt^2 - dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \qquad (68)$$

where $\Lambda_0 = \sum_{m=1}^{10}\frac{3}{r_m^2}, \quad r_0 = \sum_{m=1}^{10} r_m.$ (69)

Here, we have expanded the parameter $r_0$ into ten terms $r_1, r_2, r_3, \dots, r_{10}$, which correspond to the base radii of the cores from the hierarchical sequence (59).

We substitute series (69) into the zeroth component $g_{00}$ (equal to the denominator of the unit component $1/g_{11}$) of the metric tensor from the metric-solution (64)

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1-\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3} = 1-\frac{r_1+r_2+\dots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2. \qquad (70)$$

This expression can be decomposed into "corpuscles" in two ways:

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1-\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3} = 1-\frac{r_1+r_2+\dots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \qquad (71)$$
$$= 1+\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)-\left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)+\left(1-\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)-\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)+\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)-\left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)+\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)-$$
$$-\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)+\left(1-\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)-\left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right).$$

and

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1-\frac{r_1+r_2+\dots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \qquad (71a)$$
$$= 1+\left(1-\frac{r_1}{r}+\frac{r^2}{r_2^2}\right)-\left(1+\frac{r_2}{r}-\frac{r^2}{r_3^2}\right)+\left(1-\frac{r_3}{r}+\frac{r^2}{r_4^2}\right)-\left(1+\frac{r_4}{r}-\frac{r^2}{r_5^2}\right)+\left(1-\frac{r_5}{r}+\frac{r^2}{r_6^2}\right)-\left(1+\frac{r_6}{r}-\frac{r^2}{r_7^2}\right)+$$
$$+\left(1-\frac{r_7}{r}+\frac{r^2}{r_8^2}\right)-\left(1+\frac{r_8}{r}-\frac{r^2}{r_9^2}\right)+\left(1-\frac{r_9}{r}+\frac{r^2}{r_{10}^2}\right)-\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_1^2}\right).$$

Indeed, if we expand the parentheses on the right-hand sides of Exs. (71) and (71a) and cancel out the ± units, we obtain the original Equality (70).

In the second Ex. (71a), the core with the larger radius $r_m$ from hierarchy (59) appears in the numerator, while the ball with the smaller radius $r_{m+1}$ appears in the denominator. This means that the larger core is located inside the smaller one. This seems unusual, so we will leave Ex. (71a) without further consideration for now.

Similarly, we can write the zero components (equal to the denominators of the unit component) of the metric tensor from solution metrics (65) – (67).

$$g_{00}^{(+b)} = 1/g_{11}^{(+b)} = 1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3} = 1+\frac{r_1+r_2+\dots+r_{10}}{r}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \qquad (72)$$
$$= 1+\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)-\left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)+\left(1+\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)-\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)+\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)-\left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)+\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)-$$
$$-\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)+\left(1+\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)-\left(1-\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right);$$

$$g_{00}^{(+c)} = 1/g_{11}^{(+c)} = 1-\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3} = 1-\frac{r_1+r_2+\dots+r_{10}}{r}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \qquad (73)$$
$$= 1+\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)-\left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)+\left(1-\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)-\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)+\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)-\left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)+\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)-$$
$$-\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)+\left(1-\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)-\left(1+\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right);$$

$$g_{00}^{(+d)} = 1/g_{11}^{(+d)} = 1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3} = 1+\frac{r_1+r_2+\dots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \qquad (74)$$
$$= 1+\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)-\left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)+\left(1+\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)-\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)+\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)-\left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)+\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)-$$
$$-\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)+\left(1+\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)-\left(1-\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right).$$

We substitute the components of the metric tensors (71) – (74) into the corresponding metric-solutions (64) – (67) and as a result we obtain the following metric-dynamic model of a hierarchical chain of multi-scale cores of “corpuscles” nested inside each other like nesting dolls (see Figure 3a).

## A hierarchical 10-level chain of multi-scale cores of "corpuscles" nested like Russian dolls

with a signature of (+ – – –) (Figs. 2 and 3a)

### Core 1 (75)

of the "mega-Universe$_{10}$" with a base radius $r_1 \sim \mathbf{10^{39}}$ cm

in the interval $[r_2, r_1]$ (Fig. 3a), with a signature of (+ – – –)

I $$ds_1^{(+---)2} = \left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (76)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (77)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (78)$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (79)$$

### Core 2 (80)

of the "observable Universe$_{10}$" with a base radius $r_2 \sim \mathbf{10^{29}}$ cm

in the interval $[r_3, r_2]$ (Fig. 3a), with a signature (+ – – –)

H′ $$ds_1^{(+---)2} = \left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (81)$$

V $$ds_2^{(+---)2} = \left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (82)$$

H $$ds_3^{(+---)2} = \left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (83)$$

I $$ds_4^{(+---)2} = \left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (84)$$

### Core 3 (85)

of the "galaxy$_{10}$" with a base radius $r_3 \sim \mathbf{10^{17}}$ cm

in the interval $[r_4, r_3]$ (Fig. 3a), with a signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (86)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (87)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (88)$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (89)$$

### Core 4 (90)

of the "planet$_{10}$" with a base radius $r_4 \sim \mathbf{10^{7}}$ cm

in the interval $[r_5, r_4]$ (Fig. 3a), with a signature (+ – – –)

H′ $$ds_1^{(+---)2} = \left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (91)$$

V $$ds_2^{(+---)2} = \left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (92)$$

H $$ds_3^{(+---)2} = \left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (93)$$

I $$ds_4^{(+---)2} = \left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (94)$$

**Core 5** (95)

of the "biological cell$_{10}$" with a base radius $r_5 \sim$ **$10^{-3}$** cm

in the interval $[r_6, r_5]$ (Fig. 3a), with a signature (+ – – –)

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (96)$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (97)$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (98)$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (99)$$

**Core 6** (100)

of the "elementary particle$_{10}$" with a base radius $r_6 \sim$ **$10^{-13}$** cm

in the interval $[r_7, r_6]$ (Fig. 3a), with a signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (101)$$

H $$ds_2^{(+---)2} = \left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (102)$$

V $$ds_3^{(+---)2} = \left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (103)$$

H′ $$ds_4^{(+---)2} = \left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (104)$$

**Core 7** (105)

of the "proto-quark$_{10}$" with a base radius $r_7 \sim$ **$10^{-24}$** cm

in the interval $[r_8, r_7]$ (Fig. 3a), with a signature (+ – – –)

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (106)$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (107)$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (108)$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (109)$$

**Core 8** (110)

of the "plankton$_{10}$" with a base radius $r_8 \sim$ **$10^{-34}$** cm

in the interval $[r_9, r_8]$ (Fig. 3a), with a radius signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2) \quad (111)$$

H $$ds_2^{(+---)2} = \left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (112)$$

V $$ds_3^{(+---)2} = \left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (113)$$

H′ $$ds_4^{(+---)2} = \left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (114)$$

**Core 9** (115)

of the "proto-plankton$_{10}$" with a base radius $r_9 \sim$ **$10^{-45}$** cm

in the interval $[r_{10}, r_9]$ (Fig. 3a), with a signature (+ – – –)

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (116)$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (117)$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (118)$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (119)$$

**Core 10** (120)

of the "instanton$_{10}$" with a base radius $r_{10}$ ~$\mathbf{10^{-55}}$ cm

in the interval $[r_1, r_{10}]$ (Fig. 3a), with a signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (121)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (122)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (123)$$

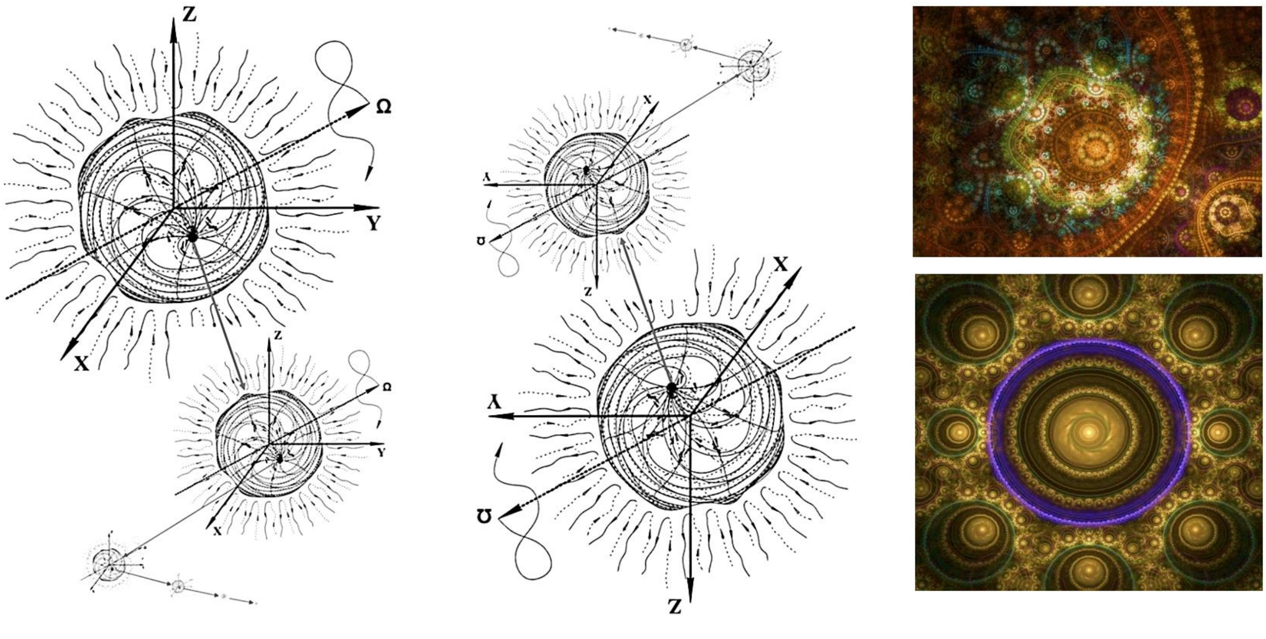
H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (124)$$

**The substrate**

of the closed spherical "mega-Universe$_{10}$"

in the interval [0,∞], with the signature (+ – – –)

*i* $$ds_5^{(+---)2} = c^2 dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta\, d\phi^2). \quad (125)$$




a) b) c)

**Fig. 3:** a) A hierarchical 10-level chain of different-scale "corpuscle" cores (i.e., convex spherical vacuum formations) nested inside each other like Russian dolls; b) An inverted hierarchical 10-level chain of different-scale "anticorpuscle" cores (i.e., concave spherical vacuum formations) nested inside each other like Russian dolls; c) Fractal illustrations of "cores in Cores"

*3.2 An inverted 10-level hierarchical antichain of multiscale cores of "anticorpuscle"*

Consider the second equation in system (61)

$R_{ik} - g_{ik}\Lambda_0 = 0,$ (126)

where $\Lambda_0 = \sum_{n=1}^{10} \Lambda_n$. (127)

The solutions to this equation are analogous to the metric-solutions (45) – (48) of Eq. (44) with signature (– + + +)

$$\text{I} \qquad ds_a^{(-)2} = -\left(1-\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \tag{128}$$

$$\text{H} \qquad ds_b^{(-)2} = -\left(1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \tag{129}$$

$$\text{V} \qquad ds_c^{(-)2} = -\left(1-\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_0}{r}-\Lambda_0\frac{r^2}{}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \tag{130}$$

$$\text{H}' \qquad ds_d^{(-)2} = -\left(1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \tag{131}$$

$$i \qquad ds_{abcd}^{(-)2} = -\,c^2dt^2 + dr^2 + r^2d\theta^2 + r^2\sin^2\theta\, d\phi^2, \tag{132}$$

$$\text{where} \quad \Lambda_0 = \sum_{n=1}^{10}\frac{3}{r_n^2}, \quad r_0 = \sum_{n=1}^{10} r_n. \tag{133}$$

Here, the parameters $r_n$ $(r_1, r_2, r_3, \dots, r_{10})$ also correspond to the base radii of the "corpuscle's" cores from the hierarchical sequence (59).

We substitute series (133) into the zero components $g_{00}$ (equal to the denominators of the unit components $1/g_{11}$) of the metric tensors from solution metrics (128) – (133)

$$g_{00}^{(-a)} = \frac{1}{g_{11}^{(-a)}} = -\left[1-\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right] = -1+\frac{r_1+r_2+\dots+r_{10}}{r} - \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \tag{134}$$
$$= -1-\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)+\left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)-\left(1-\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)+\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)-\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)+\left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)-$$
$$-\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)+\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)-\left(1-\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)+\left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right);$$

$$g_{00}^{(-b)} = \frac{1}{g_{11}^{(-b)}} = -\left[1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right] = -1-\frac{r_1+r_2+\dots+r_{10}}{r} + \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \tag{135}$$
$$= -1-\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)+\left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)-\left(1+\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)+\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)-\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)+\left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)-$$
$$-\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)+\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)-\left(1+\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)+\left(1-\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right);$$

$$g_{00}^{(-c)} = \frac{1}{g_{11}^{(-c)}} = -\left[1-\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right] = -1+\frac{r_1+r_2+\dots+r_{10}}{r} + \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \tag{136}$$
$$= -1-\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)+\left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)-\left(1-\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)+\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)-\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)+\left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)-\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)+$$
$$+\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)-\left(1-\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)+\left(1+\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right);$$

$$g_{00}^{(-d)} = \frac{1}{g_{11}^{(-d)}} = -\left[1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right] = -1-\frac{r_1+r_2+\dots+r_{10}}{r} - \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\dots+\frac{1}{r_{10}^2}\right)r^2 = \tag{137}$$
$$= -1-\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)+\left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)-\left(1+\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)+\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)-\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)+\left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)-$$
$$-\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)+\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)-\left(1+\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)+\left(1-\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right).$$

Substituting the components of the metric tensors (134) – (137) into the corresponding metric-solutions (128) – (133), we obtain the following metric-dynamic model of an antichain of multiscale cores, "anticorpuscles," stacked on top of each other like nesting dolls (see Figure 3b), turned inside out with respect to the chain (75) – (125).

## A hierarchical 10-level chain of multi-scale "anticorpuscle" cores stacked on top of each other like nesting dolls

with a signature of (– + + +) (Figs. 2 and 3b)

### Core 10 (138)

of the "antiinstanton$_{10}$" with a base radius $r_{10}$ ~$\mathbf{10^{-55}}$ cm
in the interval [$r_1$,$r_{10}$] (Fig. 3b), with a signature (– + + +)

I
$$ds_1^{(-+++)2} = -\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (139)$$

H
$$ds_2^{(-+++)2} = -\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (140)$$

V
$$ds_3^{(-+++)2} = -\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (141)$$

H′
$$ds_4^{(-+++)2} = -\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (142)$$

### Core 9 (143)

of the "antiproto-plankton$_{10}$" with a base radius $r_9$ ~ $\mathbf{10^{-45}}$ cm
in the interval [$r_{10}$,$r_9$] (Fig. 3b), with a signature (– + + +)

H′
$$ds_1^{(-+++)2} = -\left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (144)$$

V
$$ds_2^{(-+++)2} = -\left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (145)$$

H
$$ds_3^{(-+++)2} = \left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (146)$$

I
$$ds_4^{(-+++)2} = -\left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (147)$$

### Core 8 (148)

of the "antiplankton$_{10}$" with a base radius $r_8$ ~ $\mathbf{10^{-34}}$ cm
in the interval [$r_9$,$r_8$] (Fig. 3b), with a radius signature (– + + +)

I
$$ds_1^{(-+++)2} = -\left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (149)$$

H
$$ds_2^{(-+++)2} = -\left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (150)$$

V
$$ds_3^{(-+++2} = -\left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (151)$$

H′
$$ds_4^{(-+++)2} = -\left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (152)$$

### Core 7 (153)

of the "antiproto-quark$_{10}$" with a base radius $r_7$ ~ $\mathbf{10^{-24}}$ cm
in the interval [$r_8$,$r_7$] (Fig. 3b), with a signature (– + + +)

H′
$$ds_1^{(-+++)2} = -\left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (154)$$

V
$$ds_2^{(-+++)2} = -\left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (155)$$

H
$$ds_3^{(-+++)2} = -\left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (156)$$

I
$$ds_4^{(-+++)2} = -\left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (157)$$

**Core 6** (158)

of the "elementary antiparticle$_{10}$" with a base radius $r_6 \sim \mathbf{10^{-13}}$ cm

in the interval $[r_7, r_6]$ (Fig. 3b), with a signature (– + + +)

I $$ds_1^{(-+++)2} = -\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (159)$$

H $$ds_2^{(-+++)2} = -\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (160)$$

V $$ds_3^{(-+++)2} = -\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (161)$$

H′ $$ds_4^{(-+++)2} = -\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (162)$$

**Core 5** (163)

of the "biological anticell$_{10}$" with a base radius $r_5 \sim \mathbf{10^{-3}}$ cm

in the interval $[r_6, r_5]$ (Fig. 3a), with a signature (– + + +)

H′ $$ds_1^{(-+++)2} = -\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (164)$$

V $$ds_2^{(-+++)2} = -\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (165)$$

H $$ds_3^{(-+++)2} = -\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (166)$$

I $$ds_4^{(-+++)2} = -\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (167)$$

**Core 4** (168)

of the "antiplanet$_{10}$" with a base radius $r_4 \sim \mathbf{10^{7}}$ cm

in the interval $[r_5, r_4]$ (Fig. 3b), with a signature (– + + +)

H′ $$ds_1^{(-+++)2} = -\left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (169)$$

V $$ds_2^{(-+++)2} = -\left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (170)$$

H $$ds_3^{(-+++)2} = -\left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (171)$$

I $$ds_4^{(-+++)2} = -\left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (172)$$

**Core 3** (173)

of the "antigalaxy$_{10}$" with a base radius $r_3 \sim \mathbf{10^{17}}$ cm

in the interval $[r_4, r_3]$ (Fig. 3b), with a signature (– + + +)

I $$ds_1^{(-+++)2} = -\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (174)$$

H $$ds_2^{(-+++)2} = -\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (175)$$

V $$ds_3^{(-+++)2} = -\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (176)$$

H′ $$ds_4^{(-+++)2} = -\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (177)$$

**Core 2** (178)

of the "observable anti-Universe$_{10}$" with a base radius $r_2 \sim \mathbf{10^{29}}$ cm

in the interval $[r_3, r_2]$ (Fig. 3b), with a signature (– + + +)

H′ $$ds_1^{(-+++)2} = -\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (179)$$

V $$ds_2^{(-+++)2} = -\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (180)$$

H $$ds_3^{(-+++)2} = -\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (181)$$

I $$ds_4^{(-+++)2} = -\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \qquad (182)$$

## Core 1 (153)

of the "mega-anti-Universe10" with a base radius $r_1 \sim \mathbf{10^{39}}$ cm
in the interval $[r_2, r_1]$ (Fig. 3b), with a signature of (– + + +)

I $$ds_1^{(-+++)2} = -\left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (184)$$

H $$ds_2^{(-+++)2} = -\left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (185)$$

V $$ds_3^{(-+++)2} = -\left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \qquad (186)$$

H′ $$ds_4^{-+++)2} = -\left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \qquad (187)$$

## The substrate

of the closed spherical "mega-anti-Universe10"
in the interval [0,∞], with the signature (– + + +)

*i* $$ds_5^{(-+++)2} = -c^2dt^2 + dr^2 + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2). \qquad (188)$$

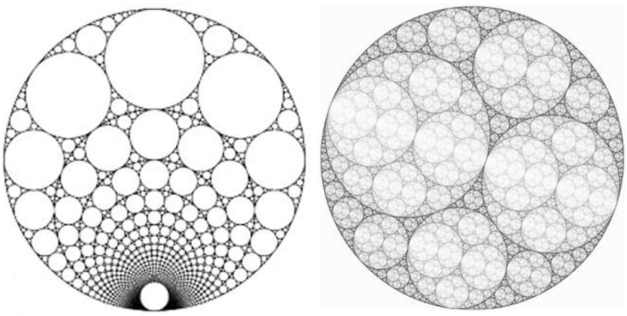
## 4 Advantages and disadvantages of hierarchical chains of "corpuscle" cores within the Hierarchical cosmological model

Let's list the main advantages of the proposed Hierarchical cosmological model (HCM):
1) The core of each "corpuscle" or "anticorpuscle" (i.e., a convex or concave stable spherical vacuum formation) from hierarchical chains (75) – (124) and (139) – (187) is described by five solution metrics of the type (38) – (42) or (45) – (49) of the second vacuum equation (37) or (44) $R_{ik} \pm g_{ik}\Lambda_a = 0$. This means that each of these cores can be studied separately.
2) The mathematical apparatus of the HCM allows for a different number of multiscale cores (cells) in one hierarchical chain, from 4 to infinity. Indeed, if, instead of the series (69), we substitute, for example, the series

$$\Lambda_0 = \sum_{m=1}^{4} \frac{3}{r_m^2}, \quad r_0 = \sum_{m=1}^{4} r_m\,; \qquad (189)$$
$$\Lambda_0 = \sum_{m=1}^{8} \frac{3}{r_m^2}, \quad r_0 = \sum_{m=1}^{8} r_m\,;$$
$$\Lambda_0 = \sum_{m=1}^{22} \frac{3}{r_m^2}, \quad r_0 = \sum_{m=1}^{22} r_m\,;$$
$$\Lambda_0 = \sum_{m=1}^{\infty} \frac{3}{r_m^2}, \quad r_0 = \sum_{m=1}^{\infty} r_m.$$

Then, performing operations similar to (71) – (74), we obtain hierarchical chains with four, eight, twenty-two, and an infinite number of cores, respectively, nested within each other.

Within the HCM, a single condition is imposed on all these hierarchical chains: all these chains, regardless of the number of cores included in them, begin with a single largest common core (e.g., the boundary of a closed mega-Universe with a radius of $r_1 \sim 10^{39}$ cm) and end at a single smallest core (e.g., the core of an «instanton» with a base radius of about $r_{10} \sim 10^{-55}$ cm).



a) b)

**Fig. 4:** Attempts to illustrate (using the "Apollo Circles" fractal) a multitude of hierarchical chains of cores nested within each other, starting with a single largest core (e.g., the core of a mega-Universe) and ending with a single smallest core (e.g., the core of an «instanton»).

At this stage of research, we do not know how many cores (cells) there are in a single largest hierarchical chain, but the advantage of the proposed mathematical model is that this number can always be adjusted as further research and refinement proceeds.

At the same time, there is one circumstance that imposes a limitation on hierarchical chains of cores. We illustrate this with an example. Suppose the hierarchical chain contains only three cores with radii $r_1 \gg r_2 \gg r_3$, nested within each other. Then the components of the metric tensor, similar to (71), will take a reduced form.

$$g_{00}^{(+a)} = \frac{1}{g_{11}^{(+a)}} = 1 - \frac{r_1 + r_2 + r_3}{r} + \left(\frac{1}{r_1^2} + \frac{1}{r_2^2} + \frac{1}{r_3^2}\right) r^2. \tag{190}$$

If Ex. (190) is decomposed into three parentheses ("corpuscles") similarly to (71)

$$g_{00}^{(+a)} = \frac{1}{g_{11}^{(+a)}} = 1 - \frac{r_1 + r_2 + r_3}{r} + \left(\frac{1}{r_1^2} + \frac{1}{r_2^2} + \frac{1}{r_3^2}\right) r^2 \neq 1 + \left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) - \left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) + \left(1 - \frac{r_3}{r} + \frac{r^2}{r_1^2}\right), \tag{191}$$

then in this case, when opening the parentheses, the extra unit {1} does not cancel out, so such a decomposition into three "corpuscles" is prohibited.

A similar situation will arise for any other odd number of different-scale cores in a hierarchical chain, i.e., in these cases, an uncompensated unit {1} will always arise.

(191a)

Thus, we arrive at an important conclusion: "**In a hierarchical chain, there can only be an even number of different-scale cores, or 'corpuscles,' nested within each other**."

(191b)

Two cores nested within each other were considered in §3.2 of [7], but this did not lead to positive results. Therefore, a second limitation can be stated: **"In a hierarchical chain, there can only be at least four different-scale cores."**

3) The hierarchical cosmological model (HCM) shows that the cores of "corpuscles" of any scale are not independent particles, but are part of a vast multi-level (cellular) system a mega-Universe. For example, the "corpuscle" we call a free "electron" has a core with a base radius $r_6 \sim 10^{-13}$ cm and an outer shell (see Figure 6) extending to the edges of the Universe. Thus, the "electron" occupies the entire Universe. This statement correlates to some extent with the postulate of quantum mechanics (in the Copenhagen interpretation) that a free electron can be found everywhere in the Universe, but with varying probabilities.

4) The maximum number of "corpuscle" cores of different scales in a single, largest hierarchical chain is unknown, but there are six levels of the hierarchical sequence (59) with core radii:

$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of the observable Universe;
$r_3 \sim 10^{19}$ cm is radius commensurate with the radius of the galactic core;
$r_4 \sim 10^{8}$ cm is radius commensurate with the radius of the core of a planet or star;
$r_5 \sim 10^{-3}$ cm is radius commensurate with the radius of a biological cell;
$r_6 \sim 10^{-13}$ cm is radius commensurate with the radius of an elementary particle core;
$r_7 \sim 10^{-24}$ cm is radius commensurate with the radius of a proto-quark core
amenable to a more in-depth metric-dynamic description based on the mathematical apparatus of Geometrized Vacuum Physics Based on the Algebra of Signature (see [3,4,5,6,7,8,9,10,11,12,13]).

We also note the main shortcomings of HCM:

1) Riemannian geometry and, in particular, Einstein's vacuum equation with an infinite number of $\pm\Lambda_a$-terms, does not limit the maximum number of different-scale cores of "corpuscles" and "anticorpuscles" in a single, largest hierarchical chain. Mathematics prohibits only an odd number of cells in any hierarchical chain. Therefore, at this stage of research, it is impossible to complete this theory.

2) If the number of differently scaled cores of "corpuscles" (convexities) and "anticorpuscles" (concavities) in any hierarchical chain is finite, then we encounter a circumstance that defies ordinary logical understanding. For example, consider expression (71)

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1 - \frac{r_1 + r_2 + \cdots + r_{10}}{r} + \left(\frac{1}{r_1^2} + \frac{1}{r_2^2} + \cdots + \frac{1}{r_{10}^2}\right) r^2 = \tag{71′}$$

$$= 1 + \left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right) - \left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right) + \left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) - \left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) + \left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) - \left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right) + \left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) -$$
$$- \left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) + \left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) - \left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right).$$

According to the hierarchy of radii (59), we see that on the left-hand side of this expression, in the first bracket in the numerator of the first term, we indicate the radius of the smallest "instanton" core $r_{10}$ ~$10^{-55}$ cm, which is located inside the proto-plankton core with radius $r_9$ ~ $10^{-45}$ cm, indicated in the denominator of the second term (see §3 in [7]); in turn, in the second bracket, the proto-plankton core is located inside the next plankton core with radius $r_8$ ~ $10^{-34}$ cm, and so on. In all the remaining brackets, the smaller core is located inside the larger core, except for the last bracket, where the largest core of the mega-Universe with radius $r_1$ ~ $10^{39}$ cm is located inside the smallest "instanton" core. The same holds true for all the other Ex. (72) – (44) and (134) – (137). Thus, in the case of a limited hierarchical chain of "corpuscle's" cores, we face the problem of the largest core of the mega-universe being located within the smallest core of an "instanton". In a certain sense, topologically, this problem resembles the closed two-dimensional surface of a "Klein bottle" (see Figure 5), but comprehending such an inversion of four-dimensional space is not easy.

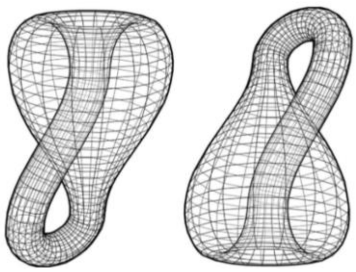


**Fig. 5:** Klein's bottle and anti-bottle

A possible solution to this problem is that, for example, an expression like (71) can also be written in reverse order:

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1 - \frac{r_1+r_2+\cdots+r_{10}}{r} + \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2 = \quad (192)$$
$$= 1 + \left(1-\frac{r_1}{r}+\frac{r^2}{r_2^2}\right) - \left(1+\frac{r_2}{r}-\frac{r^2}{r_3^2}\right) + \left(1-\frac{r_3}{r}+\frac{r^2}{r_4^2}\right) - \left(1+\frac{r_4}{r}-\frac{r^2}{r_5^2}\right) + \left(1-\frac{r_5}{r}+\frac{r^2}{r_6^2}\right) - \left(1+\frac{r_6}{r}-\frac{r^2}{r_7^2}\right) + \left(1-\frac{r_7}{r}+\frac{r^2}{r_8^2}\right) -$$
$$- \left(1+\frac{r_8}{r}-\frac{r^2}{r_9^2}\right) + \left(1-\frac{r_9}{r}+\frac{r^2}{r_{10}^2}\right) - \left(1+\frac{r_{10}}{r}-\frac{r^2}{r_1^2}\right).$$

Ex. (192) and all other Exs. (72) – (44) and (134) – (137), written in reverse order, require further consideration. In any case, at this stage of research, the problem of "Big in Small" remains unsolved.

**5 Picoscopic level of organization of "corpuscles" and "anticorpuscles"**

We will begin our consideration of metric-dynamic models of "corpuscles" and "anticorpuscles" at the level of elementary "particles," as these have been studied most extensively. That is, we will first consider stable spherical vacuum formations with characteristic core radii of the order of $r_6$ ~ $10^{-13}$ – $10^{-11}$ cm (i.e., picoscopic size).

At the same time, everything presented in this section regarding picoscopic "corpuscles" and "anticorpuscles" (elementary "particles") is also applicable to the metric-dynamic description of stable vacuum formations ("corpuscles" and "anticorpuscles") at any other scale: "protoquarks," biological "cells," naked "planets" and "stars" (see [12,13]), naked "galaxies," etc. (see [14]).

*5.1 "Electron"*

In Ex. (71)

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1 - \frac{r_1+r_2+\cdots+r_{10}}{r} + \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2. \quad (71')$$

Let's isolate the terms containing $r_6$ ~ $10^{-13}$ cm – the base radius from the radius hierarchy (59), commensurate with the radius of the core of an elementary "particle"

$$g_{00}^{(+a)} = \frac{1}{g_{11}^{(+a)}} = 1 - \frac{r_1+r_2+r_3+r_4+r_5}{r} - \frac{r_6}{r} - \frac{r_7+r_8+r_9}{r} - \frac{r_{10}}{r} + \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_3^2}+\frac{1}{r_4^2}+\frac{1}{r_5^2}\right)r^2 + \frac{r^2}{r_6^2} + \left(\frac{1}{r_7^2}+\frac{1}{r_8^2}+\frac{1}{r_9^2}\right)r^2 + \frac{r^2}{r_{10}^2}. \quad (193)$$

Here we have taken into account that the hierarchical chain must have at least four cores of different scales (see statements (191*a,b*)).

Let's introduce the notation (taking into account the radius hierarchy (59))

$$r_B = r_1 + r_2 + r_3 + r_4 + r_5 \approx r_1, \qquad r_S = r_7 + r_8 + r_9 \approx r_7, \tag{194}$$

$$\frac{1}{r_L^2} \equiv \frac{1}{r_1^2} + \frac{1}{r_2^2} + \frac{1}{r_3^2} + \frac{1}{r_4^2} + \frac{1}{r_5^2} = \frac{r_2^2 r_3^2 r_4^2 r_5^2 + r_1^2 r_3^2 r_4^2 r_5^2 + r_1^2 r_2^2 r_4^2 r_5^2 + r_1^2 r_2^2 r_3^2 r_5^2 + r_1^2 r_2^2 r_3^2 r_4^2}{r_1^2 r_2^2 r_3^2 r_4^2 r_5^2} \approx \frac{1}{r_5^2}, \tag{195}$$

$$\frac{1}{r_F^2} \equiv \frac{1}{r_7^2} + \frac{1}{r_8^2} + \frac{1}{r_9^2} = \frac{r_8^2 r_9^2 + r_7^2 r_9^2 + r_7^2 r_8^2}{r_7^2 r_8^2 r_9^2} \approx \frac{1}{r_9^2}. \tag{196}$$

Substituting the notations (194) – (196) into Exs. (71) – (73), we obtain as a result

(197)

$$g_{00}^{(+a)} = \frac{1}{g_{11}^{(+a)}} = 1 - \frac{r_B + r_6 + r_S + r_{10}}{r} + \left(\frac{1}{r_L^2} + \frac{1}{r_6^2} + \frac{1}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2 = 1 + \left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_F^2}\right) - \left(1 + \frac{r_S}{r} - \frac{r^2}{r_6^2}\right) + \left(1 - \frac{r_6}{r} + \frac{r^2}{r_L^2}\right) - \left(1 + \frac{r_B}{r} - \frac{r^2}{r_{10}^2}\right),$$

$$g_{00}^{(+b)} = \frac{1}{g_{11}^{(+b)}} = 1 + \frac{r_B + r_6 + r_S + r_{10}}{r} - \left(\frac{1}{r_L^2} + \frac{1}{r_6^2} + \frac{1}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2 = 1 + \left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_F^2}\right) - \left(1 - \frac{r_S}{r} + \frac{r^2}{r_6^2}\right) + \left(1 + \frac{r_6}{r} - \frac{r^2}{r_L^2}\right) - \left(1 - \frac{r_B}{r} + \frac{r^2}{r_{10}^2}\right),$$

$$g_{00}^{(+c)} = \frac{1}{g_{11}^{(+c)}} = 1 - \frac{r_B + r_6 + r_S + r_{10}}{r} - \left(\frac{1}{r_L^2} + \frac{1}{r_6^2} + \frac{1}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2 = 1 + \left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_F^2}\right) - \left(1 + \frac{r_S}{r} + \frac{r^2}{r_6^2}\right) + \left(1 - \frac{r_6}{r} - \frac{r^2}{r_L^2}\right) - \left(1 + \frac{r_B}{r} + \frac{r^2}{r_{10}^2}\right),$$

$$g_{00}^{(+d)} = \frac{1}{g_{11}^{(+d)}} = 1 + \frac{r_B + r_6 + r_S + r_{10}}{r} + \left(\frac{1}{r_L^2} + \frac{1}{r_6^2} + \frac{1}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2 = 1 + \left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_F^2}\right) - \left(1 - \frac{r_S}{r} - \frac{r^2}{r_6^2}\right) + \left(1 + \frac{r_6}{r} + \frac{r^2}{r_L^2}\right) - \left(1 - \frac{r_B}{r} - \frac{r^2}{r_{10}^2}\right).$$

We will also rewrite expressions (134) – (137) taking into account the notations (194) – (196)

(198)

$$g_{00}^{(-a)} = \frac{1}{g_{11}^{(-a)}} = -\left(1 - \frac{r_B + r_6 + r_S + r_{10}}{r} + \left(\frac{l}{r_L^2} + \frac{1}{r_6^2} + \frac{f}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2\right) = -1 - \left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_F^2}\right) + \left(1 + \frac{r_S}{r} - \frac{r^2}{r_6^2}\right) - \left(1 - \frac{r_6}{r} + \frac{r^2}{r_L^2}\right) + \left(1 + \frac{r_B}{r} - \frac{r^2}{r_{10}^2}\right),$$

$$g_{00}^{(-b)} = \frac{1}{g_{11}^{(-b)}} = -\left(1 + \frac{r_B + r_6 + r_S + r_{10}}{r} - \left(\frac{l}{r_L^2} + \frac{1}{r_6^2} + \frac{f}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2\right) = -1 - \left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_F^2}\right) + \left(1 - \frac{r_S}{r} + \frac{r^2}{r_6^2}\right) - \left(1 + \frac{r_6}{r} - \frac{r^2}{r_L^2}\right) + \left(1 - \frac{r_B}{r} + \frac{r^2}{r_{10}^2}\right),$$

$$g_{00}^{(-c)} = \frac{1}{g_{11}^{(-c)}} = -\left(1 - \frac{r_B + r_6 + r_S + r_{10}}{r} - \left(\frac{l}{r_L^2} + \frac{1}{r_6^2} + \frac{f}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2\right) = -1 - \left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_F^2}\right) + \left(1 + \frac{r_S}{r} + \frac{r^2}{r_6^2}\right) - \left(1 - \frac{r_6}{r} - \frac{r^2}{r_L^2}\right) + \left(1 + \frac{r_B}{r} + \frac{r^2}{r_{10}^2}\right),$$

.

$$g_{00}^{(-d)} = \frac{1}{g_{11}^{(-d)}} = -\left(1 + \frac{r_B + r_6 + r_S + r_{10}}{r} + \left(\frac{l}{r_L^2} + \frac{1}{r_6^2} + \frac{f}{r_F^2} + \frac{1}{r_{10}^2}\right) r^2\right) = -1 - \left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_F^2}\right) + \left(1 - \frac{r_S}{r} - \frac{r^2}{r_6^2}\right) - \left(1 + \frac{r_6}{r} + \frac{r^2}{r_L^2}\right) + \left(1 - \frac{r_B}{r} - \frac{r^2}{r_{10}^2}\right).$$

In metrics (197), we will leave for consideration only those brackets that contain the base radius $r_6 \sim 10^{-13}$ cm. In this case, we obtain the following metric-dynamic model of the "electron$_{10}$" (i.e., on average, a stable convex spherical vacuum formation), which is part of a hierarchical chain consisting of 10 "corpuscles" of different scales:

## "ELECTRON$_{10}$" (199)

is, on average, a spherical, stable, convex, multilayered
vacuum curvature with a signature (+ – – –), consisting of:

### The outer shell of "electron$_{10}$"

in the interval [$r_1$,$r_6$] (Fig. 6a) with a signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 - \frac{r_6}{r} + \frac{r^2}{r_L^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_L^2}\right)} - r^2 (d\theta^2 + \sin^2\theta\, d\phi^2), \tag{200}$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_6}{r} - \frac{r^2}{r_L^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_L^2}\right)} - r^2 (d\theta^2 + \sin^2\theta\, d\phi^2), \tag{201}$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_6}{r} - \frac{r^2}{r_L^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_L^2}\right)} - r^2 (d\theta^2 + \sin^2\theta\, d\phi^2), \tag{202}$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_6}{r} + \frac{r^2}{r_L^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_L^2}\right)} - r^2 (d\theta^2 + \sin^2\theta\, d\phi^2); \tag{203}$$

### The core of "electron$_{10}$"

in the interval [$r_6$,$r_9$] (Fig. 6a) with a signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 + \frac{r_S}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_S}{r} - \frac{r^2}{r_6^2}\right)} - r^2 (d\theta^2 + \sin^2\theta\, d\phi^2), \tag{204}$$

H $$ds_2^{(+---)2} = \left(1 - \frac{r_S}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_S}{r} + \frac{r^2}{r_6^2}\right)} - r^2 (d\theta^2 + \sin^2\theta\, d\phi^2), \tag{205}$$

V $$ds_3^{(+---)2} = \left(1+\frac{r_S}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (206)$$

H′ $$ds_4^{(+---)2} = \left(1-\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2); \quad (207)$$

## The substrate

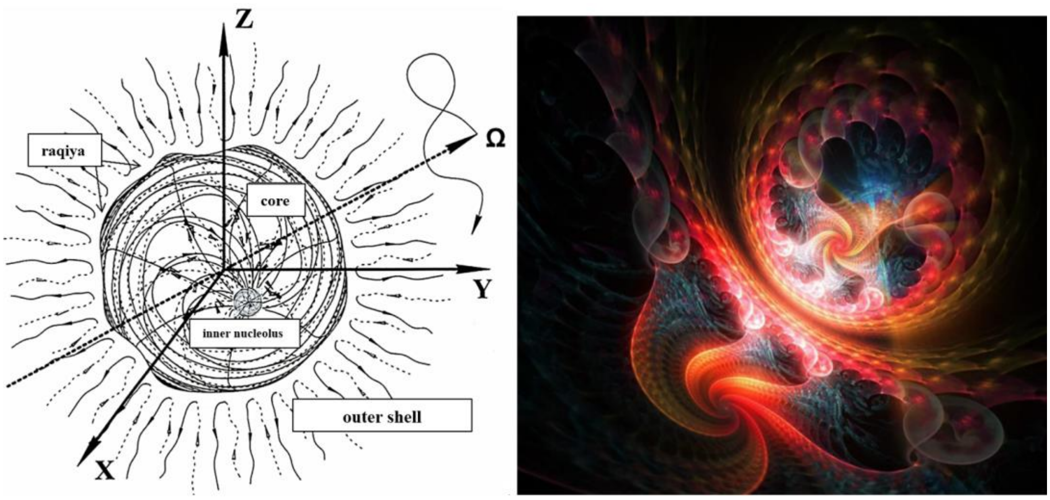
in the interval $[0,\infty]$ with a signature $(+---)$

*i* $$ds_5^{(+---)2} = c^2dt^2 - dr^2 - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (208)$$

where, according to notations (194) – (196) and the radius hierarchy (59):
$r_S \approx r_7 \sim 10^{-24}$ cm is a radius commensurate with the radius of the "proto-quark" core;
$r_L \approx r_5 \sim 10^{-3}$ cm is a radius commensurate with the radius of a "biological "cell."

The index 10 in the name of the corpuscle "ELECTRON$_{10}$" signifies that its core is part of a hierarchical chain consisting of 10 cores of "corpuscles" of different scales (see Figures 2 or 3). If this "corpuscle" were part of only, for example, a hierarchical chain of 6 "corpuscles", its name would be "ELECTRON$_6$."

Based on the analysis of the set of metric solutions (200) – (208) of Einstein's second vacuum equation using the methods of Geometricized Vacuum Physics based on the Algebra of Signature (GVPh&AS), a visualized model of the "electron$_{10}$" as a stable spherical vacuum formation (a picoscopic "corpuscle") was compiled in the articles [7,8,9]. This "corpuscle" has a clearly defined spherical core (see Figure 6), the periphery of which is strongly deformed (stretched). Towards the center of the core, the vacuum deformations decrease practically to zero, but in the vicinity of the center of the core, the vacuum again stretches almost to infinity around the inner nucleolus (the core of the "proto-quark", see Figure 6a). The zero components of the metric tensors from the solution metrics (200) – (208) describe the accelerated motions of the vacuum layers, which are intertwined into bundles and wrapped in spirals (Fig. 6b). Some vacuum layers flow from the periphery of the core along spirals toward the inner nucleolus, while other layers flow from the inner nucleolus toward the periphery of the core along reverse spirals (see [7,8,9]). Outside the core (i.e., in the outer shell of the "electron$_{10}$"), all these deformations and vacuum flows are repeated, but in this case the inner nucleolus is the core of the "electron$_{10}$," and the outer spherical periphery is, for example, the core of a "biological cell" (see [7,8,9]).




a) b)

**Fig. 6:** Illustration of a metric-dynamic model of a stable spherical vacuum formation (in particular, an "electron$_{10}$") , in the vicinity of its core with four clearly defined regions:
**The core** of the "corpuscle" (i.e., a stable spherical vacuum formation) (in particular, an "electron$_{10}$") is the central closed spherical region of vacuum with a base radius from the (59) hierarchy (in particular, $r_6 \sim 10^{-13}$ cm);
**The outer shell** of the "corpuscle" (in particular, an "electron$_{10}$") is the vacuum region surrounding its core. The outer shell of the "corpuscle" extends from its core to the inner boundaries of a significantly larger core of the next-largest "corpuscle" (for example, from the core of an "electron$_{10}$" to the inner boundary of the core of a "biological cell"), within which this core is located (Fig. 3);
**The raqiya** of a "corpuscle" (in particular, of an "electron$_{10}$") is a multilayered spherical abyss-crack separating the core of the corpuscle (in particular, of an "electron$_{10}$") from its outer shell (see §6 and § 4.11 [8]);
**The inner nucleolus** of a "corpuscle" (in particular, the core of a proto-quark) is a small closed spherical region of vacuum within the core of the "corpuscle" (in particular, within the core of an "electron$_{10}$");
**The substrate** of a "corpuscle" is a kind of memory of the initial, undeformed state of the vacuum region in which the "corpuscle" is located. That is, it is the original vacuum region before it was deformed and assumed the stable shape of a convex "corpuscle" or a concave "anticorpuscle," in particular, of an "electron$_{10}$" or "positron$_{10}$".

*5.2 "Positron"*

In metrics (198), we will retain for the purposes of this discussion only those brackets that contain the base radius $r_6 \sim 10^{-13}$ cm. This yields the following metric-dynamic model of a "positron$_{10}$" (i.e., an average stable concave spherical vacuum formation), which is part of a hierarchical chain consisting of 10 "anticorpuscle" cores of different scales (see Figure 3b):
positron$_{10}$

**"POSITRON$_{10}$"** (209)

is, on average, a spherical, stable, concave, multilayered
vacuum curvature with a signature (– + + +), consisting of:

**The outer shell of "positron$_{10}$"**

in the interval $[r_1, r_6]$ (Fig. 6a) with a signature (– + + +)

I $$ds_1^{(-+++)2} = -\left(1-\frac{r_6}{r}+\frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_6}{r}+\frac{r^2}{r_L^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (210)$$

H $$ds_2^{(-+++)2} = -\left(1+\frac{r_6}{r}-\frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_6}{r}-\frac{r^2}{r_L^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (211)$$

V $$ds_3^{(-+++)2} = -\left(1-\frac{r_6}{r}-\frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_6}{r}-\frac{r^2}{r_L^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (212)$$

H′ $$ds_4^{(-+++)2} = -\left(1+\frac{r_6}{r}+\frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_6}{r}+\frac{r^2}{r_L^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2); \quad (213)$$

**The core of "positron$_{10}$"**

in the interval $[r_6, r_9]$ (Fig. 6a) with a signature (– + + +)

I $$ds_1^{(-+++)2} = -\left(1+\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (214)$$

H $$ds_2^{(-+++)2} = -\left(1-\frac{r_S}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_S}{r}+\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (215)$$

V $$ds_3^{(-+++)2} = -\left(1+\frac{r_S}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (216)$$

H′ $$ds_4^{(-+++)2} = -\left(1-\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_S}{r}-\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2+\sin^2\theta\, d\phi^2); \quad (217)$$

**The substrate**

in the interval $[0,\infty]$ with a signature (– + + +)

*i* $$ds_5^{(+---)2} = -c^2dt^2 + dr^2 + r^2(d\theta^2+\sin^2\theta\, d\phi^2). \quad (218)$$

The «corpuscles»: "electron$_{10}$" (i.e., a stable spherical convexity of the vacuum with a picoscopic core) and "positron$_{10}$" (i.e., a stable spherical concavity of the vacuum with a picoscopic core) are complete antipodal copies of each other. Indeed, if we add the metrics (200) – (208) to the corresponding metrics (210) – (218), we obtain the original zero. In other words, if "electron$_{10}$" and "positron$_{10}$" occupy the same region of space, they must annihilate (disappear), i.e., the convexity must fill the concavity.

If the core of an "electron$_{10}$" and core of a "positron$_{10}$" are located in different places in space, then intra-vacuum (subcontt – antisubcont) currents circulate between their raqiya (i.e., spherical abyssal cracks surrounding their cores), i.e., Coulomb interaction takes place (see §10 in [9]).

## 6. Raqiya of a "corpuscles" (in particular, "electron")

Let's consider the outer shell of an "electron$_{10}$" near its core (i.e., for $r \geq r_6$) (see Figure 6a). In this vacuum region, $r_L \approx r_5 \sim 10^{-3}$ cm is ten orders of magnitude larger than the radius of the core under consideration, $r_6 \sim 10^{-13}$ cм cm. Therefore, in this case, the terms $r_6^2/r_L^2$ in metrics (200) – (203) can be neglected. Then, the metric-dynamic description of this vacuum region is simplified on average.

**The outer shell of "electron$_{10}$"**

in the vicinity of its core in the interval ($r \geq r_6 \sim 10^{-13}$ cm) (Fig. 6a)

I $$ds_1^{(+)2} = \left(1-\frac{r_6}{r}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_6}{r}\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (219)$$

H $$ds_2^{(+)2} = \left(1+\frac{r_6}{r}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_6}{r}\right)} - r^2(d\theta^2+\sin^2\theta\, d\phi^2), \quad (220)$$

The metric-dynamic description (i.e., deformations and intra-vacuum currents) in this vacuum region, based on averaging metrics (219) and (220), is given in §2.2 of [9].

In this section, we will be interested in the raqiya (i.e., spherical abyss-crack) separating the core of the "electron$_{10}$" from its outer shell ($r \approx r_6$).

From the result of averaging metrics (219) and (220)

$$ds_{12}^{(+)2} = \frac{1}{2}\left(ds_1^{(+)2} + ds_2^{(+)2}\right) = c^2dt^2 - \frac{r^2}{r^2 - r_6^2}dr^2 - r^2d\theta^2 - r^2 \sin^2\theta \, d\phi^2 \quad (221)$$

it is obvious that the $r \approx r_6$ component of the averaged metric tensor $g_{11}^{(+)}$ tends to infinity

$$\lim_{r \to r_6} g_{11} = \lim_{r \to r_6} \frac{r^2}{r^2 - r_6^2} = \infty. \quad (222)$$

This means that the relative elongation of the local part of the outer side of the vacuum at $r \approx r_6$ also tends to infinity (see Ex. (28) in [9])

$$l_r^{(+)} = \frac{\Delta r}{r} = \sqrt{1 + \frac{g_{11}^{(+)} - g_{110}^{(+)}}{g_{110}^{(+)}}} - 1 = \sqrt{\frac{r^2}{r^2 - r_6^2}} - 1, \quad (223)$$

where $g_{110}^{(+)}$ is the unit component of the metric tensor of the initial metric (208), which stores the "memory" of the state of the vacuum until its curvature.

The result calculated according to the formula (223) is presented in Figure 7. It can be seen from the graph that at $r \approx r_6$ the relative elongation of the vacuum tends to infinity. Usually in physics it is considered that if some quantity tends to infinity, then it is equivalent to a logical error (paradox). However, within the framework of the hierarchical cosmological model, there are logical grounds for solving this problem.

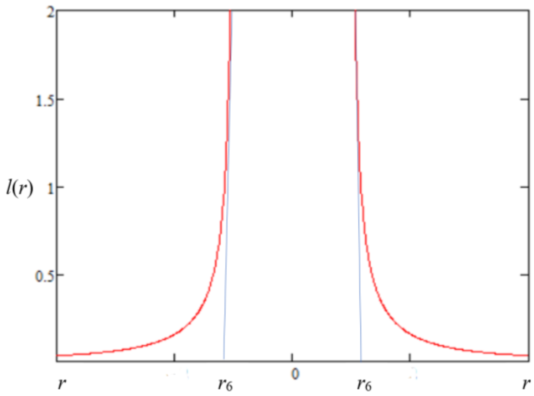


**Fig. 7:** Graphic functions (223) $l_r^{(+)} = \frac{\Delta r}{r}$

In the simplified case, the radius of the spherical abyss-crack $r_g$ can be estimated by equating to zero the zero component $g_{00}^{(+)}$ from the metric (219)

$$1 - \frac{r_6}{r_g} = 0, \quad (224)$$

from where it follows that when simplifying the core and the outer shell of the "electron10", one layer of radium with a radius of $r_g \approx r_6$ is separated.

However, in a more detailed consideration, it is necessary to use zero components of metric tensors from all four metrics (200) – (203). Then the radii of the spherical layers, which are part of the outer side of the raqiya (i.e. the spherical abyss-crack) $r_g$ is determined by four expressions

$$1 - \frac{r_6}{r_g} + \frac{r_g^2}{r_L^2} = 0, \quad 1 + \frac{r_6}{r_g} - \frac{r_g^2}{r_L^2} = 0, \quad 1 - \frac{r_6}{r_g} - \frac{r_g^2}{r_L^2} = 0, \quad 1 + \frac{r_6}{r_g} + \frac{r_g^2}{r_L^2} = 0, \quad (225)$$

which can be represented as cubic equations

$$r_g^3 + r_L^2 r_g - r_L^2 r_6 = 0. \quad r_g^3 - r_L^2 r_g - r_L^2 r_6 = 0, \quad r_g^3 - r_L^2 r_g + r_L^2 r_6 = 0, \quad r_g^3 + r_L^2 r_g + r_L^2 r_6 = 0. \quad (226)$$

Each of these cubic equations, as is known, has three roots $r_{g1}$, $r_{g2}$, $r_{g3}$ (which are determined by the Tartaglia-Cardano formula). This means that the rakiya (spherical chasm-crack), which separates the outer shell of "electron 10" from its core, is divided into 12 spherical layers with radii $r_{g1}$, $r_{g2}$, $r_{g3}$, …,$r_{g12}$, which are the roots of cubic Eqs. (226).

In turn, the core of "electron$_{10}$" is separated from its outer shell by 12 more spherical layers on the inner side of the raqiya, the radii of which $r_{hi}$ are determined by setting to zero the zero components of the metric tensors from four metrics (204) – (207)

$$1+\frac{r_S}{r_h}-\frac{r_h^2}{r_6^2}=0, \quad 1-\frac{r_S}{r_h}+\frac{r_h^2}{r_6^2}=0, \quad 1-\frac{r_S}{r_h}-\frac{r_h^2}{r_6^2}=0, \quad 1+\frac{r_S}{r_h}+\frac{r_h^2}{r_6^2}=0. \tag{227}$$

or by cubic equations

$$r_h^3+r_6^2r_h-r_6^2r_S=0, \quad r_h^3-r_6^2r_h-r_6^2r_S=0, \quad r_h^3-r_6^2r_h+r_6^2r_S=0, \quad r_h^3+r_6^2r_h+r_6^2r_S=0, \tag{228}$$

the roots of which are 12 radii $r_{h1}$, $r_{h2}$, $r_{h3}$, …,$r_{h12}$ of the inner spherical layers of the rock.

For example, we will give one of the roots of the first cubic equation $r_h^3+r_6^2r_h-r_6^2r_S=0$ from (228), calculated by the Tartaglia-Cardano formula using the DeepSeek neural network

$$r_{h1}=\sqrt[3]{\frac{r_6^2r_S}{2}+r_6^2\sqrt{\frac{r_S^2}{4}+\frac{r_6^2}{27}}}+\sqrt[3]{\frac{r_6^2r_S}{2}-r_6^2\sqrt{\frac{r_S^2}{4}+\frac{r_6^2}{27}}}$$

Thus, within the framework of the Hierarchical cosmological model, the core of the "electron$_{10}$" is separated from its outer shell by a raqiya (i.e. spherical abyss-crack), consisting of 12 outer + 12 inner = 24 attached spherical layers (see Figure 8).

**Fig. 8:** Fractal illustrations of multi-layered raqiya (i.e., spherical abyss-crack), separating core of a "corpuscle" (in particular, "electron$_{10}$") from its outer shell

Figure 8 presents an attempt to illustrate the multilayered environment of the core of the "corpuscle" (in particular, the raqiya of the "electron$_{10}$"). Here, the property of fractals to reflect the manifestations of nature is exploited. Benoit Mandelbrot discovered that fractals visualize the essence of many aspects of reality.

Let's note another important circumstance. Since the core of the "electron$_{10}$" under consideration is part of a 10-level (i.e., links) hierarchical chain, then, according to notations (194) and (195) we have

$$r_S = r_7 + r_8 + r_9, \quad (229)$$

$$r_L \equiv \sqrt{\frac{r_1^2 r_2^2 r_3^2 r_4^2 r_5^2}{r_2^2 r_3^2 r_4^2 r_5^2 + r_1^2 r_3^2 r_4^2 r_5^2 + r_1^2 r_2^2 r_4^2 r_5^2 + r_1^2 r_2^2 r_3^2 r_5^2 + r_1^2 r_2^2 r_3^2 r_4^2}}. \quad (230)$$

Therefore, substituting Exs. (229) and (230) into Eqs. (226) and (228), we discover that the spherical layers of the raqiya of the "electron$_{10}$" (see Figure 8) are connected to all other spherical formations that make up the hierarchical chain: to the closed "Universe," to the "galaxy's" core, to the "planet's" core, to the "biological cell," within which the "electron's$_{10}$" core is located, as well as to the "proto-quark's" core, to the "plankton's" core, and to the "proto-plankton's" core, all of which are located within the "electron's$_{10}$" core (see Figure 3a).

If the radii of the cores of "corpuscles" in hierarchy (59) change over time (for example, due to the expansion of the Universe), then, according to the views developed here, the properties of the raqiya (i.e., the environment) of the cores of all "corpuscles" of different scales, including the raqiya surrounding the "electron's$_{10}$" core, should also change.

Today, the radius of the observable "Universe" is very large ($r_2 \sim 10^{29}$ cm), so we have neglected the terms $r^2/r_2^2$ in metrics (200) – (207). However, if the Universe is gradually expanding at an accelerating rate, it is possible that its radius was previously small. In this case, the "electron's$_{10}$" raqiya should have a noticeable spherical layer associated with the early Universe. This could influence the properties of the "electron." Therefore, it is important to keep in mind that the "electron" could have changed during the evolution of the Universe.

In addition to the multilayered nature of the raqiya surrounding the core of the "corpuscle" (in particular, the "electron$_{10}$"), in this region there is also a paradoxical infinite stretching of the vacuum (as shown in Fig. 7). Within the framework of Riemann's differential geometry, this problem is unsolvable. Perhaps this task will be solved as a result of expanding the mathematical apparatus of differential geometry, for example, by taking into account not only curvature, but also torsion, displacement, and other distortions of space.

To outline one way to resolve the problem of infinite vacuum expansion in the region of the "corpuscle's" raqiya, let's consider the property of the "Koch curve" fractal (see Figure 9a). This fractal has the following property: if the length of the initial Koch segment is 1, then the length of the $n$-th iteration of this fractal is $(4/3)^{n-1}$. Therefore, the length of the Koch curve at $n = \infty$ tends to infinity.

a) b) c)

**Fig. 9:** a) The first six iterations of the "Koch curve" fractal; b) Increasing line irregularities as approaches the core (Prokhorov-Lebedev diagram); c) Fractal illustration of the increasingly complex vacuum curvature in the "corpuscle's" raqiya as approaches its core, due to increasing finesse of the irregularities and decreasing radii of turbulent distortions.

It should be expected that in the raqiya's region (i.e., at $r \approx r_6$), the radial stretching of the vacuum is due to a decrease in the scale of irregularities (see Figure 9 *b,c*), similar to the decrease in the scale of irregularities in the "Koch curve" as the number of iterations increases (see Figure 9a).

Furthermore, §2.2 in [9] shows that in the region of the "corpuscle" cavity, the velocity of intra-vacuum currents moving along spirals reaches the speed of light, which may be accompanied by a transition from laminar to turbulent flow.

Thus, in the region of the "corpuscle's" raqiya, all three factors may be present: multilayering; an increase in the finer refinements of fluctuations (similar to the "Koch curve" fractal); and turbulent instability of vacuum currents with an increase in their velocity as they approach the core. Therefore, it should be expected that in the corpuscle's" raqiya (i.e., in the vicinity of the spherical abyss-crack surrounding the core, in particular, of the "electron"), the vacuum is in a state of extremely complex interweaving (see Figures 8, 9, 10).

*The increasing fragility and finer grainedness turbulence of the vacuum stretching in the vicinity of the abyss-crack (raqiya) are associated, on the one hand, with an increase in entropy (i.e., uncertainty), and on the other, with a densification of information (as a measure of the removed uncertainty). As we approach the abyss, we encounter questions that were partly discussed during the "Black Hole War" between Stephen Hawking and Leonard Susskind.*

Within the framework of the hierarchical cosmological model developed here, the most complex raqiya's inter-actions are at the periphery of the largest "corpuscle" (i.e., the mega-Universe) and the smallest corpuscle (i.e., the "instanton's" core), since all hierarchical chains begin with the mega-Universe's core (with a radius of $r_{10} \sim 10^{39}$ cm) and end at the "instanton's" core (with a radius of $r_{10} \sim 10^{-55}$ cm), while hierarchical antichains begin with the "instanton" core and end at the mega-Universe core. Therefore, in the vicinity of these cores (i.e., in their interactions), there is an infinite number of intertwined layers. The situation, however, is complicated by the fact that, within the framework of the Hierarchical cosmological model, the mega-Universe is located in the "instanton's" core.

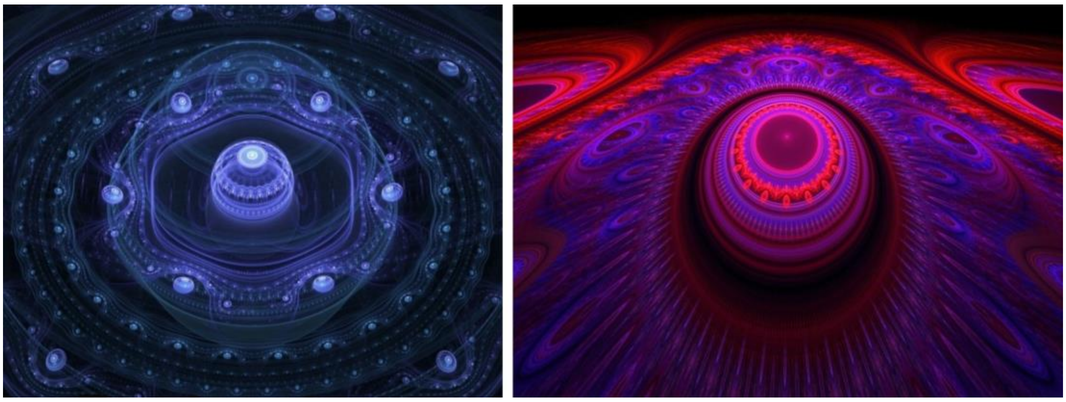
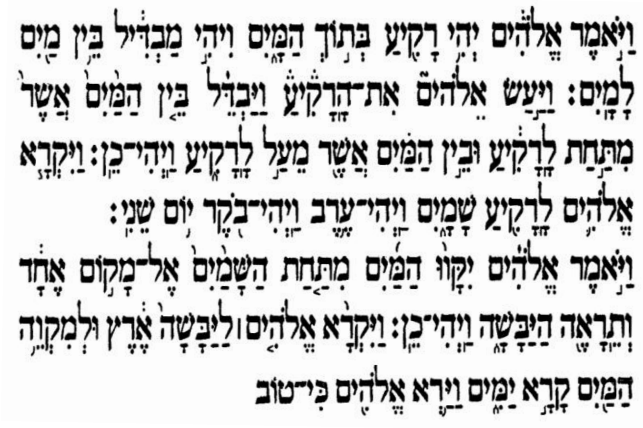


**Fig. 10:** Fractal illustrations of a raqiya (i.e., a spherical abyss-crack) surrounding the core of a "corpuscle," specifically, an "electron$_{10}$"

The concept of raqiya (רקיע) is taken from the TORAH, Genesis 1:6 -13 (or the Bible, Genesis 1:6-13), which describes the creation of spherical vaults among the upper and lower waters during the Second Day of CREATION:

***And* אלהימ *(GOD) Said: 'Let there be* רקיע *(raqiya) in the midst of the* המים *(ha-maim - ה(5)-waters) and let it be a division between the* מים *(maim - waters) and the* למים *(lo-maim - counter-waters)'. And GOD Created* הרקיע *(5- raqiya) and Separated the 5-waters under the* לרקיע *(ל - raqiya) from the 5-waters above the* לרקיע *(ל - raqiya), and it was so. GOD called* לרקיע *(ל - raqiya)* שמים *(sky), and there was Evening and there was Morning – the Second Day. And GOD said: Let the 5-waters under the 5-heavens (raqiya) flow into one place, and let the* היבשה *(dry land) become visible. And it was so. And GOD called the dry land Earth, and the mikvah 5-waters HE called 10-waters. And GOD Saw that it was Good***


ויאמר אלהים יהי רקיע בתוך המים ויהי מבדיל בין מים
למים: ויעש אלהים את־הרקיע ויבדל בין המים אשר
מתחת לרקיע ובין המים אשר מעל לרקיע ויהי־כן: ויקרא
אלהים לרקיע שמים ויהי־ערב ויהי־בקר יום שני:
ויאמר אלהים יקוו המים מתחת השמים אל־מקום אחד
ותראה היבשה ויהי־כן: ויקרא אלהים ׀ ליבשה ארץ ולמקוה
המים קרא ימים וירא אלהים כי־טוב

**7 Picoscopic "quarks" and "antiquarks"**

*Further, to shorten the notation, we will omit the subscript in the names of "corpuscles" and "anticorpuscles." For example, instead of "electron$_k$" and "positron$_k$" we will henceforth write "electron" and "positron" without subscripts. However, we will note that the "corpuscles" and "anticorpuscles" under study are part of some hierarchical chain.*

In the framework of "Geometrized Vacuum Physics based on the Algebra of Signature " (GVPh&AS) [3,4,5,6,7,8,9, 10,11,12,13,14,15,16], in our opinion, a method has been successfully applied in which all possible solutions of the Einstein vacuum equation related to the same region of space are taken, then these solutions are averaged to determine the average vacuum deformation in this region and twisted (using Clifford algebra) to determine the distribution of velocities and accelerations of intra-vacuum currents (flows) in the same region.

Since averaging the metric solutions of the same Einstein vacuum equation leads to positive results, then within the framework of the theory developed here, it is proposed to take the following step: to consider unstable convex-concave spherical formations, the additive combination (i.e. averaging) of which again, on average, leads to stable convex or concave vacuum formations.

As shown above, the metric-dynamic model of the "electron" is defined by the solution metrics (200) – (208) of Einstein's second vacuum equation $R_{ik} + g_{ik}\Lambda = 0$. All these metrics have the same signature (+ – – –), which defines the topological properties of the convex vacuum structure. The metric-dynamic model of the "positron" is defined by the same metrics (210) – (218), but with the opposite signature (– + + +), which corresponds to the stable concavity of the vacuum.

An unstable convex-concave vacuum state can be defined by the same metrics as the "electron" or "positron," but with any signature other than (+ – – –) and (– + + +):

$$\begin{matrix} (++++) & (+++-) & (-++-) & (++-+) \\ (---+) & (+---) & (--++) & (-+-+) \\ (+--+) & (++--) & (-+++) & (+-++) \\ (--+-) & (+-+-) & (-+--) & (----) \end{matrix} \qquad (231)$$

Below is Table 1 with the conventional names of colored "quarks" and "antiquarks."

Table 1 – Signatures of colored "quarks" and "antiquarks"

| Signature type, i.e. number of + and – | Signatures of «quarks$_k$» | | Signatures of «antiquarks$_k$» | | Color "quark" or "antiquark" |
|---|---|---|---|---|---|
| | 10 metrics of the type (232) with signature: | Designation $x_i^+$-"quark$_k$" | 10 metrics of the type (232) with signature: | Designation $x_i^-$-"antiquark$_k$" | |
| 1–3 | (+ – – –) | $e_y^+$-"quark$_k$" («electron») | (– + + +) | $e_y^-$-"antiquark$_k$" («positron») | yellow |
| 1–3 | (+ + + –) | $d_r^+$ -"quark$_k$" | (– – – +) | $d_r^-$-"antiquark$_k$" | red |
| | (+ + – +) | $d_g^+$ -"quark$_k$" | (– – + –) | $d_g^-$-"antiquark$_k$" | green |
| | (+ – + +) | $d_b^+$-"quark$_k$" | (– + – –) | $d_b^-$-"antiquark$_k$" | blue |
| 2–2 | (+ – – +) | $u_r^+$-"quark$_k$" | (– + + –) | $u_r^-$-"antiquark$_k$" | red |
| | (+ – + –) | $u_g^+$ -"quark$_k$" | (– + – +) | $u_g^-$-"antiquark$_k$" | green |
| | (+ + – –) | $u_b^+$-"quark$_k$" | (– – + +) | $u_b^-$-"antiquark$_k$" | blue |
| 4 | (+ + + +) | $i_w^+$-"quark$_k$" | (– – – –) | $i_w^-$-"antiquark$_k$" | white |

*Where the index k in the name of a "quark$_k$" or "antiquark$_k$" depends on how many "corpuscles" are in the hierarchical chain of particles in the vacuum structure. Within the framework of the 10-level hierarchical cosmological model developed here, this index can take the values k = 4,6,8,10.*

The metric-dynamic models of 16 picoscopic "quarks" and "antiquarks" are defined by sets of 10 metrics of the type (200) – (208) or (210) – (218), but with the corresponding signature from Table 1. As an example, we present the $u_r$-antiquark in expanded form:

## $u_{г}^{-}$-"ANTIQUARK" (232)

unstable "convex-concave" multilayer curvature of vacuum
with signature (– + + –), consisting of:

**The outer shell of the $u_{г}^{-}$-"antiquark"**

in the interval $[r_1, r_6]$, with signature (– + + –)

I $$ds_1^{(-++-)2} = -\left(1 - \frac{r_6}{r} + \frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_L^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2, \quad (233)$$

H $$ds_2^{(-++-)2} = -\left(1 + \frac{r_6}{r} - \frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_L^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2, \quad (234)$$

V $$ds_3^{(-++-)2} = -\left(1 - \frac{r_6}{r} - \frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_L^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2, \quad (235)$$

H′ $$ds_4^{(-++-)2} = -\left(1 + \frac{r_6}{r} + \frac{r^2}{r_L^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_L^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2; \quad (236)$$

**The core of the $u_{г}^{-}$-"antiquark"**

in the interval $[r_6, r_7]$, with signature (– + + –)

I $$ds_1^{(-++-)2} = -\left(1 + \frac{r_S}{r} - \frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_S}{r} - \frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2, \quad (237)$$

H $$ds_2^{(-++-)2} = -\left(1 - \frac{r_S}{r} + \frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_S}{r} + \frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2, \quad (238)$$

V $$ds_3^{(-++-)2} = -\left(1 + \frac{r_S}{r} + \frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_S}{r} - \frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2, \quad (239)$$

H′ $$ds_4^{(-++-)2} = -\left(1 - \frac{r_S}{r} - \frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_S}{r} - \frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2 sin^2\,\theta\, d\phi^2; \quad (240)$$

**The substrate of the $u_{г}^{-}$-"antiquark"**

in the interval [0, ∞]], with signature (– + + –)

*i* $$ds_5^{(-++-))2} = -c^2dt^2 + dr^2 + r^2d\theta^2 - r^2\, sin^2\,\theta\, d\phi^2 \quad (241)$$

The metric-dynamic models of all other "quarks" and "antiquarks" are similar to (233) – (241), but with the signatures presented in Table 1.

Except for the convex "electron" (i.e., the $e_{у}^{-}$-"quark") with the signature (+ – – –) and the concave "positron" ($e_{у}^{-}$–-"antiquark") with the signature (– + + +), all other "quarks" and "antiquarks" are unstable convex-concave vacuum entities, since metrics, for example, of the form (233) – (241) with the signature (– + + –), are not solutions of Einstein's second vacuum equation $R_{ik} + g_{ik}\Lambda = 0$ (i.e., they do not satisfy the stability conditions or conservation laws). Indeed, substituting the components of metric tensors from metrics of the form (233) – (241) with any other signature from the matrix (231) except (+ – – –) and (– + + +) into Einstein's second vacuum equation does not lead to equality to zero. This is the reason for confinement, i.e., the reason for the absence of convex-concave "quarks" and "antiquarks" in the free state.

## 8 Metric-dynamical models of the "proton" and "antiproton"

It was shown above that stable convex and concave vacuum structures are described only by sets of metric solutions to Einstein's second vacuum equation with signatures (+ – – –) and (– + + +). However, not only the "electron" (i.e., the $e_{у}^{+}$-"quark") (199) and the "positron" (i.e., the $e_{у}^{-}$-"antiquark") (209) can be spherical stable vacuum structures.

Stable spherical vacuum structures with signatures (+ – – –) or (– + + +) can be composed of two u-"quarks" (or *u*-"antiquarks") of different colors and one d-"quark" (or *d*-"antiquark") from Table 1:

| | | | | | |
|---|---|---|---|---|---|
| $d_{к}^{+}(+\ +\ +\ -)$ | | $d_{з}^{+}(+\ +\ -\ +)$ | | $d_{г}^{+}(+\ -\ +\ +)$ | |
| $u_{з}^{-}(-\ +\ -\ +)$ | (242) | $u_{г}^{-}(-\ -\ +\ +)$ | (243) | $u_{к}^{-}(-\ +\ +\ -)$ | (244) |
| $u_{г}^{-}\underline{(-\ -\ +\ +)}$ | | $u_{к}^{-}\underline{(-\ +\ +\ -)}$ | | $u_{з}^{-}\underline{(-\ +\ -\ +)}$ | |
| $p_1^{-}(-\ +\ +\ +)_+$ | | $p_2^{-}(-\ +\ +\ +)_+$ | | $p_3^{-}(-\ +\ +\ +)_+$ | |

where $p_i^-$ are three possible states of the $p_i^-$-"proton" (*i* = 1, 2, 3) with the signature (– + + +).

| | | | | | |
|---|---|---|---|---|---|
| $d_{к}^{-}(-\ -\ -\ +)$ | | $d_{з}^{-}(-\ -\ +\ -)$ | | $d_{г}^{-}(-\ +\ -\ -)$ | |
| $u_{з}^{+}(+\ -\ +\ -)$ | (245) | $u_{г}^{+}(+\ +\ -\ -)$ | (246) | $u_{к}^{+}(+\ -\ -\ +)$ | (247) |
| $u_{г}^{+}\underline{(+\ +\ -\ -)}$ | | $u_{к}^{+}\underline{(+\ -\ -\ +)}$ | | $u_{з}^{+}\underline{(+\ -\ +\ -)}$ | |
| $p_1^{+}(+\ -\ -\ -)_+$ | | $p_2^{+}(+\ -\ -\ -)_+$ | | $p_3^{+}(+\ -\ -\ -)_+$ | |

where $p_i^+$ are three possible states of the $p_i^+$-"antiproton" (*i* = 1, 2, 3) with the signature (– + + +).

Indeed, if we add the + and – signs in the numerators of the ranking expressions (242) – (247) column by column, then the denominators of these expressions yield the signature signs (+ – – –) or (– + + +).

In a more compact form, the $p_i^-$-"proton" and $p_i^+$-"antiproton" states can be written as is customary in quantum chromodynamics.

$$p_1^- = u_g^- u_b^- d_r^+,\quad p_2^- = u_r^- u_b^- d_g^+,\quad p_3^- = u_g^- u_r^- d_b^+, \tag{248}$$

$$p_1^+ = u_g^+ u_b^+ d_r^-,\quad p_2^+ = u_r^+ u_b^+ d_g^-,\quad p_3^+ = u_g^+ u_r^+ d_b^-. \tag{249}$$

The difference, however, is that in the Standard Model, protons are composed of quarks, and antiprotons are composed of antiquarks, whereas in the Algebra of Signature, the $p_i^-$-"proton" and pi+ "antiproton" are composed of a mixture of both "quarks" and "antiquarks." Therefore, in Algebra of Signature, "matter" (more precisely, spherical convex vacuum entities) and "antimatter" (spherical concave vacuum anti-entities) are mixed, and the problem associated with the baryon asymmetry of the Universe is eliminated.

For example, let's imagine a multilayer metric-dynamical model of the $p_1^-$-"proton" (242).

$d_к^+$(+ + + –)
$u_з^-$(– + – +)
$u_г^-$(– – + +)
$p_1^-$(– + + +) $_+$

in expanded form:

## $P_1^-$-"PROTON" (250)

a stable, on average, concave, multilayered, spherical vacuum formation
with a common signature of (– + + +), consisting of:

### $d_r^+$-"quark"

unstable "convex-concave" multilayer curvature of vacuum
with signature: (+ + + –), consisting of:

**The outer shell of the $d_r^+$-"quark"** (251)

in the interval $[r_5,r_6]$ (Fig.11) with signature (+ + + –)

$$ds_1^{(+++-)2} = \left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_2^{(+++-)2} = \left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_3^{(+++-)2} = \left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_4^{(+++-)2} = \left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2;$$

**The core of the $d_r^+$-"quark"** (252)

in the interval $[r_6,r_9]$ (Fig.11) with signature (+ + + –)

$$ds_1^{(+++-)2} = \left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_2^{(+++-)2} = \left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_3^{(+++-)2} = \left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_4^{(+++-)2} = \left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2;$$

**The substrate of the $d_r^+$-"quark"** (253)

in the interval $[0,\infty]$, with signature (+ + + –)

$$ds_5^{(+++-)2} = c^2dt^2 + dr^2 + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2;$$

## $u_g^-$-"antiquark"

unstable "convex-concave" multilayer curvature of vacuum
with signature: (– + – +), consisting of:

**The outer shell of the $u_g^-$-"antiquark"** (254)

in the interval $[r_5,r_6]$ (Fig. 11), with signature (– + – +)

$$ds_1^{(-+-+)2} = -\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_2^{(-+-+)2} = -\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_3^{(-+-+)2} = -\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_4^{(-+-+)2} = -\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2;$$

**The core of the $u_g^-$-"quark"** (255)

in the interval $[r_6,r_9]$ (Fig. 11), with signature (– + – +)

$$ds_1^{(-+-+)2} = -\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_2^{(-+-+)2} = -\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_3^{(-+-+)2} = -\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_4^{(-+-+)2} = -\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)}-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2;$$

**The substrate of the $u_g^-$-"quark"** (256)

in the interval [0,∞] (Fig. 11), with signature (– + – +)

$$ds_5^{(-+-+)2} = -c^2dt^2+dr^2-r^2d\theta^2+r^2\sin^2\theta\, d\phi^2;$$

## $u_b^-$-"antiquark"

unstable "convex-concave" multilayer curvature of vacuum
with signature: (– – + +), consisting of:

**The outer shell of the $u_b^-$-"antiquark"** (257)

in the interval $[r_5,r_6]$ (Fig. 11), with signature (– – + +)

$$ds_1^{(--++)2} = -\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)}+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_2^{(--++)2} = -\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)}+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_3^{(--++)2} = -\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)}+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_4^{(--++)2} = -\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)}+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2;$$

**The core of the $u_b^-$-"antiquark"** (258)

in the interval $[r_6,r_9]$, with signature (– – + +)

$$ds_1^{(--++)2} = -\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)}+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_2^{(--++)2} = -\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)}+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_3^{(--++)2} = -\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)}+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2,$$

$$ds_4^{(--++)2} = -\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)}+r^2d\theta^2+\sin^2\theta\, d\phi^2;$$

**The substrate of the $u_b^-$-"antiquark"** (259)

in the interval [0, ∞] (Fig. 11), with signature (– + – +)

$$ds_5^{(--++)2} = -c^2dt^2-dr^2+r^2d\theta^2+r^2\sin^2\theta\, d\phi^2.$$

Here, according to hierarchy (59) and notations (194) and (195), it is assumed that

$r_6 \sim 10^{-13}$ cm, $\quad r_S = r_7 + r_8 + r_9 \approx r_7 \sim 10^{-24}$ cm, $\quad \frac{1}{r_L^2} \equiv \frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_3^2}+\frac{1}{r_4^2}+\frac{1}{r_5^2} \approx \frac{1}{r_5^2} \sim \frac{1}{10^{-6}}$.

Illustration of the metric-dynamic model of the core and the near outer shell of the "proton" based on the analysis of the set of metric solutions (250), carried out using the methods of Geometricized Vacuum Physics based on the Algebra Signature (GVPh&AS) [8,9,10], shown in Figure 11,

When adding up homogeneous terms in metrics (251), (254), and (257) according to the algorithm specified in ranking (242), we obtain, on average, a set of metrics (210) – (214), describing the metric-dynamic state of the outer shell of the "positron". However, inside the "proton's" core, it is necessary to take into account the constant chaotic displacement of the inner nucleolus of the $d_\kappa^+$-"quark" and the inner nucleoli of the $u_g^-$- "antiquark" and $u_b^-$- "antiquark" relative to each other and to the common center $r = 0$ (see Figure 11). The radius of the $p_1^-$-"proton" core, consisting of the cores of two "antiquarks" and one "quark", is greater than the radius of the "positron" core, since their inner nucleoli interact in a complex (chaotic) manner, attracting and repelling each other. Only on average do the centers of these cores coincide with a common center: $<r_з> = 0$, $<r_г> = 0$, $<r_к> = 0$.. Therefore, it is necessary to apply not only a metric-dynamic but also a statistical description of intracore processes, which is partially considered in §4.9 in [8], as well as in [15].

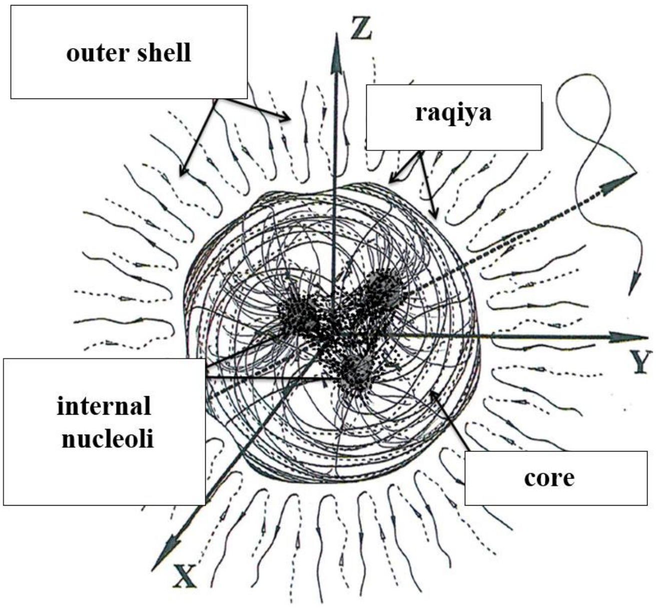



**Fig. 11:** Illustration of a concave on average spherical stable vacuum formation, consisting of two colored "antiquarks" and one "quark" (specifically, a $p_i^-$-"proton" (250)). The inner nuclei of these vacuum formations are in constant, chaotic motion relative to each other and relative to the common center of the $p_i^-$-"proton's" core.

The problem of confinement of three convex-concave spherical formations, for example, the $d_r^+$-"quark", the $u_g^-$-"antiquark", and the $u_g^-$-"antiquark", is solved by itself, since each of them cannot exist separately for long. Only together do they form a stable, on average, "concave" vacuum formation, which we conventionally call the $p_i$-"proton" (Fig. 11).

The interior of the "proton's" core is constantly and rapidly transitioning from one "quark's" state, for example, (242), to another, for example, (244). That is, the "proton" constantly transitions from a state with one composition of colored "quarks" and "antiquarks" to a state with a different composition through the exchange of "gluons" (298) – (299). In other words, the vacuum deformations inside the "proton's" core are constantly and complexly reconstructed. Therefore, in real time, we are dealing with the average state of the "proton".

$$p^- = 1/3\ (p^-_1 + p^-_2 + p^-_3) \qquad (260)$$

or, taking into account (248):

$$p^- = 1/3\ (u^-_g\, u^-_b\, d^+_r \;+\; u^-_r\, u^-_b\, d^+_g \;+\; u^-_g\, u^-_r\, d^+_b). \qquad (261)$$

The set of metric solutions (251) – (259), using the mathematical apparatus of the Algebra of Signatures [3,4,5,6,7,8, 9,10,11], allows us to extract information about a multitude of processes occurring within the core of a "proton" or "antiproton", in its raqiya, and in the outer shell. A more complete geometrized physics of "cores" requires a separate study.

## 9 Metric-dynamic model of the "neutron"

In modern nuclear physics (quantum chromodynamics), the neutron is considered to consist of two d-quarks with charge $(-1/3)e$ and one u-quark with charge $(2/3)e$ (where $e$ is the electron charge).

$$n = ddu. \tag{262}$$

As a result of this combination, the neutron turns out to be an electrically neutral particle with zero total charge: $(-1/3)e + (-1/3)e + (2/3)e = 0$.

In the GVPh&AS, developed here, no stable 3-"quarks" vacuum formation with zero "electric" charge is obtained, since there is no additive combination of three of the 16 signatures:

$$\begin{array}{llll}
(++++) & (+++-) & (-++-) & (++-+) \\
(---+) & (+---) & (--++) & (-+-+) \\
(+--+) & (++--) & (-+++) & (+-++) \\
(--+-) & (+-+-) & (-+--) & (----)
\end{array} \tag{263}$$

which lead to a zero signature (0 0 0 0). As shown in [9], where the nature of electric charge is studied using Algebra of Signature, a zero signature of the averaged metric signifies electrical neutrality.

The desired result (i.e., an average zero "electrical" environment of the vacuum formation core) is achieved in the case of rankings consisting of four signatures. Therefore, within the framework of the theory developed here, an "electrically" neutral corpuscle ("neutron") can have the following topological (nodal) configurations:

$$\begin{array}{llll}
i_w^-\ (----) & i_w^-\ (----) & i_w^-\ (----) & i_w^-\ (----) \\
d_b^+\ (+-++) & d_g^+\ (++-+) & d_b^+\ (+-++) & u_g^-\ (-+-+) \\
u_r^-\ (-++-) & d_r^+\ (+++-) & u_g^-\ (-+-+) & d_b^+\ (+-++) \\
d_g^+\ \underline{(++-+)} & u_b^-\ \underline{(--++)} & d_r^+\ \underline{(+++-)} & d_r^+\ \underline{(+++-)} \\
n_1^0\ (0\ 0\ 0\ 0)_+ & n_2^0\ (0\ 0\ 0\ 0)_+ & n_3^0\ (0\ 0\ 0\ 0)_+ & n_4^0\ (0\ 0\ 0\ 0)_+ \\
 & & & \\
i_w^+\ (++++) & i_w^+\ (++++) & i_w^+\ (++++) & i_w^+\ (++++) \\
d_b^-\ (-+--) & d_g^-\ (--+-) & d_b^-\ (-+--) & u_g^+\ (+-+-) \\
u_r^+\ (+--+) & d_r^-\ (---+) & u_g^+\ (+-+-) & d_b^-\ (-+--) \\
d_g^-\ \underline{(--+-)} & u_b^+\ \underline{(++--)} & d_r^-\ \underline{(---+)} & d_r^-\ \underline{(---+)} \\
n_5^0\ (0\ 0\ 0\ 0)_+ & n_6^0\ (0\ 0\ 0\ 0)_+ & n_7^0\ (0\ 0\ 0\ 0)_+ & n_8^0\ (0\ 0\ 0\ 0)_+
\end{array} \tag{264}$$

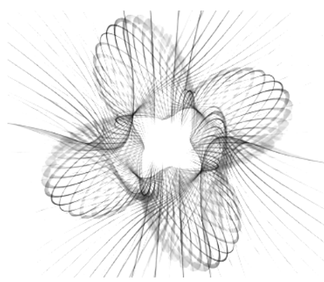
Let's recall that each signature in the rankings (264) corresponds to a "quark" or "antiquark" from Table 1, each of which is described by 10 metrics of the form (233) – (241) with a corresponding signature.

In these rankings, in addition to the colored $d$ and $u$ "quarks" and "antiquarks" known in quantum chromodynamics, there are also exotic white "quarks" and "antiquarks":

$i_w^+$ is a "quark," i.e., 10 metrics of the form (232) with a signature (+ + + +);
$i_w^-$ is an "antiquark," i.e., 10 metrics of the form (232) with a signature (– – – –),
where the index $i$ stands for invisible.

The $i_w^+$-"quark" and $i_w^+$-"quark" are called white because they are virtually invisible inside the "neutron's" core, as from a topological perspective, they represent a "dot" and an "anti-dot" (see §4 in [4]). Perhaps for this reason, their presence in the "neutron's" core was not detected experimentally and was not taken into account in the Standard Model of elementary particles.

Thus, within the framework of the Algebra of signature, the eight possible states of the "neutron" can be represented as rankings (263) or in a more traditional form:



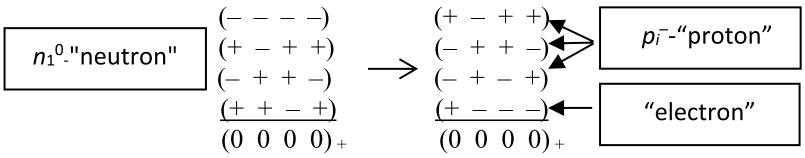
$$n_1^0 = i_w^- d_b^+ d_g^+ u_r^-, \quad n_2^0 = i_w^- d_r^+ d_g^+ u_b^-, \quad n_3^0 = i_w^- d_r^+ d_b^+ u_g^-, \quad n_4^0 = i_w^- d_r^+ d_b^+ u_g^-, \tag{104}$$

$$n_5^0 = i_w^+ d_b^- d_g^- u_r^+, \quad n_6^0 = i_w^+ d_g^- d_r^- u_b^+, \quad n_7^0 = i_w^+ d_b^- d_r^- u_g^+, \quad n_8^0 = i_w^+ d_b^- d_r^- u_g^+.$$

This notation of topological nodes (i.e., "neutron" states) differs from the notation of the neutron's composition in quantum chromodynamics (262) by the presence of indistinguishable $i_w^+$-"quark" and $i_w^+$-"antiquark."

Due to complex intra-core topological metamorphoses, any additive 4-"quark"-"antiquark" ranking combination (265) can rearrange itself so that within the core of a given vacuum formation, a $p_i^-$-"proton" and an "electron" (i.e., a hydrogen "atom") are formed:

(266)




Such a rearrangement (i.e., the binding of a topological knot) within the "neutron's" core can in some cases lead to its decay into a "proton," "electron," and "neutrino":

$n \rightarrow p^- + e^+ + \nu_{e+}$, (267)

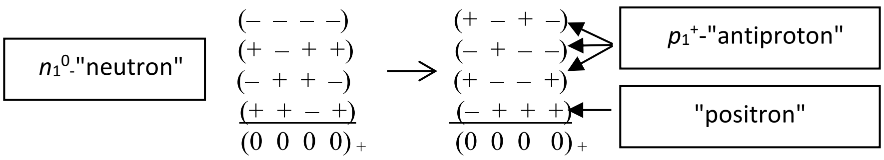
where $\nu_{e+}$ is the electron "neutrino."

Note that in the "Geometrized Vacuum Physics Based on the Algebra of Signature" (GVPh&AS), developed here, the "neutrino" has its own metric-dynamic model. A "neutrino" can either be bound to the corresponding "corpuscle's" core or exist independently (see [10, 11]).

Note that in signature metamorphoses (i.e., in the processes of binding topological knots), the law of conservation of the "+" and "-" signs applies. For example, in the ranking (266) before the transformation there were 8 "+" and 8 "–", and after the transformation there remained 8 "+" and 8 "–".

Intra-core signature (i.e. topological) transformations can also lead to configurations of "quarks" and "antiquarks" in the form of a $p_1^+$-"antiproton" and a "positron" (i.e. an "anti-atom" of hydrogen)

(268)




This could lead to the decay of the "neutron" into a $p_1^+$-"antiproton" and a "positron":

$n \rightarrow p^+ + e^- + \nu_{e-}$, (269)

where $\nu_{e+}$ is the positron "neutrino."

Such decays should be detected in practice. If this prediction of the GVPh&AS is not confirmed, then the reason for the absence of decays of type (269) must be sought.

One such reason could be the following: in the case of a "neutron" transformation of type (266), 10 signs change, while in the case of a transformation of type (268), 12 signs change. A sign change signifies a restructuring of the intranuclear topology (i.e., a change in the convex-concave state of the local vacuum region inside and, possibly, outside the "neutron's" core), which requires energy expenditure. Therefore, the probability of a 10-digit transformation like (266) is less energy-consuming and therefore more probable than a 12-digit transformation like (268).

This apparent asymmetry can be compensated for by considering the transformation of all eight possible states of the "neutron" (264). Furthermore, the lower probability does not exclude the possibility of a decay like (268). Therefore, the prediction of the possibility of a "neutron" decaying not only into a "proton" and "electron," but also into an "antiproton" and "positron" must be thoroughly studied and experimentally verified.

Intra-core vacuum fluctuations are so rapidly variable that, for a macroscopic observer, a "neutron" is the result of averaging all its possible states

(270)

$$n = 1/8\,(n_1^0 + n_2^0 + n_3^0 + n_4^0 + n_5^0 + n_6^0 + n_7^0 + n_8^0) =$$

$$= 1/8\,(i_w^- d_b^+ d_g^+ u_r^- + i_w^- d_r^+ d_g^+ u_b^- + i_w^- d_r^+ d_b^+ u_g^- + i_w^- d_r^+ d_b^+ u_g^- + i_w^+ d_b^- d_g^- u_r^+, + i_w^+ d_g^- d_r^- u_b^+, + i_w^+ d_b^- d_r^- u_g^+ + i_w^+ d_b^- d_r^- u_g^+).$$

The "atomic" Algebra of signatures (i.e., the geometrized physics of "protons" and "neutrons") requires a separate study.

## 10 Metric-dynamic model of the deuterium "atom"

A deuterium "atom" consists of one "proton," one "neutron," and one "electron." The topological (nodal) configuration of such a vacuum region is as follows:

$$
\begin{array}{c}
\text{“proton”} \\ \\ + \\ \text{"neutron"} \\ \\ + \\ \underline{\text{“electron”}} \\ =
\end{array}
\left\{
\begin{array}{c}
(+\ +\ +\ -) \\ (-\ +\ -\ +) \\ (-\ -\ +\ +) \\ (-\ -\ -\ -) \\ (+\ -\ +\ +) \\ (-\ +\ +\ -) \\ (+\ +\ -\ +) \\ \underline{(+\ -\ -\ -)} \\ {}^{2}H(0\ 0\ 0\ 0)_{+}
\end{array}
\right.
\quad \text{or} \quad
\begin{array}{c}
(+\ +\ -\ +) \\ (-\ -\ +\ +) \\ (-\ +\ +\ -) \\ (+\ +\ +\ +) \\ (+\ -\ +\ -) \\ (-\ +\ -\ -) \\ (-\ -\ -\ +) \\ \underline{(+\ -\ -\ -)} \\ {}^{2}H(0\ 0\ 0\ 0)_{+}
\end{array}
\quad \text{or} \ldots \tag{271}
$$

where each signature corresponds to a "quark" or "antiquark" from Table 1, i.e., a set of 10 metrics of type (232).

A deuterium "atom" can also consist of an "antiproton," a "neutron," and a "positron":

$$
\begin{array}{c}
\text{"antiproton"} \\ \\ + \\ \text{"neutron"} \\ \\ + \\ \underline{\text{"positron"}} \\ =
\end{array}
\left\{
\begin{array}{c}
(-\ -\ -\ +) \\ (+\ -\ +\ -) \\ (+\ +\ -\ -) \\ (+\ +\ +\ +) \\ (-\ +\ -\ -) \\ (+\ -\ -\ +) \\ (-\ -\ +\ -) \\ \underline{(-\ +\ +\ +)} \\ {}^{2}H(0\ 0\ 0\ 0)_{+}
\end{array}
\right.
\quad \text{or} \quad
\begin{array}{c}
(-\ -\ +\ -) \\ (+\ +\ -\ -) \\ (+\ -\ -\ +) \\ (-\ -\ -\ -) \\ (-\ +\ -\ +) \\ (+\ -\ +\ +) \\ (+\ +\ +\ -) \\ \underline{(-\ +\ +\ +)} \\ {}^{2}H(0\ 0\ 0\ 0)_{+}
\end{array}
\quad \text{or} \ldots \tag{272}
$$

Each nodal (i.e., signature, or topological) configuration (271) or (272) can be realized with a certain probability and can transition from one state to another over time due to intra-core processes (topological rearrangements) involving gluon exchange (300), while maintaining the overall result (i.e., the topological node) ${}^{2}H(0\ 0\ 0\ 0)+$.

Within the framework of the GVPh&AS developed here, there is no such thing as a deuterium "atom" or a deuterium "anti-atom," but only a single deuterium "atom," in which the "quarks" and "antiquarks" are so constantly transformed into each other that at some point, a given spherical vacuum formation, on average, exists in the "atom" state, while at other points, it exists as an "anti-atom." This applies to all local and global vacuum formations under study. Thus, as noted above, the proposed GVPh&AS does not address the problem of baryon asymmetry of the Universe. However, another question remains: "Why don't 'corpuscles' and 'anticorpuscles' (i.e., 'matter' and 'antimatter') annihilate?"

The following answer is proposed: "Annihilation of 'corpuscles' and 'anticorpuscles' does not occur due to their chaotic (thermal) motion." The point is that in this work, we consider 'corpuscles' and 'anticorpuscles' in a static (resting) state. Therefore, they are precisely opposite to each other and can jointly completely restore the original (undeformed) region of the vacuum; i.e., the convexity of the vacuum can exactly fill its concavity. However, reality is significantly more complex:

- firstly, the shapes of the cores of "corpuscles" and "anticorpuscles" in reality are constantly chaotically distorted, like a quivering spherical jelly (see Figures 6 and 11), therefore the distorted cores of "corpuscles" and "anticorpuscles" do not coincide and cannot exactly fill each other;
- secondly, as shown in [10], toroidal-helical intra-vacuum currents (subcont-antisubcont vortices) are induced around the moving cores of "corpuscles" and "anticorpuscles", which support the motion of these cores by inertia and do not allow them to annihilate, even if they move next to each other, or move towards each other.

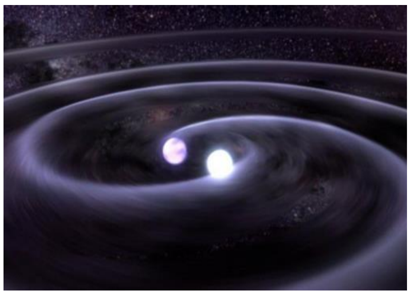


**Fig. 12:** Illustration of the "dance of death" of a "corpuscle" (vacuum convexity) and an "anticorpuscle" (vacuum concavity). In this case, this pair emits all the excess for a complete coincidence

Thus, the GVPh&AS predicts that the annihilation of identical "corpuscles" and "anticorpuscles" can only occur when their translational motion has completely stopped (i.e., at a temperature close to zero). Only then can the identical "corpuscle" and "anticorpuscle" begin their "dance of death" (see Figure 12), shedding all excess energy in the form of radiation and completely "freezing" into a perfectly spherical state upon complete fusion.

Many combinations of signatures similar to (271) and (272) can be created, reflecting the possibilities of the "color" combinatorics of intranuclear topological (nodal or signature) metamorphoses. However, the quark configuration of a given "node" always remains the same: three *u*-“quarks“, three *d*-“quarks“, one *i*-“quark“, and one *e*-“quark“. Therefore, we will agree to designate the topological node “deuterium atom” as follows:

$$^{2}H = 3u3die. \tag{273}$$

Taking into account the topological properties of metrics with the corresponding signatures (see §4 in [4]), we find that this topological knot consists of 3 intertwined “tori”, 4 oval surfaces and one “point”.

**11 Metric-dynamic models of "atoms"**

In the previous sections, metric-dynamic models of the "electron," "positron," "proton," hydrogen "atom," and deuterium "atom" were derived from picoscopic "quarks" and "antiquarks" (see Table 1). Similarly, all known chemical elements of the D.I. Mendeleev's periodic table can be "constructed" ("woven") from these vacuum formations. The average sizes of the "atomic" cores $r_c$ depend on the number of "quarks" and "antiquarks" $A$, that form the corresponding "topological knots." The radius of the core of an "atom" can be estimated using the approximate expression:

$$r_c \approx \frac{3}{2} A^{1/3} r_6 \approx \frac{3}{2} A^{1/3}\cdot 10^{-13}\ \text{cm}. \tag{274}$$

For example, one of many possible topological (nodal) configurations of the helium "atom" 4He is shown below.

$$\begin{array}{cl}
(+\ +\ -\ +) & \\
(-\ -\ +\ +) & p_2^{-}\text{-“proton”} \\
(-\ +\ +\ -) & \\
 & \\
(-\ +\ -\ -) & \\
(+\ -\ -\ +) & p_3^{+}\text{-“antiproton”} \\
(+\ -\ +\ -) & \\
 & \\
(-\ +\ +\ +) & \text{"positron"} \\
 & \\
(-\ -\ -\ -) & \\
(+\ +\ -\ +) & n_2^{0}\text{-"neutron"} \\
(+\ +\ +\ -) & \\
(-\ -\ +\ +) & \\
 & \\
(+\ +\ +\ +) & \\
(+\ -\ +\ -) & n_8^{0}\text{-"neutron"} \\
(-\ +\ -\ -) & \\
(-\ -\ -\ +) & \\
 & \\
(+\ -\ -\ -) & \text{“electron”} \\
\hline
{}^{4}He\ (0\ \ 0\ \ 0\ \ 0) & \text{helium "atom"}
\end{array} \tag{275}$$

This "atom" consists of 16 "quarks" and "antiquarks," therefore, according to expression (274), the radius of its core is approximately equal to

$$r_я \approx \frac{3}{2} 16^{1/3} r_6 \approx 3\cdot 10^{-13}\ \text{cm}.$$

As already noted, "atomic" Algebra of signature (in particular, one of its sections: "vacuum knot topology") requires a separate, extensive study, but some laws of this line of research can already be formulated:

1) Extended Pauli's rule: identical triple and quadruple configurations of "quarks" and "antiquarks" do not exist in a single "atom";

2) "Protons" and "antiprotons," as well as opposing "neutrons," are present in the "atom" in distinct signature (or color, or topological) configurations;

3) “Electrons” and “positrons” in the “atom” do not annihilate, since they are blurred and entangled among the most complex convex-concave configurations and cannot be isolated into separate vacuum formations capable of completely compensating each other’s manifestations.

## 12 Metric-dynamical models of "mesons" and "baryons"

In quantum chromodynamics, mesons are composed of a quark and an antiquark and are defined by the formula

$$M = q^- q^+ = q_\alpha^- q_\alpha^+ = \frac{1}{\sqrt{3}}\left(q_b^- q_b^+ + q_r^- q_r^+ + q_g^- q_g^+\right), \tag{114}$$

where $q_\alpha{}^-$ is the quark's color triplet $\alpha = r, b, g$); $q_\alpha{}^+$ is the antiquark's color triplet.

Baryons consist of three quarks and are given by the formula

$$B = \frac{1}{\sqrt{6}} q_\alpha q_\beta q_\gamma \varepsilon_{\alpha\beta\gamma}, \tag{277}$$

where $\varepsilon_{\alpha\beta\gamma}$ is the completely antisymmetric tensor.

"Mesons" and "baryons" are constructed in a similar manner within the GVPh&AS framework.

We consider a specific example: the three varieties of π-mesons in the theory of strong interactions have the following quark structure:

$$\pi^+ = u^- d^+, \qquad \pi^0 = \frac{1}{\sqrt{2}}(u^- u^+ - d^+ d^-), \qquad \pi^- = u^+ d^-. \tag{278}$$

In the GVPh&AS framework, for example, the meson $\pi^+ = u^- d^+$ is represented as rankings (i.e., topological nodes):

$$\begin{array}{c} d_r{}^+ (+ + \ + -) \\ \underline{u_g{}^- (- \ + \ - +)} \\ \pi_1{}^+ (0\ 2+\ 0\ 0)_+ \end{array} \qquad \begin{array}{c} d_g{}^+ (+ \ + - \ +) \\ \underline{u_b{}^- (- \ - \ + \ +)} \\ \pi_2{}^+ (0\ \ 0\ 0\ 2+)_+ \end{array} \qquad \begin{array}{c} d_b{}^+ (+ - \ + \ +) \\ \underline{u_r{}^- (- + \ + \ -)} \\ \pi_3{}^+ (0\ \ 0\ 2+\ 0)_+ \end{array} \tag{279}$$

where each signature corresponds to a set of 10 metrics of type (232) with a corresponding signature of rankings (279).

Such convex-concave vacuum formations cannot be stable. They can fold into a given topological configuration, but instantly rearrange themselves into another type of topological (knot) entanglement or, on average, smooth out.

In turn, the quark structure of the neutral $\pi^0$-meson

$$\pi^0 = \frac{1}{\sqrt{2}}(u^- u^+ - d^+ d^-) \tag{280}$$

may have the following ranking (topological, nodal) analogues:

$$\begin{array}{c} u_r{}^+ (+ - - +) \\ u_g{}^- (- + - +)_+ \\ - \\ d_r{}^+ (+ + + -) \\ \underline{d_g{}^- (- - + -)_+} \\ \pi_1{}^0 (0\ 0\ 0\ 0) \end{array} \qquad \begin{array}{c} u_g{}^+ (+ - + -) \\ u_b{}^- (- - + +)_+ \\ - \\ d_g{}^+ (+ + - +) \\ \underline{d_b{}^- (- + - -)_+} \\ \pi_2{}^0 (0\ 0\ 0\ 0) \end{array} \qquad \begin{array}{c} u_b{}^+ (+ + - -) \\ u_r{}^- (- + + -)_+ \\ - \\ d_b{}^+ (+ - + +) \\ \underline{d_r{}^- (- - - +)_+} \\ \pi_3{}^0 (0\ 0\ 0\ 0) \end{array} \tag{281}$$

of elementary particles can also be constructed (or "braided") within the framework of the Algebra of signature.

The signature (topological, nodal) configurations of the GVPh&AS differ from those of the Standard Model of elementary particles only by the presence of additional $i_w{}^+$-"quarks" and $i_w{}^-$-"antiquarks," as well as by the fact that stable pico- and microscopic vacuum formations consist of picoscopic "quarks" and "antiquarks" (Table 1). In other words, within of the GVPh&AS framework, the microworld consists of a mixture of "quarks" and "antiquarks" (Table 1), which form the entire diversity of "corpuscles" and "anticorpuscles" ("particles," "atoms," "molecules") of various scales. In such a world, "corpuscles" and "anticorpuscles" cannot annihilate because they differ from each other due to random distortions of their shape and their chaotic movements (thermal motion), since annihilation requires a virtually exact match in shape. Therefore, the problem of baryon asymmetry of matter is absent in the GVPh&AS.

*To understand the above, take a piece of fabric and tear a tuft from it. Then try to reinsert the torn tuft. Obviously, replacing the torn tuft so that the tear is unnoticeable is practically impossible. Returning the torn tuft of vacuum (i.e., the core of the "corpuscle") to the site of the hole (i.e., the core of the "anticorpuscle"), fully restoring the vacuum's extent, is possible, but only after a "dance of death" (see Figure 12) and complex oscillations with the release of hard radiation.*

**13 Boson's models in the framework of the GVPh&AS**

In general relativity, weak perturbations of the space-time continuum (vacuum) are described by the metric

$$ds_6^{(+)2} = g_{ij}^{(+)} dx^i dx^j, \tag{282}$$

where $g_{ij}^{(+)} = \eta_{ij}^{(+)} + h_{ij}^{(+)}$; (283)

$$h_{ij}^{(+)} = \begin{pmatrix} h_+^{(+)} & h_\times^{(+)} \\ h_\times^{(+)} & -h_+^{(+)} \end{pmatrix}$$

is a symmetric rank-2 tensor, which is considered as a tensor field on the background of a flat 4-dimensional metric Minkowski space with signature (+ – – –), with all operations of raising and lowering tensor indices being performed using the unperturbed metric tensor $\eta_{ij}^{(+)}$;

$$\eta_{ij}^{(+)} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} \tag{284}$$

is the metric tensor of Minkowski space with signature (+ – – –).

In this case, as is known [18], Einstein's first vacuum equation $R_{ij} = 0$ reduces to the wave equation for small perturbations $h_{ij}^{(+)}$

$$R_{ij} \approx \left(\nabla - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right) h_{ij}^{(+)} = 0. \tag{285}$$

In the Algebra of signature [3, 4, 5], at least a two-sided consideration is permissible. That is, in addition to the perturbation of the outer side of the vacuum, i.e., Minkowski space with signature (+ – – –), it is also necessary to take into account the perturbation of the inner side of the vacuum, i.e., Anti-Minkowski spaces with signature (– + + +) and metric

$$ds_6^{(-)2} = g_{ij}^{(-)} dx^i dx^j, \tag{286}$$

where

$$g_{ij}^{(-)} = \eta_{ij}^{(-)} + h_{ij}^{(-)}; \tag{287}$$

$$h_{ij}^{(-)} = \begin{pmatrix} h_+^{(-)} & h_\times^{(-)} \\ h_\times^{(-)} & -h_+^{(-)} \end{pmatrix}, \quad \eta_{ij}^{(-)} = \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}. \tag{288}$$

In the case of small perturbations of a double-sided vacuum, the equation $R_{ij} = 0$ reduces to a wave equation of the form

$$R_{ij} \approx \left(\nabla - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\left(h_{ij}^{(+)} + i h_{ij}^{(-)}\right) = 0. \tag{289}$$

A separate study is needed to geometrize the theory of small vacuum perturbations from the standpoint of the GVPh&AS. In this article, we note only that, under small perturbations, the vacuum behaves like an elastic medium through which colored wave perturbations propagate (see Figure 13).

**Fig. 13:** Fractal illustrations of vacuum wave disturbances of various scales

*13.1 Colored "photons" and "antiphotons"*

Based on spectral-signature analysis (see §6 in [3]), we introduce the concepts of colored "photons" and "antiphotons."

Table 2 – Colored "photons" and "antiphotons"

| Colored photon | Stignature | Colored antiphoton | Stignature |
|---|---|---|---|
| $w = \exp\{\zeta_1 2\pi/\lambda_{m,n}\,(\mathrm{ct} + x + y + z)\}$ | {+ + + +} | $\bar{w} = \exp\{\zeta_1\, 2\pi/\lambda_{m,n}\,(-\mathrm{ct} - x - y - z)\}$ | {+ + + +} |
| $e = \exp\{\zeta_2 2\pi/\lambda_{m,n}\,(\mathrm{ct} - x - y - z)\}$ | {+ − − −} | $\bar{e} = \exp\{\zeta_2\, 2\pi/\lambda_{m,n}(\mathrm{ct} + x + y + z)\}$ | {− + + +} |
| $r = \exp\{\zeta_3 2\pi/\lambda_{m,n}\,(\mathrm{ct} - x - y + z)\}$ | {+ − − +} | $\bar{r} = \exp\{\zeta_3\, 2\pi/\lambda_{m,n}(-\,\mathrm{ct} + x + y - z)\}$ | {− + + −} |
| $g = \exp\{\zeta_4 2\pi/\lambda_{m,n}\,(\mathrm{ct} - x + y - z)\}$ | {+ − + −} | $\bar{g} = \exp\{\zeta_4 2\pi/\lambda_{m,n}\,(-\,\mathrm{ct} + x - y + z)\}$ | {− + − +} |
| $b = \exp\{\zeta_5 2\pi/\lambda_{m,n}(\mathrm{ct} + x - y - z)\}$ | {+ + − −} | $\bar{b} = \exp\{\zeta_5\, 2\pi/\lambda_{m,n}\,(-\,\mathrm{ct} - x + y + z)\}$ | {− − + +} |
| $o = \exp\{\zeta_6 2\pi/\lambda_{m,n}\,(\mathrm{ct} - x + y + z)\}$ | {+ − + +} | $\bar{o} = \exp\{\zeta_6\, 2\pi/\lambda_{m,n}(-\,\mathrm{ct} + x - y - z)\}$ | {− + − −} |
| $h = \exp\{\zeta_7 2\pi/\lambda_{m,n}(\mathrm{ct} + x + y - z)\}$ | {+ + + −} | $\bar{h} = \exp\{\zeta_7\, 2\pi/\lambda_{m,n}(-\,\mathrm{ct} + x - y - z)\}$ | {− − − +} |
| $\mathrm{z} = \exp\{\zeta_8 2\pi/\lambda_{m,n}\,(\mathrm{ct} + x - y + z)\}$ | {+ + − +} | $\bar{z} = \exp\{\zeta_8\, 2\pi/\lambda_{m,n}\,(-\,\mathrm{ct} - x + y - z)\}$ | {− − + −} |

where $\lambda_{m,n}$ is the wavelength of vacuum disturbances in the range $\Delta\lambda_{m,n} = 10^m - 10^n$ cm.
$\zeta_m$ are orthonormal objects satisfying the anticommutative relations of the Clifford algebra.

$$\zeta_m \zeta_k + \zeta_k \zeta_m = 0 \ \text{ for } \ m \neq k\,, \quad \zeta_m \zeta_m = 1, \quad \text{or} \quad \zeta_m \zeta_k + \zeta_k \zeta_m = 2\delta_{km}, \tag{290}$$

where $\delta_{km}$ is the Kronecker delta ($\delta_{km}$= 0 for $m \neq k$ and $\delta_{km}$= 1 for $m = k$). One possible definition of the ζm objects and the Kronecker delta $\delta_{km}$ is presented below:

(291)

$$\zeta_1 = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \qquad \zeta_5 = \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\zeta_2 = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \end{pmatrix} \qquad \zeta_6 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\zeta_3 = \begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \end{pmatrix} \qquad \zeta_7 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$\zeta_4 = \begin{pmatrix} 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix} \qquad \zeta_8 = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix},$$

$$\delta_{km} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}.$$

### *13.2 "Photon" and "antiphoton"*

A harmonic (more precisely, spiral) perturbation of a vacuum with circular polarization (see §11 in [4]), as a special case of the solution of wave equations (289), is described by the expression

$$\cos\{(2\pi/\lambda_{m,n})(ct-x-y-z)\} + i\sin\{(2\pi/\lambda_{m,n}\ (ct-x-y-z)\} = \exp\{i\ (2\pi/\lambda_{m,n})(ct-x-y-z)\} = \exp\{i(\omega t - \mathbf{k}\cdot\mathbf{r})\}. \quad (292)$$

We will conventionally call this perturbation an *e*-"photon" with the signature {+ – – –} (see Table 2), (recall that the concept of signature was introduced in §4 in [1]).

A spiral vacuum disturbance propagating in the opposite direction,

$$\cos\{(2\pi/\lambda_{m,n})(-ct+x+y+z)\} + i\sin\{(2\pi/\lambda_{m,n})(-ct+x+y+z)\} = \exp\{i\ (2\pi/\lambda_{m,n})(-ct+x+y+z)\} = \exp -\{i(\omega t - \mathbf{k}\cdot\mathbf{r})\} \quad (293)$$

we call the *e*-"antiphoton" with signature {– + + +}.

The level of elementary "particles" (i.e., "corpuscles" with picosopic core) corresponds to spiral vacuum disturbances with a wavelength in the range $\Delta\lambda_{m,n} = \Delta\lambda_{-12,-15} = 10^{-12} - 10^{-15}$ cm.

*13.3 $W^{\pm}$-"bosons"*

Within the GVPh&AS framework, the three color states of the $W^{+}$-"boson" are defined by the following expressions and their corresponding rankings, which define a more complex version of the vacuum wave disturbance consisting of three colored "photons" and "antiphotons" from Table 2 (here $\lambda_{m,n} = \lambda$ )

(294)

$$\begin{array}{ll} \exp\{i\,2\pi/\lambda\,(-ct - x - y + z)\}\times & \{-\ -\ -\ +\} \\ \times\exp\{j\,2\pi/\lambda\,(\ ct - x + y - z)\}\times & \{+\ -\ +\ -\} \\ \times\exp\{k\,2\pi/\lambda\,(\ ct + x - y - z)\} & \underline{\{+\ +\ -\ -\}} \\ & \{+\ -\ -\ -\}_{+} \end{array}$$

$$\begin{array}{ll} \exp\{i\,2\pi/\lambda\,(-ct - x + y - z)\}\times & \{-\ -\ +\ -\} \\ \times\exp\{j\,2\pi/\lambda\,(\ ct + x - y - z)\}\times & \{+\ +\ -\ -\} \\ \times\exp\{k\,2\pi/\lambda\,(\ ct - x - y + z)\} & \underline{\{+\ -\ -\ +\}} \\ & \{+\ -\ -\ -\}_{+} \end{array}$$

$$\begin{array}{ll} \exp\{i\,2\pi/\lambda\,(-ct + x - y - z)\}\times & \{-\ +\ -\ -\} \\ \times\exp\{j\,2\pi/\lambda\,(\ ct - x - y + z)\}\times & \{+\ -\ -\ +\} \\ \times\exp\{k\,2\pi/\lambda\,(\ ct - x + y - z)\} & \underline{\{+\ -\ +\ -\}} \\ & \{+\ -\ -\ -\}_{+} \end{array}$$

Три цветных состояния $W^{-}$-«бозона»:

(295)

$$\begin{array}{ll} \exp\{i\,2\pi/\lambda\,(\ ct + x + y - z)\}\times & \{+\ +\ +\ -\} \\ \times\exp\{j\,2\pi/\lambda\,(-ct + x - y + z)\}\times & \{-\ +\ -\ +\} \\ \times\exp\{k\,2\pi/\lambda\,(-ct - x + y + z)\} & \underline{\{-\ -\ +\ +\}} \\ & \{-\ +\ +\ +\}_{+} \end{array}$$

$$\begin{array}{ll} \exp\{i\,2\pi/\lambda\,(\ ct + x - y + z)\}\times & \{+\ +\ -\ +\} \\ \times\exp\{j\,2\pi/\lambda\,(-ct - x + y + z)\}\times & \{-\ -\ +\ +\} \\ \times\exp\{k\,2\pi/\lambda\,(-ct + x + y - z)\} & \underline{\{-\ +\ +\ -\}} \\ & \{-\ +\ +\ +\}_{+} \end{array}$$

$$\begin{array}{ll} \exp\{i\,2\pi/\lambda\,(\ ct - x + y + z)\}\times & \{+\ -\ +\ +\} \\ \times\exp\{j\,2\pi/\lambda\,(-ct + x + y - z)\}\times & \{-\ +\ +\ -\} \\ \times\exp\{k\,2\pi/\lambda\,(-ct + x - y + z)\} & \underline{\{-\ +\ -\ +\}} \\ & \{-\ +\ +\ +\}_{+}\ , \end{array}$$

where *i, j, k* are imaginary units that form an anticommutative algebra:

$$i^2 = j^2 = k^2 = ijk = -1 \quad \text{и} \quad ij + ji = 0, \qquad (296)$$

this is a special case of $\zeta_m$ objects (291).

*13.4 $Z^{0}$-"bosons"*

The six color states of the $Z^{0}$-"boson" are defined by the following expressions and the corresponding rankings, consisting of four-color "photons" and "antiphotons" from Table 2.

(297)

$$\begin{array}{ll} \exp\{\ 2\pi/\lambda\,(-ct - x - y - z)\}\times & \{-\ -\ -\ -\} \\ \times\exp\{i\,2\pi/\lambda\,(\ ct - x + y + z)\}\times & \{+\ -\ +\ +\} \\ \times\exp\{j\,2\pi/\lambda\,(-ct + x + y - z)\}\times & \{-\ +\ +\ -\} \\ \times\exp\{k\,2\pi/\lambda\,(\ ct + x - y + z)\} & \underline{\{+\ +\ -\ +\}} \\ & \{0\ 0\ 0\ 0\}_{+} \end{array}$$

$$\begin{array}{ll} \exp\{\ 2\pi/\lambda\,(-ct - x - y - z)\}\times & \{-\ -\ -\ -\} \\ \times\exp\{i\,2\pi/\lambda\,(\ ct + x - y + z)\}\times & \{+\ +\ -\ +\} \\ \times\exp\{j\,2\pi/\lambda\,(\ ct + x + y - z)\}\times & \{+\ +\ +\ -\} \\ \times\exp\{k\,2\pi/\lambda\,(-ct - x + y + z)\} & \underline{\{-\ -\ +\ +\}} \\ & \{0\ 0\ 0\ 0\}_{+} \end{array}$$

$$\begin{array}{ll} \exp\{\ 2\pi/\lambda\,(-ct-x-y-z)\}\times & \{-\ -\ -\ -\} \\ \times\exp\{i\,2\pi/\lambda\,(\ \ ct-x+y+z)\}\times & \{+\ -\ +\ +\} \\ \times\exp\{j\,2\pi/\lambda\,(-ct+x-y+z)\}\times & \{-\ +\ -\ +\} \\ \times\exp\{k\,2\pi/\lambda\,(\ \ ct+x+y-z)\} & \underline{\{+\ +\ +\ -\}} \\ & \{0\ \ 0\ \ 0\ \ 0\}_+ \end{array}$$

$$\begin{array}{ll} \exp\{\ 2\pi/\lambda\,(\ \ ct+x+y+z)\}\times & \{+\ +\ +\ +\} \\ \times\exp\{i\,2\pi/\lambda\,(-ct+x-y-z)\}\times & \{-\ +\ -\ -\} \\ \times\exp\{j\,2\pi/\lambda\,(\ \ ct-x-y+z)\}\times & \{+\ -\ -\ +\} \\ \times\exp\{k\,2\pi/\lambda\,(-ct-x+y-z)\} & \underline{\{-\ -\ +\ -\}} \\ & \{0\ \ 0\ \ 0\ \ 0\}_+ \end{array}$$

$$\begin{array}{ll} \exp\{\ 2\pi/\lambda\,(\ \ ct+x+y+z)\}\times & \{+\ +\ +\ +\} \\ \times\exp\{i\,2\pi/\lambda\,(-ct-x+y-z)\}\times & \{-\ -\ +\ -\} \\ \times\exp\{j\,2\pi/\lambda\,(-ct-x-y+z)\}\times & \{-\ -\ -\ +\} \\ \times\exp\{k\,2\pi/\lambda\,(\ \ ct+x-y-z)\} & \underline{\{+\ +\ -\ -\}} \\ & \{0\ \ 0\ \ 0\ \ 0\}_+ \end{array}$$

$$\begin{array}{ll} \exp\{\ 2\pi/\lambda\,(\ \ ct+x+y+z)\}\times & \{+\ +\ +\ +\} \\ \times\exp\{i\,2\pi/\lambda\,(-ct+x-y-z)\}\times & \{-\ +\ -\ -\} \\ \times\exp\{j\,2\pi/\lambda\,(\ \ ct-x+y-z)\}\times & \{+\ -\ +\ -\} \\ \times\exp\{k\,2\pi/\lambda\,(-ct-x-y+z)\} & \underline{\{-\ -\ -\ +\}} \\ & \{0\ \ 0\ \ 0\ \ 0\}_+ \end{array}$$

*13.5 "Gluons"*

In quantum chromodynamics, there are 8 types of gluons:
- colored gluons:

$$g_1 = (r\bar{b} + b\bar{r})/\sqrt{2}\,, \qquad g_2 = -i(r\bar{b} - b\bar{r})/\sqrt{2},$$
$$g_3 = (r\bar{g} + g\bar{r})/\sqrt{2}, \qquad g_4 = -i(r\bar{g} - g\bar{r})/\sqrt{2},$$
$$g_5 = (b\bar{g} + g\bar{b})/\sqrt{2}, \qquad g_6 = -i(b\bar{g} - g\bar{b})/\sqrt{2}; \tag{298}$$

- colorless gluons:

$$g_7 = (r\bar{r} + b\bar{b})/\sqrt{2}, \qquad g_8 = (r\bar{r} + b\bar{b} \ - 2g\bar{g})/\sqrt{2}. \tag{299}$$

In the Algebra of stignatures, there are 6 stignatures, each with two identical signs (see (34) in §5.10 in [1]).

$\{+--+\}\ \{++--\}\{+-+-\}$

$\{-++-\}\ \{--++\}\{-+-+\}.$

Therefore, from Table 2, we can distinguish 3 colored "photons" and 3 colored "antiphotons" (the colors of which correspond to the colors of $u^+$-"quarks" and $u^-$-"antiquarks"; see Table 1).

Table 3

| Colored photon | Stignature | Colored antiphoton | Stignature |
|---|---|---|---|
| $r = \exp\{i\ 2\pi/\lambda\,(\mathrm{ct} - x - y + z)\}$ | $\{+\ -\ -\ +\}$ | $\bar{r} = \exp\{i\ 2\pi/\lambda\,(-\,\mathrm{ct} + x + y - z)\}$ | $\{-\ +\ +\ -\}$ |
| $g = \exp\{j\ 2\pi/\lambda\,(\mathrm{ct} - x + y - z)\}$ | $\{+\ -\ +\ -\}$ | $\bar{g} = \exp\{j\ 2\pi/\lambda\,(-\,\mathrm{ct} + x - y + z)\}$ | $\{-\ +\ -\ +\}$ |
| $b = \exp\{k\ 2\pi/\lambda\,(\mathrm{ct} + x - y - z)\}$ | $\{+\ +\ -\ -\}$ | $\bar{b} = \exp\{k\ 2\pi/\lambda\,(-\,\mathrm{ct} - x + y + z)\}$ | $\{-\ -\ +\ +\}$ |

From these colored “photons” and “antiphotons” one can compose 8 gluons according to rules (298) and (299) using the methods of the Algebra of signature [3,4,5,6,7]. For example,

$$g_1 = \frac{r\bar{b}+b\bar{r}}{\sqrt{2}} = \left(e^{i\frac{2\pi}{\lambda}(ct-x-y+z)} \times e^{k\frac{2\pi}{\lambda}(-ct-x+y+z)} + e^{k\frac{2\pi}{\lambda}(ct+x-y-z)} \times e^{i\frac{2\pi}{\lambda}(-ct-x+y-z)}\right)/\sqrt{2}, \qquad (300)$$

$$g_2 = \frac{r\bar{g}+g\bar{r}}{\sqrt{2}} = \left(e^{i\frac{2\pi}{\lambda}(ct-x-y+z)} \times e^{j\frac{2\pi}{\lambda}(-ct+x-y+z)} + e^{j\frac{2\pi}{\lambda}(ct-x+y-z)} \times e^{i\frac{2\pi}{\lambda}(-ct+x+y-z)}\right)/\sqrt{2},$$

$$g_3 = \frac{b\bar{g}+g\bar{b}}{\sqrt{2}} = \left(e^{k\frac{2\pi}{\lambda}(ct+x-y-z)} \times e^{j\frac{2\pi}{\lambda}(-ct+x-y+z)} + e^{j\frac{2\pi}{\lambda}(ct-x+y-z)} \times e^{k\frac{2\pi}{\lambda}(-ct-x+y+z)}\right)/\sqrt{2}.$$

These are wave disturbances that are toroidal in nature.

*13.6 "Landscape"*

Unlike the Standard Model of elementary particles, the GVPh&AS model contains another "boson," which we call the "landscape":

$$\begin{array}{rl} \exp\{\zeta_1 2\pi/\lambda(\ ct+x+y+z)\} & \{+\ +\ +\ +\} \\ \times\exp\{\zeta_3 2\pi/\lambda(\ ct-x-y+z)\}\times & \{-\ -\ -\ +\} \\ \times\exp\{\zeta_4 2\pi/\lambda(-ct-x+y-z)\}\times & \{+\ -\ -\ +\} \\ \times\exp\{\zeta_5 2\pi/\lambda(\ ct+x-y-z)\}\times & \{-\ -\ +\ -\} \\ \times\exp\{\zeta_6 2\pi/\lambda(-ct+x-y-z)\}\times & \{+\ +\ -\ -\} \\ \times\exp\{\zeta_7 2\pi/\lambda(\ ct-x+y-z)\}\times & \{-\ +\ -\ -\} \\ \times\exp\{\zeta_8 2\pi/\lambda(-ct+x+y+z)\}\times & \{+\ -\ +\ -\} \\ \times\exp\{\zeta_1 2\pi/\lambda(-ct-x-y-z)\}\times & \{-\ +\ +\ +\} \\ \times\exp\{\zeta_2 2\pi/\lambda(\ ct+x+y-z)\}\times & \{-\ -\ -\ -\} \\ \times\exp\{\zeta_3 2\pi/\lambda(-ct+x+y-z)\}\times & \{+\ +\ +\ -\} \\ \times\exp\{\zeta_4 2\pi/\lambda(\ ct+x-y+z)\}\times & \{-\ +\ +\ -\} \\ \times\exp(\zeta_5 2\pi/\lambda(-ct-x+y+z)\}\times & \{+\ +\ -\ +\} \\ \times\exp\{\zeta_6 2\pi/\lambda(\ ct-x+y+z)\}\times & \{-\ -\ +\ +\} \\ \times\exp\{\zeta_7 2\pi/\lambda(-ct+x-y+z)\}\times & \{+\ -\ +\ +\} \\ \times\exp\{\zeta_8 2\pi/\lambda(\ ct-x-y-z)\} & \{-\ +\ -\ +\} \\ & \underline{\{+\ -\ -\ -\}} \\ & \{0\ 0\ 0\ 0\}_+ \end{array} \qquad (301)$$

It is possible that this “landscape” has the properties of a “graviton” and a “Higgs boson”.

**CONCLUSION**

Ha-Shamayim (Heavens) declare the Glory of GOD, of the Creation Ha-Rakiya (Firmament) proclaims HIS Handiwork. Day to day pours forth Speech, and Night to night reveals Knowledge.

Tegelim 19:2-3 (Psalm 19:2-3)

I Am the Alpha and the Omega, the First and the Last, the Beginning and the End (Revelation 1:8, 22:13)

This article is intended to deepen and refine the "Geometrized Vacuum Physics Based on the Algebra of Signature " (GVPh&AS) presented in [3,4,5,6,7,8,9,10,11,12,13,14,15].

Solutions to Einstein's vacuum equation with a large number of $\Lambda_j$-terms and taking into account all possible 16 signatures of 4-metrics (231) led to the creation of the Hierarchical cosmological model, which allows us to outline solutions to many problems in modern natural science.

In particular, the following results were obtained:
- metric-dynamic models of all picoscopic "quarks," "leptons," "mesons," "baryons," and "bosons" comprising the Standard Model of elementary particles were constructed. Based on these models, an algorithm for composing all the "atoms" from the D.I. Mendeleev's periodic table and "molecules" was proposed;
- it was shown that "corpuscles" and "anticorpuscles" (i.e., stable spherical convex and concave vacuum formations) are not independent objects, but are part of a hierarchical chain on a Universal scale. Moreover, all the differently scaled cores of the "corpuscles" in this chain are not only nested within one another, but also influence each other's raqiya layers (spherical shells of cores);

- the possibility of resolving the problem of the baryon asymmetry of the Universe has been obtained. It is obvious that at the beginning of Creation (i.e., during the Origin of the Universe) there was complete parity between "corpuscles" and "anti-corpuscles" (i.e., convexities and concavities of the vacuum), since only even (at least paired) mutually opposite convexities and concavities can arise from emptiness (vacuum). However, in the process of the Evolution of the Universe, mechanisms of local disproportionate unraveling of topological knots and anti-knots (i.e., smoothing of "corpuscles" and "anti-corpuscles" in different proportions) are not excluded for the release of the potential energy of vacuum deformations, directed, for example, at the accelerated expansion of space (see (36) – (37)). At the same time, within the framework of the GVPh&AS, "atoms" and "molecules" consist of both "quarks" and "antiquarks", i.e., "corpuscles" and "anticorpuscles" coexist and cannot annihilate due to the complex fluctuations and chaotic (thermal) motion in which they participate. The annihilation of vacuum convexities and concavities is possible only at a temperature close to absolute zero (i.e., at a practical stop of their translational motion) and a complete coincidence in shape (i.e., the convexity must completely correspond in shape to the concavity);
- the problem of confinement of "quarks" and "antiquarks" in the cores of "baryons" has been solved. In the GVPh&AS, "quarks" and "antiquarks" are a discrete set of convex-concave vacuum states, and cannot exist separately for long. Only those sets of "quarks" and "antiquarks" from Table 1 that, on average, form a full convexity or a full concavity remain stable, for example, "protons" and "antiprotons" (242) – (247). Also stable are neutral vacuum formations in which "quarks" and "antiquarks", on average, completely compensate each other's manifestations, for example, "neutrons" (264), "hydrogen atoms" (268), and "deuterium" atoms (271);
- in the GVPh&AS all 10 levels of the hierarchical chain (i.e., all different-scale "corpuscles" and "anticorpuscles") in the ground state are arranged identically. In this article, we have considered in detail only the "quark" - "antiquark" structure of the cores of stable spherical vacuum formations of the picoscopic level (i.e., with nuclear radii of the order of $r_6 \sim 10^{-12} – 10^{-14}$ cm). In the article [12,13] it is shown that completely analogous "quarks" and "antiquarks" of the planetary scale with characteristic nuclear radii $r_4 \sim 10^7$ cm (see Table 1 in [12]) determine the metric-dynamic models of bare "planets" and bare "stars", which attract micro- and picoscopic vacuum formations to their environments. In turn, in the article [14] completely analogous "quarks" and "antiquarks" of the galactic scale with characteristic radii of cores $r_3 \sim 10^{17}$ cm (see Table 1 in [14]) are introduced, which determine the metric-dynamic models of naked "galaxies" gathering "stars" and "planets" around their shells. Thus, the Standard Model of multi-scale "corpuscles" and "anticorpuscles" must include not only picoscopic "quarks" and "antiquarks" (Table 1), but also planetary "quarks" and "antiquarks" (Table 1 in [12]), and galactic "quarks" and "antiquarks" (Table 1 in [14]), and analogous "quarks" and "antiquarks" of the remaining links of the hierarchical chain with characteristic radii from the hierarchy of radii (59).

The proposed Hierarchical cosmological model, together with the mathematical apparatus and methods of the GVPh&AS for processing data contained in sets of solution metrics of Einstein's vacuum equations, allow us to "look inside" core's processes (see §2.2.3 and 2.2.4 in [9]), describe electrostatics (see §2.2 in [9]) and electromagnetic phenomena (see §4.3 in [6]), geometrize the concept of electric charge (see §2.2.2 in [9]), investigate the nature of gravity (see [13]), propose methods for generating large-scale "neutrinos" (see [11]), and describe many other effects. But all these achievements have been obtained only in the range of 6 characteristic radii of cores of "corpuscles" and "anticorpuscles" from the hierarchy (59):

$r_2 \sim 10^{28}$ cm is radius commensurate with the radius of the observable Universe;
$r_3 \sim 10^{17}$ cm is radius commensurate with the radius of the galactic core;
$r_4 \sim 10^{7}$ cm is radius commensurate with the radius of the core of a planet or star;
$r_5 \sim 10^{-3}$ cm is radius commensurate with the radius of a biological cell;
$r_6 \sim 10^{-13}$ cm is radius commensurate with the radius of an elementary particle core;
$r_7 \sim 10^{-24}$ cm is radius commensurate with the radius of a proto-quark core;

We cannot observe objects larger than $r_2 \sim 10^{28}$ cm and smaller than $r_7 \sim 10^{-24}$ cm. Therefore, the hierarchical cosmological model has the following significant drawback: "Einstein's vacuum equation with a large number of $\Lambda_j$-terms does not provide a limit on the number of cores of different-scale "corpuscles" and "anticorpuscles" nested within each other in a single hierarchical chain.

Mathematics confidently shows only that the number of links in any finite hierarchical chain of different-scale "corpuscles" and "anticorpuscles" must be even (see (190) – (191b)). In this article, we consider the hypothesis that the maximal hierarchical chain contains no more than 10 links (i.e., different-scale cores of "corpuscles" and "anticorpuscles" nested inside each other, see Figures 2 and 3) – this number satisfies the parity criterion, but has not been experimentally substantiated.

*Ten links (levels) in one hierarchical chain are taken according to the number of Ten Sefirot of the Tree of Life in Lurianic Kabbalah. However, the sages of the TORAH assert that three Raqiyas (Heavens) are hidden, and only seven Raqiyas (Heavens) are revealed. For example, it is written in the Babylonian Talmud, in tractate Hagigah 12a-12b (commentary related to verses 1:6-8 of the TORAH, i.e., to the Second Day of Creation): - "Rabbi Yehuda said: There are seven Rakim (Heavens) (רקיעים שבעה): Vilon, Raqiya, Shehakim, Zevul, Maon, Machon, Aravot. Of course, for science these testimonies of the sages are not an argument, but only a possible hint for a working hypothesis.*

*CONDUCT leaves other Traces of the Presence. It is interesting that modern science began with the Leaning Tower of Pisa, which has 7 galleries, as well as a foundation, base and roof: 10 levels in total. Time is divided into 7 days of the week, 30 days in a month. In Dante Alighieri's Divine Comedy, there are 10 heavens of Paradise, which correspond to the Ptolemaic system of the world: The Moon is the Heaven of the righteous who broke their vow; Mercury is the Heaven of figures who strove for glory; Venus is the Heaven of the loving and merciful; The Sun is the Heaven of sages and theologians; Mars is the Heaven of warriors for the faith; Jupiter is the Heaven of just rulers; Saturn is the Heaven of contemplative monks, mystics; Fixed stars are the heaven of the apostles and the triumphant Church; Crystal Heaven (Prime Mover) is the heaven of angels and virtuous people; The Empyrean is the Divine "Fiery Heaven" where G-D and the souls of the blessed dwell. The 7 days of Pesach (Passover) and the 10 plagues of Egypt. The 10 Commandments of the TORAH. ... 10 Levels of Paradise (worlds) and 10 levels of Hell (anti-worlds), 10 fingers and 10 toes, 7 openings in the human head, and a total of 10 visible openings in the body of a man or woman... – Nature is fractal, within It the Unified Original Principles are manifested multiple times, multifaceted, and multifaceted.*

A major problem, however, is that if the number of links in the hierarchical chain is limited (i.e., more than 4 and up to an arbitrarily large but finite number), then it inevitably turns out that the largest core (e.g., a mega-Universe with a base radius $r_1 \sim 10^{39}$ cm) must be located inside the smallest core (e.g., an "instanton's" core with a base radius $r_{10} \sim 10^{-55}$ cm), see (71′) – (192).

A closed geometric inversion of "small into large" may help to understand the "Klein bottle" (see Figure 5).

It is possible that the solution to the "Big in small" problem within the framework of the GVPh&AS is related to the fact that there are two ways to expand the same expression, for example, (71) and (192).

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1 - \frac{r_1+r_2+\cdots+r_{10}}{r} + \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2 = \tag{71}$$

$$= 1 + \left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right) - \left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right) + \left(1-\frac{r_8}{r}+\frac{r^2}{r_7^2}\right) - \left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right) + \left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right) - \left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right) +$$

$$+ \left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right) - \left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right) + \left(1-\frac{r_2}{r}+\frac{r^2}{r_1^2}\right) - \left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right)$$

and

$$g_{00}^{(+a)} = 1/g_{11}^{(+a)} = 1 - \frac{r_1+r_2+\cdots+r_{10}}{r} + \left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2 = \tag{192}$$

$$= 1 + \left(1-\frac{r_1}{r}+\frac{r^2}{r_2^2}\right) - \left(1+\frac{r_2}{r}-\frac{r^2}{r_3^2}\right) + \left(1-\frac{r_3}{r}+\frac{r^2}{r_4^2}\right) - \left(1+\frac{r_4}{r}-\frac{r^2}{r_5^2}\right) + \left(1-\frac{r_5}{r}+\frac{r^2}{r_6^2}\right) - \left(1+\frac{r_6}{r}-\frac{r^2}{r_7^2}\right) +$$

$$+ \left(1-\frac{r_7}{r}+\frac{r^2}{r_8^2}\right) - \left(1+\frac{r_8}{r}-\frac{r^2}{r_9^2}\right) + \left(1-\frac{r_9}{r}+\frac{r^2}{r_{10}^2}\right) - \left(1+\frac{r_{10}}{r}-\frac{r^2}{r_1^2}\right).$$

But this requires further consideration.
A consequence of the "Big in the Small" problem is that all hierarchical chains must begin with a single largest core (e.g., the inner boundary of the mega-Universe with a base radius $r_1 \sim 10^{39}$ cm) and end at a single smallest core (e.g., the instanton core with a base radius $r_{10} \sim 10^{-55}$ cm) (see Figures 1, 2, and 4b), since if the largest core is located inside the smallest core, their boundaries (or rather, their boundaries) must touch (see Figures 16).

However, if there is only one smallest core for all hierarchical chains converging to it (see Figures 4b and 15), then the question of the geographic location of the instanton core arises. As strange as it may sound, if the boundaries of the smallest core touch (i.e., practically coincide) with the boundary of the largest core, then it turns out that the "instanton's" core is located everywhere in the mega-Universe.

*Perhaps Niels Bohr would have considered such a theory crazy enough to be true.*

**Fig. 14:** Fractal illustrations of the convergence of all hierarchical chains of different-scale "corpuscle's" cores to a single smallest core (e.g., an "instanton")

An inherent consequence of the uniqueness of the "mega-Universe's" core, which coincides internally with the "instanton's" core, is the requirement of signature (i.e., topological) completeness and vacuum balance. This means that this single mega-mini-core must possess "quark"-"antiquark" completeness. That is, the metric-dynamic model of the mega-mini "corpuscle" must be described by a neutral ranking.

$$\begin{array}{l}
(+\ +\ +\ +)\\
(-\ -\ -\ +)\\
(+\ -\ -\ +)\\
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(-\ +\ +\ -)\\
(+\ +\ -\ +)\\
(-\ -\ +\ +)\\
(+\ -\ +\ +)\\
(-\ +\ -\ +)\\
\underline{(+\ -\ -\ -)}\\
(0\ \ 0\ \ 0\ \ 0)_{+}
\end{array} \qquad (303)$$

where each signature in the ranking (303) corresponds to a mega-mini Universal's "quark" or "antiquark" from Table 1, and each of them is described by 10 metrics of the type (233) – (241) with the corresponding signature and with the corresponding radii, for example:

**Mega-mini Universal $u_r$ -"ANTIQUARK"** (232)

A global unstable "convex-concave" vacuum state
with a signature (– + + –), consisting of:

**The outer shell of the mega-mini-Universal $u_r$ –"antiquark"**

in the interval [$r_1$,$r_{10}$], with a signature (– + + –)

I $$ds_1^{(-++-)2} = -\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (233)$$

H $$ds_2^{(-++-)2} = -\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (234)$$

V $$ds_3^{(-++-)2} = -\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (235)$$

H′ $$ds_4^{(-++-)2} = -\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2; \quad (236)$$

**The core of the mega-mini-Universal $u_r$ -"antiquark"**

in the interval [$r_{10}$,$r_1$], with a signature (– + + –)

I $$ds_1^{(-++-)2} = -\left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_1^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_1^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (237)$$

H $$ds_2^{(-++-)2} = -\left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_1^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_1^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (238)$$

V $$ds_3^{(-++-)2} = -\left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_1^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_1^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (239)$$

H′ $$ds_4^{(-++-)2} = -\left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_1^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_1^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2; \quad (240)$$

**The substrate**

in the interval [0,∞], with a signature (– + + –)

*i* $$ds_5^{(-++-)2} = -c^2dt^2 + dr^2 + r^2(d\theta^2 - sin^2\,\theta\, d\phi^2). \quad (241)$$

Based on metric solutions to Einstein's vacuum equation with a large (more precisely, practically infinite) number of $\pm\Lambda_j$-terms and the mathematical methods of Geometrized Vacuum Physics Based on the Algebra of Signature (GVPh&AS) [3,4,5,6,7,8,9,10,11,12,13,14,15], we can obtain a powerful, multi-level mental reflection of the world in our consciousness, equipped with tools for a deeper understanding of this global illusion.

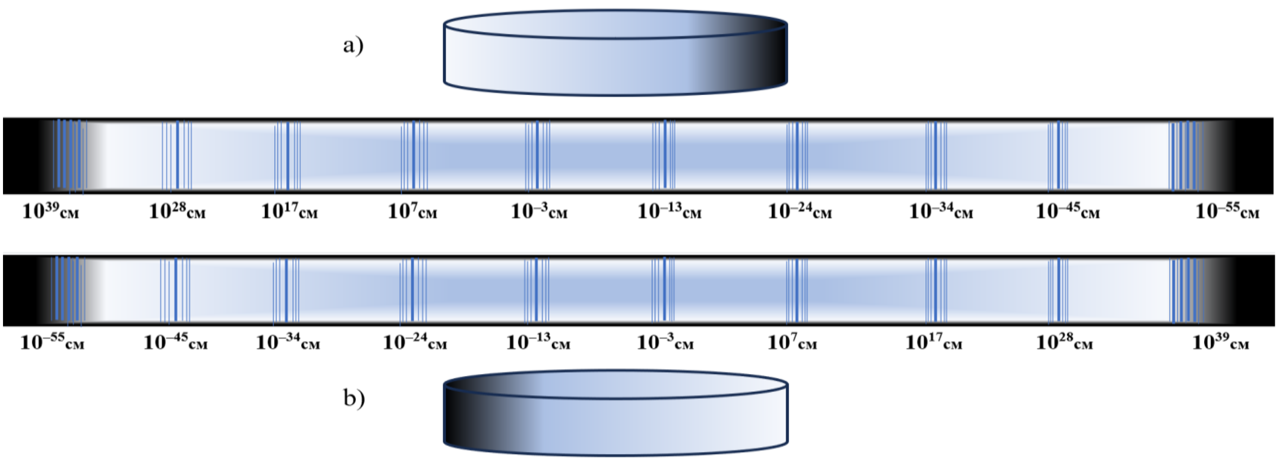


**Fig. 15:** Discrete-infinite spectrum of cores radii
a) "corpuscles" and b) "anticorpuscles" in centimeters

The spectrum of radii of "corpuscle" and "anticorpuscle" cores has the following discrete-infinite structure (Figure 15). The only core of the first largest "corpuscle" (for example, the "mega-Universe" with a base radius $r_1 \sim 10^{39}$ cm) in each hierarchical chain and the only core of the last smallest "corpuscle" (for example, the core of the "instanton" with a base radius $r_{10} \sim 10^{-55}$ cm) in the same chain have a practically infinite number of spherical frills with very close radii (i.e., these shells are practically fused with each other).

Furthermore, the basic radii of the core of "corpuscles" and "anticorpuscles" (more precisely, "quarks" and "antiquarks") from hierarchy (59) differ from each other in magnitude by approximately 10 orders of magnitude (Figure 16). However, the shell (spherical shell) surrounding the core of each of the "quarks" and "antiquarks" is further split into 12 +12 = 24 spherical layers (see §9). Furthermore, "quarks" and "antiquarks" of different scales form a multitude of "atoms" and "molecules" with their own core radii. Thus, each basic radius from hierarchy (59) is split into a virtually infinite number of sub-radii. As a result, in the Closed Mega-Universe, the spectrum of core's radii of "corpuscles" and "anticorpuscles" of different scales is practically discretely infinite. Thus, "the INFINITE gives birth to the Infinite, but conditionally discrete," while each diskette is also practically infinite.

We extend our philosophical understanding of Existence with the question: "Can the LIVING give birth to the nonliving?" A similar analysis more inclines us to the answer: "It cannot!" This means that everything comprehended by geometrized physics is only the corporeal shells of living beings. We are inclined to believe that elementary "particles," "atoms," and "molecules" are the bodies of Fermi viruses, Fermi bacteria, and Fermi organisms, while "corpuscles" with core on a planetary and stellar scale are the bodies of planetary and stellar viruses, bacteria, and organisms (see Fig. 16). In turn, "corpuscles" with core on a galactic scale are the bodies of galactic viruses, bacteria, and organisms.

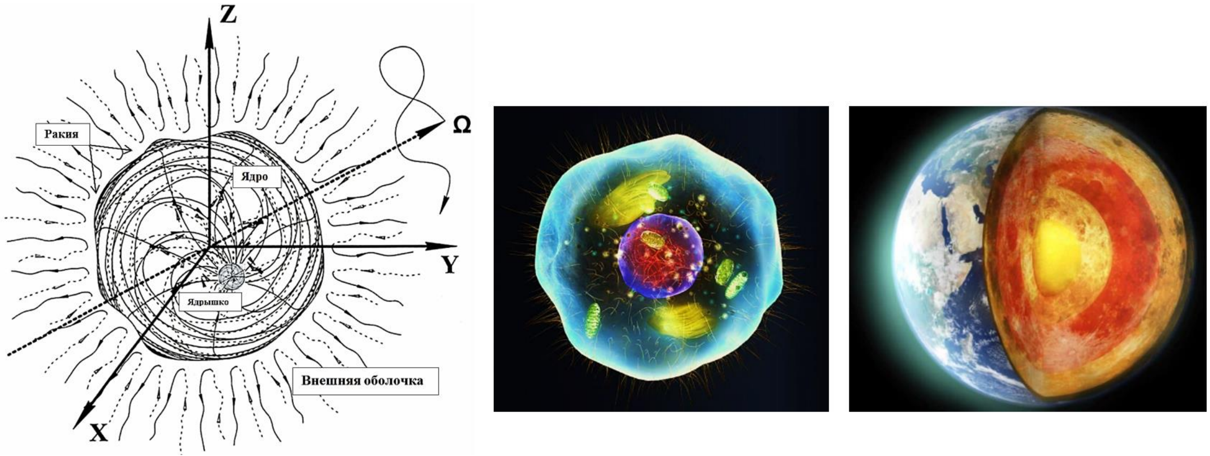


**Fig. 16:** Visual analogy between the bodily shells (core) of an "electron" (204) – (207), a biological cell, and a planet

In this regard, it makes sense to test the hypothesis, already expressed many times by naturalists and philosophers, that the development of the Universe is connected not with the Big Bang, but with the formation of the Mother's Womb and the growth of the Universal Embryo within Her (see Figure 17).

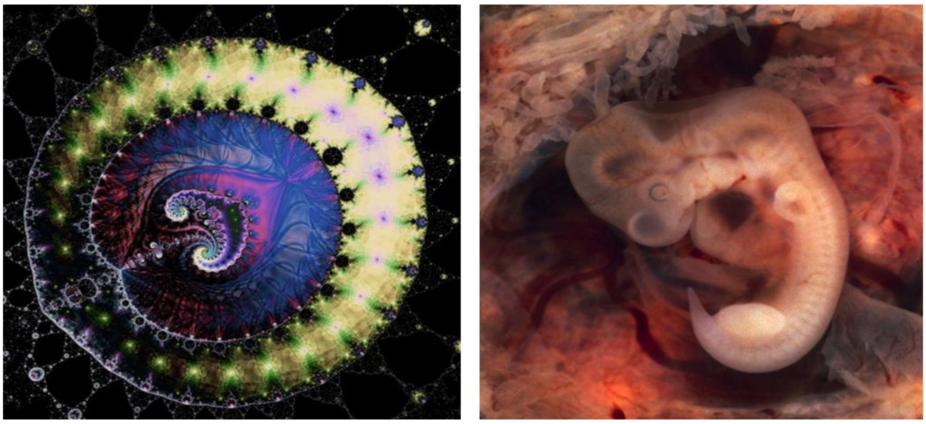

**Fig. 17:** Illustration of the development of the Embryo in the Universal Maternal Womb (i.e., in a Closed Cavity)

Philosophers and scientists of the 17th–19th centuries unwittingly killed Nature in human consciousness through deterministic mathematics and simplification of models of observable phenomena. They reduced the manifestations of Living Reality (of Baruch Spinoza and Gottfried Leibniz) to the actions of a mechanism. Nietzsche declared, "God is dead, and I was at His funeral." But in the 20th century, something went wrong; determinism spiraled out of control and gave way first to chance, then to probability, and finally to rationality.

In the works of Ilya Prigogine on "Dissipative Structures" [20] and in the works of Melvin Vopson on "Infodynamics" [21, 22], it is shown that when approaching equilibrium, Nature behaves intelligently. Complex (at first glance, chaotic) systems strive for information ordering, data compression, and symmetry. The "information entropy" of a system tends not to increase, but to decrease or remain constant [21]. In the works of M. Vopson, information is not an abstract concept, but a physical substance underlying our reality. For example, in the article [22], it is shown that the "information force", which causes particles to group together to optimize data, is equivalent to Newton's law of universal gravitation [21]. The ideas presented in M. Vopson's Infodynamics are in many ways consistent with Einstein's vacuum equations, which predetermine the informational frugality of forms and the energy-efficient dynamics of the most optimal and stable vacuum formations: "corpuscles" and "anticorpuscles". Einstein's vacuum equations initially programmed the potential efficiency and informational economy of forms and movement.

A comparison of the stages of abdominal expansion in a pregnant woman and the growth of an embryo in the womb (see Figure 18) with the stages of the expansion of the Universe within the Big Bang theory reveals the similarity of these optimal processes. Both processes are characterized by the same pattern: a nearly point-like start → explosive initial growth → rapid growth followed by deceleration → linear decelerating growth → transition to accelerated growth. Also similar are the transitions from chaos to structure, the emergence of the first free light (after 380,000 years), and the appearance of a heartbeat (after 4 weeks). However, the growth curves for the mass of baryonic matter in the Universe and the mass of an embryo in the womb due to cellular division do not coincide.

If we look closely, we see that NATURE (ELOHIM) has no other way to Co-create and Create something Meaningful than by Generating (i.e., identifying and organizing self-sustaining structures). Explosion is more associated not with Creation, but with destruction and chaos (i.e., with an increase in entropy).

*“Quarks” and “antiquarks” of various levels of Being (picoscopic, microscopic, planetary, galactic, Universal, etc.), considered in this work and in GVPh&AS as a whole, largely correlate in meaning and qualities with the monads in the Monadology of Gottfried Wilhelm Leibniz.*

Many researchers see direct analogies between the processes occurring in biological life forms and in cosmological structures. For example, the structure of neurons in the cerebral cortex (dendrites, axons, synapses) is remarkably similar to the structure of the cosmic web of dark matter. Furthermore, the distribution of galaxies on large scales obeys the same statistical laws as the distribution of synaptic connections in the brain. The Universe Breathes and Thinks. Through the human mind, It re-conceptualizes Itself.

However, in academic circles, such views are viewed with great caution, i.e., not as an object of research, but as metaphors.

In 1997, Juan Maldacena showed that a universe with negative curvature (i.e., anti-de Sitter space, or AdS) is mathematically identical to quantum conformal field theory (CFT) on the boundary of such a world (i.e., he proved the AdS/CFT correspondence). Many modern physicists suggest that this is also true for Universes with positive or zero curvature, and this may be a solution to Hawking's paradox about the disappearance of information in a black hole. Therefore, the idea of a Holographic Universe, in which our three-dimensional world is a projection of quantum information recorded by a Grand Quantum Computer onto the two-dimensional surface of its boundary, similar to how a three-dimensional image in a hologram is encoded on flat film, no longer seems absurd. Thus, within the framework of modern views, reality itself is physically structured as a hologram, with the Highest level of existence being an information code for a lower level, but with more dimensions. Science has only a small "step" left to realize that this world is the Result of the Effort of a Single, Grandiose MIND (GOD). But this “step” is longer than life.

Geometrized Vacuum Physics Based on the Algebra of Signatures (GVPh&AS) and on solutions of Einstein's vacuum equations does not contradict theories that view the world as a digital computer simulation. These worldviews complement each other, since they are based on similar principles of data optimization, information dynamics [21,22], economy of information and energy capacity, and noise-resistant codes and algorithms (see §5 in [1]). Moreover, Riemannian geometry allows the introduction of a tangent geodesic coordinate system at each point of curved space, in which first-order curvature is absent, which suggests the pointlike illusory nature of reality. However, the second derivatives of the metric associated with the curvature tensor cannot be eliminated by any coordinate transformation, so tidal forces remain and can be understood in terms of quantum entanglement between neighboring points of curved space.

The ultimate goal of this work, in conjunction with GVPh&AS [3,4,5,6,7,8,9,10,11,12,13,14,15], is the creation in human consciousness of a grandiose imaginary World, reflecting the superficial manifestations of the Intelligence of external Reality. In this analog simulation of Reality (i.e., in the mental World), the human mind, armed with the mathematics and differential geometry of GVPh&AS and the computing power of friendly artificial neural networks, is capable of peering into previously inaccessible depths and expanses of the Universe and examining many processes that are beyond the reach of our senses and experimental measuring systems. For example, it is possible to visualize and observe processes within the nuclei of atoms and black holes. The criterion for the truth of the theory being created remains Practice, through direct and indirect verification of the predictions of the Hierarchical Cosmological Model and the GVPh&AS. But Beauty is added to Practice, as an attribute of conscious Optimality and the manifested Intelligence of the Created World. The mathematical apparatus of Riemann-Einstein's nullified geometry, together with the Algebra of Signatures [3,4,5,6] and the stochastic quantum mechanics of Edward Nelson [16], generates the harmony of the Raqiyas (i.e., Heavens) of charming Beauty and Grace.


## ACKNOWLEDGEMENTS

I sincerely thank David Reid, Tatyana Levy, Alexander Maslov, Alexander Bolotov and Georgy Usachev for their assistance.


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