GEOMETRIZED VACUUM PHYSICS. PART VI: HIERARCHICAL COSMOLOGICAL MODEL

FÍSICA DEL VACÍO GEOMETRIZADA. PARTE VI: MODELO COSMOLÓGICO JERÁRQUICO

Mikhail Batanov-Gaukhman[1]
(1) Moscow Aviation Institute (National Research University), Institute No. 2 "Aircraft and rocket engines and power plants", st. Volokolamsk highway, 4, Moscow – Russia, 125993
(e-mail: alsignat@yandex.ru)

Recibido: 22/08/2023 - Evaluado: 12/09/2023 - Aceptado: 28/09/2023

ABSTRACT

This article is the sixth part of a scientific project under the general title "*Geometrized vacuum physics based on the Algebra of signature*" (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e). This article proposes a hierarchical cosmological model, which is developed based on the solution of the extended Einstein vacuum equation with an infinite number of lambda terms. The solution of a simplified vacuum equation with ten lambda terms is considered in more detail. As a result, a metric-dynamic model of a discrete hierarchical sequence of stable spherical vacuum formations ("corpuscles"), which are nested into each other like nesting dolls, was obtained. From this hierarchical sequence, the level of elementary particles isolated and examined in more detail. The use of methods and mathematical apparatus of Riemann differential geometry and the Algebra of signature allows us to obtain metric-dynamic models of all elements of the Standard Model of elementary particles: "quarks", "leptons", "nucleons", "mesons", "photons", "gluons", as well as the "atom" of hydrogen and the "atom" of helium. It has been suggested that metric-dynamic models of stable vacuum formations ("corpuscles") of the "stellar-planetary" "galactic" and "universal" levels can be constructed in a similar way. The connection between the extended general theory of relativity and quantum mechanics is shown. At the end of the article, the advantages and disadvantages of the proposed hierarchical cosmological model are considered and the metaphysical prerequisites for resolving the problems that have arisen are outlined.

RESUMEN

Este artículo es la sexta parte de un proyecto científico bajo el título general "*Física del vacío geometrizada basada en el álgebra de firmas*" (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e). En este artículo se propone un modelo cosmológico jerárquico, que se desarrolla a partir de la solución de la ecuación de vacío de Einstein extendida con un número infinito de términos lambda. Se considera con más detalle la solución de una ecuación de vacío simplificada con diez términos lambda. Como resultado, se obtuvo un modelo métrico-dinámico de una secuencia jerárquica discreta de formaciones de vacío esféricas estables ("corpúsculos"), que están anidadas unas en otras como muñecas rusas. A partir de esta secuencia jerárquica, se aísla y examina con más detalle el nivel de partículas elementales. El uso de los métodos y aparatos matemáticos de la geometría diferencial de Riemann y del álgebra de signaturas permite obtener modelos métrico-dinámicos de todos los elementos del Modelo Estándar de partículas elementales: "quarks", "leptones", "nucleones", "mesones", "fotones", "gluones", así como el "átomo" de hidrógeno y el "átomo" de helio. Se ha sugerido que de manera similar se pueden construir modelos métrico-dinámicos de formaciones de vacío estables ("corpúsculos") de los niveles "estelar-planetario", "galáctico" y "universal". Se muestra la conexión entre la teoría general de la relatividad extendida y la mecánica cuántica. Al final del artículo se consideran las ventajas y desventajas del modelo cosmológico jerárquico propuesto y se describen los prerrequisitos metafísicos para resolver los problemas que han surgido.

Keywords: cosmological model, geometrized physics, vacuum, models of elementary particles
Palabras clave: modelo cosmológico, física geometrizada, vacío, modelos de partículas elementales

BACKGROUND AND INTRODUCTION

This work is the sixth in a series of articles under the general title "Geometricized vacuum physics based on the Algebra of Signature." The previous five articles are listed in the references (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e).

In article (Batanov-Gaukhman, 2023e) it was shown that in the Riemann geometry approximation (Figure 1 in (Batanov-Gaukhman, 2023e)) the greatest interest is in Einstein's vacuum equations with the ±Λ term (51) in (Batanov-Gaukhman, 2023e)

$$\begin{cases} R_{ik} + \Lambda_1 g_{ik} = 0, \\ R_{ik} - \Lambda_2 g_{ik} = 0, \end{cases} \tag{1}$$

which, due to the principle of "Fair distribution" set out in §1.5 in (Batanov-Gaukhman, 2023e), are combined into one averaged equation (135) in (Batanov-Gaukhman, 2023e)

$$R_{ik} + ½\, g_{ik}(\Lambda_1 - \Lambda_2) = 0, \tag{2}$$

where $\Lambda_1 = \frac{3}{r_1^2}$, $\Lambda_2 = \frac{3}{r_2^2}$; r_1 is the radius of the first sphere, r_2 is the radius of the second sphere.

When considering the vacuum equation (2), three possible cases were identified (see §3.1 in (Batanov-Gaukhman, 2023e)):

1) $\Lambda_1 - \Lambda_2 = 0$ or $\Lambda_1 = \Lambda_2$; (3)

2) $½\, (\Lambda_1 - \Lambda_2) = \Lambda_\Sigma$; (4)

3) $½\, (\Lambda_1 - \Lambda_2) = -\Lambda_\Sigma$. (5)

Due to the principle of "Absolute absence", also stated in §1.5 in (Batanov-Gaukhman, 2023e), and the condition of "vacuum balance" that follows from this principle, the first condition $\Lambda_1 - \Lambda_2 = 0$ is most preferable, since everything that appears from the vacuum must be in a mutually opposite form.

However, in this case, Eq. (2) takes the form of Einstein's first vacuum equation (42) in (Batanov-Gaukhman, 2023e)

$$R_{ik} = 0, \tag{6}$$

the solutions of which (see §2 in (Batanov-Gaukhman, 2023e)) do not allow us to construct a completely geometrized cosmological model of the world filled with an infinite number of corpuscles.

A completely geometrized cosmological model is understood to be a model representation in which there are no material particles or bodies in the world, but only stable (corpuscular) and unstable deformed regions of vacuum.

The article (Batanov-Gaukhman, 2023e) also considers the second case $½\, (\Lambda_1 - \Lambda_2) = \Lambda_\Sigma$. This condition reduces Eq. (2) to the form of Einstein's second vacuum equation (140) in (Batanov-Gaukhman, 2023e)

$$R_{ik} + g_{ik}\Lambda_\Sigma = 0. \tag{7}$$

Solutions of this equation are considered in §3 in (Batanov-Gaukhman, 2023e). As a result, metric-dynamic models of a mutually opposite pair of single stable spherical vacuum formations of the Schwarzschild-de Sitter "cell" and "anti-cell" type were obtained (see §4 in (Batanov-Gaukhman, 2023e)).

Thus, in the article (Batanov-Gaukhman, 2023e) it was found that the first and second vacuum equations in Einstein's equations (6) and (7) lack the potential to describe a set of stable spherical objects.

In connection with this, at the end of the article (Batanov-Gaukhman, 2023e) an extended third Einstein's vacuum equation (194) with an infinite (more precisely, countless) number of lambda terms was proposed

$$R_{ik} + ½\, g_{ik}(\Lambda_1 + \Lambda_2) = 0, \tag{8}$$

where $\Lambda_1 = \sum_{m=1}^{\infty} \Lambda_m$ and $\Lambda_2 = \sum_{n=1}^{\infty}(-\Lambda_n)$, (9)

here $\Lambda_m = \frac{3}{r_m^2}$, $\Lambda_n = \frac{3}{r_n^2}$; (10)

r_m is the radius of the m-th sphere, r_n is the radius of the n-th anti-sphere.

Let's rewrite the extended vacuum equation (8) taking into account Exs. (9)

$$R_{ik} + ½\, g_{ik}\left(\sum_{m=1}^{\infty} \Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right) = 0. \tag{11}$$

Note that the covariant and ordinary partial derivatives of the tensor on the left-hand side of Eq. (11) are equal to zero (see §6 in (Batanov-Gaukhman, 2023e))

$$\nabla_j\left[R_{ik} + ½\, g_{ik}\left(\sum_{m=1}^{\infty} \Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right)\right] = \frac{\partial\left[\left(R_{ik} + ½\, g_{ik}\left(\sum_{m=1}^{\infty}\Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right)\right]}{\partial x^j} = 0, \tag{12}$$

therefore Eq. (11) is an expression of conservation laws, as well as the first and second Einstein vacuum equations (6) and (7) (see the end of the Introduction and §6 in (Batanov-Gaukhman, 2023e)).

This article is devoted to an attempt to find metric solutions to the extended Einstein vacuum equation (11), and to constructing a metric-dynamic cosmological model of the surrounding world based on these solutions.

Recall that in the geometrized vacuum physics developed here, the subject of study is the $\lambda_{m,n}$-vacuum, i.e. a 3-dimensional landscape illuminated from a void by mutually perpendicular rays of light with a wavelength $\lambda_{m,n}$ from the range $\Delta\lambda = 10^m - 10^n$ cm (see §2.1 in (Batanov-Gaukhman, 2023a)).

MATERIALS AND METHOD

1 Different versions of the extended vacuum equation

The extended vacuum equation (11) can be used for different cosmological models. To show the different possibilities, we write this equation in the following form

$$R_{ik} + ½\, g_{ik} \sum_{m=1}^{\infty} \Lambda_m - ½\, g_{ik} \sum_{n=1}^{\infty} \Lambda_n = R_{ik} + ½\, g_{ik} \sum_{m=1}^{\infty} \frac{3}{r_m^2} - ½\, g_{ik} \sum_{n=1}^{\infty} \frac{3}{r_n^2} = 0. \tag{13}$$

For example, if $½ \sum_{m=1}^{\infty} \Lambda_m = \Lambda$, $\sum_{n=1}^{\infty} \Lambda_n = R$, then Eq. (13) can take the form of Einstein's vacuum equation

$$R_{ik} - ½\, R g_{ik} + \Lambda g_{ik} = 0. \tag{14}$$

If $½\sum_{m=1}^{\infty}\Lambda_m = \Lambda$, $\sum_{n=1}^{\infty}\Lambda_n = 0$, then Eq. (13) takes the form

$$R_{ik} + \Lambda g_{ik} = 0. \tag{15}$$

If $\sum_{m=1}^{\infty}\Lambda_m = 0$, $½\sum_{n=1}^{\infty}\Lambda_n = \Lambda$, then Eq. (13) takes the form of Einstein's second vacuum equation

$$R_{ik} - \Lambda g_{ik} = 0. \tag{16}$$

If the second term in Eq. (13) is represented as an alternating series

$$½\, g_{ik}\left(\sum_{m=1}^{\infty}\Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right) = ½\, g_{ik}\sum_{m=1}^{\infty}(-1)^{m+1}\Lambda_m, \tag{17}$$

then Eq. (13) takes the form

$$R_{ik} + ½\, g_{ik}\sum_{m=1}^{\infty}(-1)^{m+1}\Lambda_m = 0. \tag{18}$$

The covariant and ordinary partial derivatives of the tensors on the left-hand side of all vacuum equations (14), (15), (16) and (18) are zero. This means that all these equations are expressions of the conservation law and can be used as the basis for a cosmological model.

2 Simplified extended vacuum equation

The condition of maintaining the "vacuum balance" (see Introduction (Batanov-Gaukhman, 2023a) and §1.5 in (Batanov-Gaukhman, 2023e)) dictates the need to use Eq. (13)

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

subject to $\sum_{m=1}^{\infty}\Lambda_m - \sum_{n=1}^{\infty}\Lambda_n = R = 0,$ (19)

where $R = g^{ik}R_{ik}$ is scalar curvature.

In this case, Eq. (13) is equivalent to the first vacuum equation (6) $R_{ik} = 0$. It turns out that condition (19) also leads the situation into a logical dead end. Moreover, nothing can be said yet regarding the infinite series $\sum_{m=1}^{\infty}\Lambda_m$ and $\sum_{n=1}^{\infty}\Lambda_n$.

Therefore, at the beginning, we will consider the solutions of the system of simplified extended vacuum equations with ten ±Λ-terms

$$\begin{cases} R_{ik} + g_{ik}\sum_{m=1}^{10}\Lambda_m = 0, \\ R_{ik} - g_{ik}\sum_{m=1}^{10}\Lambda_m = 0. \end{cases} \tag{20}$$

There is no logical basis for limiting the infinite series $\sum_{m=1}^{\infty}\Lambda_m$ to ten terms. Therefore, further calculations should be considered as an analysis of a priori (preliminary) hypothesis.

Let the sum of ten Λ-terms of the series be equal to a specific numerical value Λ_0

$$\sum_{m=1}^{10}\Lambda_m = \Lambda_0. \tag{21}$$

Then the system of equations (20) takes the form of the second vacuum equation (7)

$$\begin{cases} R_{ik} + g_{ik}\Lambda_0 = 0, \\ R_{ik} - g_{ik}\Lambda_0 = 0. \end{cases} \tag{22}$$

The metric solutions of this system of equations correspond to the solutions of the second vacuum equation (see §3.2 in (Batanov-Gaukhman, 2023e) considering $\Lambda_0 = 3/r_0^2$):

- five metrics with signature $(+ - - -)$

$$ds_1^{(+)2} = \left(1 - \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{23}$$

$$ds_2^{(+)2} = \left(1 + \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{24}$$

$$ds_3^{(+)2} = \left(1 - \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{25}$$

$$ds_4^{(+)2} = \left(1 + \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{26}$$

$$ds_5^{(+)2} = c^2 dt^2 - dr^2 - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \tag{27}$$

- and five metrics with signature $(- + + +)$

$$ds_1^{(-)2} = -\left(1 - \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{28}$$

$$ds_2^{(-)2} = -\left(1 + \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{29}$$

$$ds_3^{(-)2} = -\left(1 - \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_0}{r} - \frac{\Lambda_0 r^2}{3}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{30}$$

$$ds_4^{(-)2} = -\left(1 + \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{31}$$

$$ds_5^{(-)2} = -c^2 dt^2 + dr^2 + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{32}$$

but in this case, according to Exs. (10) and (21)

$$\Lambda_0 = \sum_{m=1}^{10} \Lambda_m = \sum_{m=1}^{10} \frac{3}{r_m^2}, \tag{33}$$

$$r_0 = \sum_{m=1}^{10} r_m. \tag{34}$$

Note that when solving the first vacuum equation $R_{ik} = 0$ (see §2 in (Batanov-Gaukhman, 2024b)), r_0 can always be represented as a sum of m terms $r_0 = \sum_{m=1}^{10} r_m$.

To understand further logical constructions, it is necessary to repeat what was written in §§ 3, 4, 5 in (Batanov-Gaukhman, 2023e) in relation to the solution metrics (23) – (32), taking into account the mathematical apparatus of the Signature Algebra.

We substitute series (33) and (34) into the zero component (equal to the denominator of the unit component) of the metric tensor from the metric-solution (23)

$$1 - \frac{r_0}{r} + \frac{\Lambda_0 r^2}{3} = 1 - \frac{r_1 + r_2 + \cdots + r_{10}}{r} + \left(\frac{1}{r_1^2} + \frac{1}{r_2^2} + \cdots + \frac{1}{r_{10}^2}\right) r^2.$$

This expression can be represented as

$$1-\frac{r_1+r_2+\cdots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2= \tag{35}$$
$$=1+\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)-\left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)+\left(1-\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)-\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)+\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)-\left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)+\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)-$$
$$-\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)+\left(1-\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)-\left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right).$$

Indeed, if we open the brackets on the right side of Ex. (35), we get equality.

Similarly, we can write the zero components (equal to the denominators of the unit component) of the metric tensor from the metric-solutions (24) – (26)

$$1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}=1+\frac{r_1+r_2+\cdots+r_{10}}{r}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2= \tag{36}$$
$$=1+\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)-\left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)+\left(1+\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)-\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)+\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)-\left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)+\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)-$$
$$-\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)+\left(1+\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)-\left(1-\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right),$$

$$1-\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}=1-\frac{r_1+r_2+\cdots+r_{10}}{r}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2= \tag{37}$$
$$=1+\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)-\left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)+\left(1-\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)-\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)+\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)-\left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)+\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)-$$
$$-\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)+\left(1-\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)-\left(1+\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right),$$

$$1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}=1+\frac{r_1+r_2+\cdots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2= \tag{38}$$
$$=1+\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)-\left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)+\left(1+\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)-\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)+\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)-\left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)+\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)-$$
$$-\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)+\left(1+\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)-\left(1-\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right).$$

We also write down the zero components and denominators of the unit component of the metric tensor from the metric- solutions (28) – (31)

$$-\left[1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right]=-\left[1-\frac{r_1+r_2+\cdots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2\right]= \tag{39}$$
$$=-1-\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)+\left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)-\left(1-\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)+\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)-\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)+\left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)-\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)+$$
$$+\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)-\left(1-\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)+\left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right),$$

$$-\left[1+\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right]=-\left[1+\frac{r_1+r_2+\cdots+r_{10}}{r}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2\right]= \tag{40}$$
$$=-1-\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)+\left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)-\left(1+\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)+\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)-\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)+\left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)-\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)+$$
$$+\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)-\left(1+\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)+\left(1-\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right),$$

$$-\left[1-\frac{r_0}{r}-\frac{\Lambda_0 r^2}{3}\right]=-\left[1-\frac{r_1+r_2+\cdots+r_{10}}{r}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2\right]= \tag{41}$$
$$=-1+\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)-\left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)+\left(1-\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)-\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)+\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)-\left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)+\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)-$$
$$-\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)+\left(1-\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)-\left(1+\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right),$$

$$-\left[1+\frac{r_0}{r}+\frac{\Lambda_0 r^2}{3}\right]=-\left[1+\frac{r_1+r_2+\cdots+r_{10}}{r}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\cdots+\frac{1}{r_{10}^2}\right)r^2\right]= \tag{42}$$
$$=-1-\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)+\left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)-\left(1+\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)+\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)-\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)+\left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)-\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)+$$
$$+\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)-\left(1+\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)+\left(1-\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right).$$

Each term enclosed in brackets on the right-hand sides of Exs. (35) – (42), when substituted into metrics (23) – (32), is a separate solution of the second Einstein vacuum equation of the form (7).

3 Hierarchy of spherical vacuum formations

"YOU have Arranged all things by measure and number and weight"
Wisdom of Solomon, 11:20

We will try to connect the radii of spherical vacuum formations r_m, included in Exs. (35) – (42), with the discrete hierarchy of characteristic sizes of bodies in the world around us.

Let's assume that the basis of a fully geometrized cosmological model contains only two geometric constants: R_v is the parametric radius of the Universe (cm), and $l_v \approx c\ \Delta t \approx c\cdot 1$ sec $\approx 3\cdot 10^{10}$ cm is the distance that a beam of light travels in a vacuum during a time interval of $\Delta t = 1$ sec.

The path taken by a beam of light in a vacuum in 1 second is taken as a basis for the following reasons. As shown in §7.3 in (Batanov-Gaukhman, 2023c)*, the speed of light is the speed at which the vacuum is broken. As will be found below, it is precisely this break (a spherical abyss-crack) that separates the cores of spherical vacuum formations from their outer shells. With regard to time, only a heuristic answer is possible: 1 sec is an anthropic constant that roughly corresponds to the period of a human heartbeat, while 1 cm is a convenient unit of distance measurement for humans, approximately equal to 1/3 of a human finger phalanx. Naturally, anthropic constants underlie measurements, since man, according to many religious denominations and philosophers, is the measure of everything. Such an anthropic statement seems unconvincing, but it will be revealed later that if we take the path $l_v \approx 3\cdot 10^{10}$ cm as a basis, we get a discrete hierarchical sequence of radii of stable vacuum formations, close to those observed. Whether it is by chance or by the Will of Providence, but the length of the equator of our planet Earth is also approximately $l_{eq} \approx 3\cdot 10^{10}$ cm, if we measure its rough surface not in kilometers, but in meters (i.e. units of length commensurate with the average height of a person). However, is it possible to admit the absence of the Influence of Providence after we learn that the disks of the Sun and Moon in the sky are equal to each other, since the probability of such a coincidence is infinitely small.*

Let's assume that the radii r_m in components (35) – (42) of metrics (23) – (32) are estimated by a heuristic formula consisting of the two above-mentioned constants

$$r_m \sim \frac{R_v^2}{l_v^m}=\frac{R_v^2}{(3\cdot 10^{10})^m}\ \text{cm}. \tag{43}$$

If we assume that $R_v \approx 10^{25}$ cm, then

$$r_m \sim \frac{R_v^2}{l_v^m}=\frac{10^{50}}{(3\cdot 10^{10})^m}\,. \tag{44}$$

We sequentially substitute m from 1 to 10 into formula (44), as a result we obtain a discrete hierarchy of radii:

$r_1 \sim 10^{39}$ cm is radius commensurate with the radius of the mega-Universe*; (44a)
$r_2 \sim 10^{29}$ 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*;
$r_8 \sim 10^{-34}$ 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*.

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 observed spherical macro- and microscopic bodies. The remaining spherical bodies with radii r_1, r_7, r_8, r_9, r_{10} are far beyond the current technical capabilities of observation. To date, we cannot confidently state whether spherical bodies with such dimensions exist or not. However, it is permissible to try to construct a cosmological model (in the status of a working hypothesis) with the participation of these hypothetical stable spherical formations.

Obviously, for example, from the metric-solutions (23) – (27), taking into account the disclosed components of the metric tensor (35) – (38), it is possible to separately isolate and consider a set of five metric-solutions of the form (173) – (178) in (Batanov-Gaukhman, 2023e) of the second vacuum equation of Einstein (140) in (Batanov-Gaukhman, 2023e)

$$ds_1^{(+)2} = \left(1 - \frac{r_b}{r} + \frac{r^2}{r_a^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_b}{r} + \frac{r^2}{r_a^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{45}$$

$$ds_2^{(+)2} = \left(1 + \frac{r_b}{r} - \frac{r^2}{r_a^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_b}{r} - \frac{r^2}{r_a^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{46}$$

$$ds_3^{(+)2} = \left(1 - \frac{r_b}{r} - \frac{r^2}{r_a^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_b}{r} - \frac{r^2}{r_a^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{47}$$

$$ds_4^{(+)2} = \left(1 + \frac{r_b}{r} + \frac{r^2}{r_a^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_b}{r} + \frac{r^2}{r_a^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{48}$$

$$ds_5^{(+)2} = c^2dt^2 - dr^2 - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \tag{49}$$

where a = 1,2,3,…,10; $b = a + 1$.

The set of these five metric-solutions is partly considered in §4 in (Batanov-Gaukhman, 2023e), where it was shown that these Kottler - de Sitter -Schwarzschild metrics describe a metric-dynamic model of a convex spherical vacuum formation, which was called the "Schwarzschild-de Sitter cell". Recall that, as shown in (Batanov-Gaukhman, 2023e), this vacuum formation is stable, since the set of metrics (45) – (59) are solutions of the second vacuum equation (140) in (Batanov-Gaukhman, 2023e), which plays the role of the energy conservation law, just like equations (13) and (20).

Thus, the metric-solutions (23) – (32), considering the expressions (35) – (42), determine the metric-dynamic description of the hierarchical ten-level cosmological model. In this hierarchical model, ten spherical formations of different scales are nested inside each other like nesting dolls. That is, the internal nucleolus of each core, in turn, is the core for the next nucleolus, and so on up to ten iterations, as shown in Figure 1.

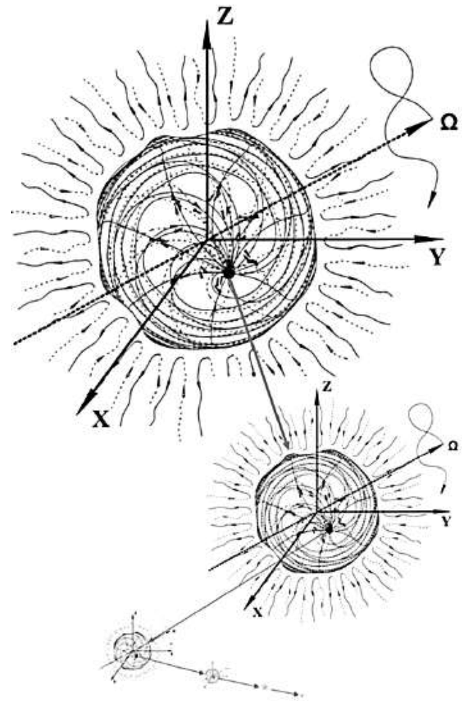


Fig. 1: Sequence of nested spherical formations of different scales

However, this hierarchical ten-level cosmological model has one circumstance that cannot be logically explained. The fact is that from metrics (23) – (32) it follows that the 1st sphere (whose radius is commensurate with the radius of the mega-Universe r_1 ~ 10^{39} cm) is located inside the 10th sphere (with an instanton size of r_{10} ~ 10^{-55} cm). To verify this, follow, for example, the sequence of terms in Ex. (35)

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

Note the last closing term, which contains r_1 and r_{10}. This means that the sphere with radius r_1 is inside the sphere with radius r_{10}, as can be seen from the previous terms of this expression. A similar situation occurs in all Exs. (35) – (42). This closed nature of the 10-level cosmological model requires additional study and understanding.

4 Level of Elementary Particles

4.1 "Electron" and "Positron"

Of all the spherical formations included in the ten-level hierarchy described by the set of metric solutions (23) – (32), the level of elementary particles has been studied most thoroughly. Therefore, we will begin the study of the hierarchical cosmological model with spherical vacuum formations with a characteristic radius r_6 ~ 10^{-13} cm, which corresponds to the size of an elementary particle.

Further, the names of particles (i.e., stable spherical $\lambda_{m,n}$-vacuum formations) are put in quotation marks, for example, "electron" and "positron", since the metric-dynamic models of these spherical formations differ in many ways from the ideas about these formations in modern physics.

In metrics (23) – (27), taking into account (35) – (38), we will leave for consideration only those terms that contain radii $r_6 \sim 10^{-13}$ cm. As a result, we obtain the following multilayer metric-dynamic model of a stable "convex" spherical $\lambda_{-12,-15}$-vacuum formation, which we will call "electron":

"ELECTRON" (50)

Stable "convex" multilayer spherical curvature of $\lambda_{-12,-15}$-vacuum
with signature (+ – – –), consisting of:

The outer shell of the "electron"

in the interval $[r_5, r_6]$ (see Figure 2)

$$ds_1^{(+---)2} = \left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (51)$$

$$ds_2^{(+---)2} = \left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (52)$$

$$ds_3^{(+---)2} = \left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (53)$$

$$ds_4^{(+---)2} = \left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (54)$$

The core of the "electron"

in the interval $[r_6, r_7]$ (see Figure 2)

$$ds_1^{(+---)2} = -\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{-\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (55)$$

$$ds_2^{(+---)2} = -\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{-\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (56)$$

$$ds_3^{(+---)2} = -\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{-\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (57)$$

$$ds_4^{(+---)2} = -\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{-\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (58)$$

The substrate of the "electron"

in the interval $[0, \infty]$

$$ds_5^{(+---)2} = c^2 dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta\, d\phi^2). \quad (59)$$

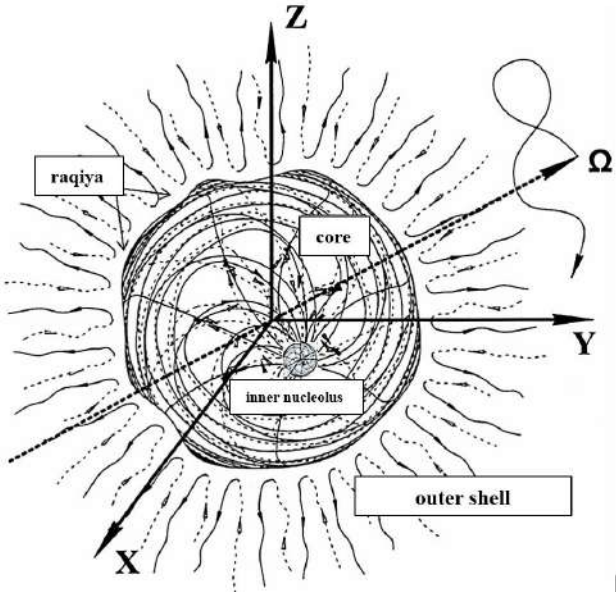


Fig. 2: A fully geometrized model of a convex stable spherical vacuum formation (in particular, an "electron") with four clearly defined regions:
The **core** of the "electron" is the central closed spherical region of $\lambda_{-12,-15}$-vacuum;
The **outer shell** of the "electron" is the region of $\lambda_{-12,-15}$-vacuum surrounding the core of the "electron";
The **raqiya** of the "electron" is a multilayer spherical abyss-crack separating the core of the "electron" from its outer shell;
The **inner nucleolus** is a small closed spherical region of $\lambda_{-12,-15}$-vacuum inside the core of the "electron";
The **substrate** of the "electron" is the original undeformed region of vacuum in which the "electron" is located. This is a kind of memory of what this vacuum region was like before it was deformed and took on the stable form of an "electron"

Similarly, in metrics (28) – (32), taking into account (39) – (42), we will also leave only those terms that contain the radii r_6. As a result, we will obtain the following multilayer metric-dynamic model of a stable "concave" spherical $\lambda_{-12,-15}$-vacuum formation, which we will call "positron":

"POSITRON" (60)

Stable "concave" multilayer spherical curvature of $\lambda_{-12,-15}$-vacuum
with signature (– + + +), consisting of:

The outer shell of the "positron"

in the interval $[r_5, r_6]$ (see Figure 2)

$$ds_1^{(-+++)2} = -\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (61)$$

$$ds_2^{(-+++)2} = -\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (62)$$

$$ds_3^{(-+++)2} = -\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (63)$$

$$ds_4^{(-+++)2} = -\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (64)$$

The core of the "positron"

in the interval [r_6, r_7] (see Figure 2)

$$ds_1^{(-+++)2} = -\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\,d\phi^2), \quad (65)$$

$$ds_2^{(-+++)2} = -\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\,d\phi^2), \quad (66)$$

$$ds_3^{(-+++)2} = -\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\,d\phi^2), \quad (67)$$

$$ds_4^{(-+++)2} = -\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\,d\phi^2); \quad (68)$$

The substrate of the "positron"

in the interval [0, ∞]

$$ds_5^{(-+++)2} = -\,c^2dt^2 + dr^2 + r^2(d\theta^2 + sin^2\,\theta\,d\phi^2). \quad (69)$$

The sets of metrics (50) and (60) differ only in signature. That is, "electron" and "positron" are completely identical, but antipodal (mutually opposite) copies of each other. If "electron" is conventionally called a "convex" stable spherical $\lambda_{-12,-15}$-vacuum formation (see Figure 2), then "positron" is exactly the same conventionally "concave" stable spherical $\lambda_{-12,-15}$-vacuum formation. Such a mutually opposite pair of $\lambda_{-12,-15}$-vacuum formations fully corresponds to the condition of vacuum balance.

Partial analysis of sets of metric-solutions (50) and (60) and using the mathematical apparatus of the Algebra of signature (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e) was performed in §4 in (Batanov-Gaukhman, 2023e), under the condition $r_a = r_6$, $r_b = r_7$. A more detailed study of the "electron" and "positron" will be presented in the following articles of this project. Partial analysis of sets of metrics (50) and (60) is presented in (Batanov-Gaukhman, 2017). In this article, we do not dwell on a detailed study of metric-dynamic models of vacuum formations, since the main goal is to outline the contours of the development of a completely geometrized hierarchical cosmological model.

4.2 Metric-dynamic model of "quarks" and "antiquarks"

Above it was conventionally accepted that the "electron" is a stable spherical convexity of the $\lambda_{-12,-15}$-vacuum, which is described by the set of metrics (51) – (59) with the signature (+ − − −); and the "positron" is an exact opposite copy of the "electron", i.e. a stable spherical concavity of the $\lambda_{-12,-15}$-vacuum, which is described by the set of metrics (61) – (69) with the opposite signature (− + + +).

In the articles (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e), where "Geometrized Vacuum Physics from the Position of the Algebra of Signature" is consistently developed, it is shown that it is necessary to take into account all 16 signatures:

$$\begin{matrix} (++++) & (+++-) & (-++-) & (++-+) \\ (---+) & (-+++) & (--++) & (-+-+) \\ (+--+) & (++--) & (+---) & (+-++) \\ (--+-) & (+-+-) & (-+--) & (----) \end{matrix} \quad (70)$$

Therefore, we introduce the concept of convex-concave $\lambda_{-12,-15}$-vacuum formations, which we will call "quarks".

Table 1: Colored "quarks" and "antiquarks"

Signature type, i.e. number of + and –	«Quarks»		«Antiquarks»		Color "quark" or "antiquark"
	10 metrics of the type (50) with signature:	Designation x_i^+-"quark"	10 metrics of the type (60) with signature:	Designation x_i^--"antiquark"	
1–3	(+ – – –)	e_y^+-"quark" («electron»)	(– + + +)	e_y^--"antiquark" («positron»)	yellow
1–3	(+ + + –)	d_r^+ -"quark"	(– – – +)	d_r^--"antiquark"	red
	(+ + – +)	d_g^+ -"quark"	(– – + –)	d_g^--"antiquark"	green
	(+ – + +)	d_b^+-"quark"	(– + – –)	d_b^--"antiquark"	blue
2–2	(+ – – +)	u_r^+-"quark"	(– + + –)	u_r^--"antiquark"	red
	(+ – + –)	u_g^+ -"quark"	(– + – +)	u_g^--"antiquark"	green
	(+ + – –)	u_b^+-"quark"	(– – + +)	u_b^--"antiquark"	blue
4	(+ + + +)	i_w^+-"quark"	(– – – –)	i_w^--"antiquark"	white

For example, let us represent the u_r^--"antiquark" in expanded form:

u_r^--"ANTIQUARK" (71)

Unstable "convex-concave" multilayer curvature of $\lambda_{-12,-15}$-vacuum
with signature: (– + + –), consisting of:

The outer shell of the u_r^--"antiquark"

in the interval [r_5, r_6]

$$ds_1^{(-++-)2} = -\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (72)$$

$$ds_2^{(-++-)2} = -\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (73)$$

$$ds_3^{(-++-)2} = -\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2, \quad (74)$$

$$ds_4^{(-++-)2} = -\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} + r^2d\theta^2 - r^2sin^2\,\theta\, d\phi^2; \quad (75)$$

The core of the u_r^--"antiquark"

in the interval $[r_6, r_7]$

$$ds_1^{(-++-)2} = -\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (76)$$

$$ds_2^{(-++-)2} = -\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (77)$$

$$ds_3^{(-++-)2} = -\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (78)$$

$$ds_4^{(-++-)2} = -\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2; \quad (79)$$

The substrate of the u_r^--"antiquark"

in the interval $[0, \infty]$

$$ds_5^{(-++-)2} = -c^2dt^2 + dr^2 + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2. \quad (80)$$

The metric-dynamic models of all other "quarks" and "antiquarks" listed in Table 1 are based on a set of metrics of the form (72) – (80), but with the corresponding signature.

Except for the convex "electron" (i.e., e_y^+-"quark") with the signature (+ − − −) and the concave "positron" (e_y^--"antiquark") with the signature (− + + +), all other "quarks" are unstable convex-concave curvature of the $\lambda_{-12,-15}$-vacuum formations, since metrics, for example, of the form (72) – (80) with the signature (− + + −), do not satisfy the stability conditions (7). That is, when substituting the components of metric tensors from metrics of the form (72) – (80), with any other signature except (+ − − −) and (− + + +), into Einstein's second vacuum equation (7), equality does not occur.

4.3 Metric-dynamic models of "proton" and "antiproton"

It was shown above that stable $\lambda_{-12,-15}$-vacuum formations describe only metric-solutions of Einstein's vacuum equations with signatures (+ − − −) and (− + + +). However, not only the "electron" (i.e. e_y^+-"quark") (50) and the "positron" (i.e., e_y^--"antiquark") (60) can be spherical stable formations.

In §2.8 in (Batanov-Gaukhman, 2023b) it was shown that the following mutually opposite triads of signatures are possible, which in sum (or on average) lead to signatures (+ − − −) and (− + + +) (see ranking Exs. (51) – (53) in (Batanov-Gaukhman, 2023b))

$$\begin{array}{lcll} (-\ -\ -\ +) & + & (+\ +\ +\ -) & = 0 \\ (+\ -\ +\ -) & + & (-\ +\ -\ +) & = 0 \\ \underline{(+\ +\ -\ -)} & + & \underline{(-\ -\ +\ +)} & = 0 \\ (+\ -\ -\ -)_+ & + & (-\ +\ +\ +)_+ & = 0 \end{array} \quad (81)$$

$$\begin{array}{lcll} (-\ -\ +\ -) & + & (+\ +\ -\ +) & = 0 \\ (+\ +\ -\ -) & + & (-\ -\ +\ +) & = 0 \\ \underline{(+\ -\ -\ +)} & + & \underline{(-\ +\ +\ -)} & = 0 \\ (+\ -\ -\ -)_+ & + & (-\ +\ +\ +)_+ & = 0 \end{array} \quad (82)$$

$$\begin{array}{lcll} (-\ -\ +\ -) & + & (+\ +\ -\ +) & = 0 \\ (+\ +\ -\ -) & + & (-\ -\ +\ +) & = 0 \\ \underline{(+\ -\ -\ +)} & + & \underline{(-\ +\ +\ -)} & = 0 \\ (+\ -\ -\ -)_+ & + & (-\ +\ +\ +)_+ & = 0. \end{array} \quad (83)$$

Thus, on average, stable spherical vacuum formations with signatures (+ – – –) or (– + + +) can be composed of two different-colored *u*-"quarks" (or *u*-"antiquarks") and one *d*-"quark" (or *d*-"antiquark") from Table 1:

$$\begin{array}{l} d_r^+(+\ +\ +\ -) \\ u_g^-(-\ +\ -\ +) \\ u_b^-\underline{(-\ -\ +\ +)} \\ p_1^-(-\ +\ +\ +)_+ \end{array} \quad (84) \qquad \begin{array}{l} d_g^+(+\ +\ -\ +) \\ u_b^-(-\ -\ +\ +) \\ u_r^-\underline{(-\ +\ +\ -)} \\ p_2^-(-\ +\ +\ +)_+ \end{array} \quad (85) \qquad \begin{array}{l} d_b^+(+\ -\ +\ +) \\ u_r^-(-\ +\ +\ -) \\ u_g^-\underline{(-\ +\ -\ +)} \\ p_3^-(-\ +\ +\ +)_+ \end{array} \quad (86)$$

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

$$\begin{array}{l} d_r^-(-\ -\ -\ +) \\ u_g^+(+\ -\ +\ -) \\ u_b^+\underline{(+\ +\ -\ -)} \\ p_1^+(+\ -\ -\ -)_+ \end{array} \quad (87) \qquad \begin{array}{l} d_g^-(-\ -\ +\ -) \\ u_b^+(+\ +\ -\ -) \\ u_r^+\underline{(+\ -\ -\ +)} \\ p_2^+(+\ -\ -\ -)_+ \end{array} \quad (88) \qquad \begin{array}{l} d_b^-(-\ +\ -\ -) \\ u_r^+(+\ -\ -\ +) \\ u_g^+\underline{(+\ -\ +\ -)} \\ p_3^+(+\ -\ -\ -)_+ \end{array} \quad (89)$$

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

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

$$p_1^- = u_g^- u_b^- d_r^+, \quad p_2^- = u_r^- u_b^- d_g^+, \quad p_3^- = u_g^- u_r^- d_b^+, \tag{90}$$

$$p_1^+ = u_g^+ u_b^+ d_r^-, \quad p_2^+ = u_r^+ u_b^+ d_g^-, \quad p_3^+ = u_g^+ u_r^+ d_b^-. \tag{91}$$

The difference, however, is that in the Standard Model protons consist of quarks and antiprotons consist of antiquarks, whereas in the Algebra of signature the p_i^--"proton" and p_i^+-"antiproton" consist of a mixture of both x_i^+-"quarks" and x_i^--"antiquarks". Therefore, in the Algebra of signature, "matter" (more precisely, spherical vacuum formations) and "antimatter" (more precisely, spherical vacuum antiformations) are mixed, and there is no problem associated with the baryon asymmetry of the Universe. For example, let's imagine a multilayer metric-dynamic model of the p_1^--"proton" (84)

$$\begin{array}{l} d_r^+(+\ +\ +\ -) \\ u_g^-(-\ +\ -\ +) \\ u_b^-\underline{(-\ -\ +\ +)} \\ p_1^-(-\ +\ +\ +)_+ \end{array}$$

in expanded form (where $r_5 \sim 10^{-3}$ cm, $r_6 \sim 10^{-13}$ cm, $r_7 \sim 10^{-24}$ cm):

P_1^--"PROTON" (92)

A stable, on average, concave, multilayered, spherical $\lambda_{-12,-15}$-vacuum formation
with a common signature of (– + + +), consisting of:

d_r^+-"quark" (93)

Unstable "convex-concave" multilayer curvature of $\lambda_{-12,-15}$-vacuum
with signature: (+ + + –), consisting of:

The outer shell of the d_r^+-"quark" (+ + + –)
in the interval [r_5, r_6] (Figure 3)

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

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

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

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

The core of the d_r^+-"quark" (+ + + –) (94)

in the interval [r_6, r_7] (Figure 3)

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

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

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

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

The substrate of the d_r^+-"quark" (+ + + –) (95)

in the interval [0, ∞]

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

u_g^--"antiquark" (96)

Unstable "convex-concave" multilayer curvature of $\lambda_{-12,-15}$-vacuum
with signature: (– + – +), consisting of:

The outer shell of the u_g^--"antiquark" (– + – +)

in the interval [r_5, r_6] (Figure 3)

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

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

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

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

The core of the u_g^--"quark" (– + – +) (97)

in the interval [r_6, r_7] (Figure 3)

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

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

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

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

The substrate of the u_g^--"quark" (– + – +) (98)

in the interval [0, ∞]

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

u_b^--"antiquark" (99)

Unstable "convex-concave" multilayer curvature of $\lambda_{-12,-15}$-vacuum
with signature: (– – + +), consisting of:

The outer shell of the u_b^--"antiquark" (− − + +)
in the interval [r_5, r_6] (Figure 3)

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

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

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

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

The core of the u_b^--"antiquark" (− − + +) (100)
in the interval [r_6, r_7] (Figure 3)

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

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

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

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

The substrate of the u_b^--"antiquark" (− − + +) (101)
the interval [0, ∞]

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

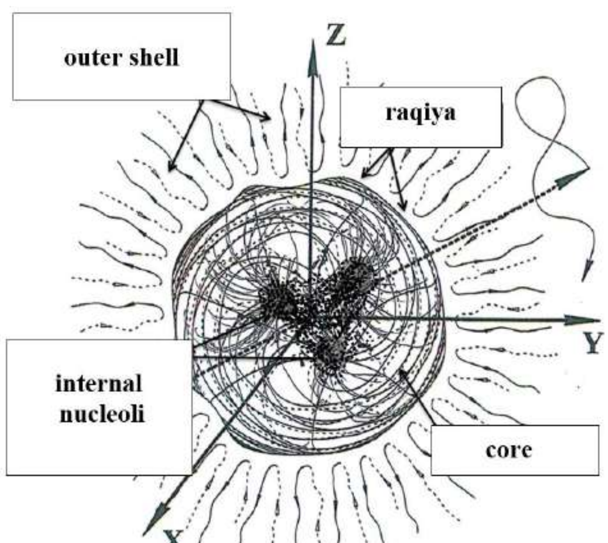


Fig. 3: A spherical vacuum formation consisting of three colored "quarks" and antiquarks" (in particular, a "proton"). The internal nucleoli of these 3 valence "quarks" and "antiquarks" are in constant chaotic motion relative to each other

When averaging the homogeneous terms in the metrics (93) – (101), we obtain a set of metrics (61) – (69), describing the metric-dynamic state of the "positron". However, it should be expected that the radius of the "proton" core, consisting of the cores of three "quarks" and "antiquarks", will be larger than the radius of the "positron" core, since the internal nucleoli of the three "quarks" and "antiquarks", interacting in a complex way repel each other from the common center $r = 0$ (Figure 3).

The problem of confinement of three convex-concave spherical formations, for example: d_r^+-"quark", u_g^--"antiquark" and u_b^--"antiquark" is solved by itself, since each x_i^+-"quark" or x_i^--"antiquark" (except e_y^- and e_y^+) is an unstable state of the $\lambda_{-12,-15}$-vacuum.

Separately the d_r^+-"quark", u_g^--"antiquark" and u_b^--"antiquark" cannot exist for long, since the sets of metrics (93) – (101) describing them are not solutions of the second Einstein's vacuum equation (7) separately. Only together they form a stable, on average, "concave" $\lambda_{-12,-15}$-vacuum formation, which we have conventionally called p_i -"proton" (see Figure 3).

The centers of the inner nucleoli of the three "quarks" and "antiquarks" (in particular, $u_g^- u_b^- d_r^+$) inside the nucleus of the "proton" must wander so chaotically relative to the common center $r = 0$ and relative to each other (see Figure 3) that only on average their centers coincide with the common center: $\langle r_g \rangle = 0$, $\langle r_b \rangle = 0$, $\langle r_r \rangle = 0$. Therefore, we are forced to apply not only a metric-dynamic, but also a statistical description of intranuclear processes, which is partly considered in (Batanov-Gaukhman, 2024) and in §4.9.

The interior of the "proton" core is constantly rapidly transitioning from one quark state to another (i.e. from a state with one composition of colored "quarks" and "antiquarks" to a state with another composition). In other words, the deformations of the $\lambda_{-12,-15}$-vacuum inside the "proton" core are constantly rearranging in a complex manner. Therefore, on a real-time scale, we are dealing with an average state of the "proton"

$p^- = 1/3\,(p_1^- + p_2^- + p_3^-)$ or $p^- = 1/3\,(u_g^- u_b^- d_r^+ + u_r^- u_b^- d_g^+ + u_g^- u_r^- d_b^+)$.

The sets of metrics (93) – (101) using the mathematical apparatus of the Algebra of signature (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e) allow us to extract information about a set of processes and sub-processes occurring inside the core of the "proton" or "antiproton". A more complete geometrized physics of "nucleons" is supposed to be presented in the following articles of this project.

4.4 Metric-dynamic model of the "neutron"

In modern nuclear physics (quantum chromodynamics) it is believed that the neutron consists of two d-quarks with a charge of $(-1/3)e$ and one u - quark with a charge of $(2/3)e$ (where e is the charge of the electron)

$n = ddu$.

As a result of such a combination, the neutron turns out to be an electrically neutral particle with a zero-total charge

$(-1/3)e + (-1/3)e + (2/3)e = 0$.

In the geometrized vacuum physics developed here, not a single 3-"quark" particle with a zero electric environment is obtained. Since there is not a single additive combination of three of the 16 signatures (70) that lead to a zero signature (0 0 0 0). As it turns out later, zero signature means neutrality.

The desired result is achieved in the case of rankings consisting of four signatures. Therefore, an electrically neutral "particle" ("neutron") can have the following topological (nodal) configurations:

$$\begin{array}{llll}
\begin{array}{l} i_w^{-}\,(-\;-\;-\;-) \\ d_b^{+}(+\;-\;+\;+) \\ u_r^{-}\,(-\;+\;+\;-) \\ d_g^{+}\underline{(+\;+\;-\;+)} \\ n_1^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array} &
\begin{array}{l} i_w^{-}\,(-\;-\;-\;-) \\ d_g^{+}\,(+\;+\;-\;+) \\ d_r^{+}\,(+\;+\;+\;-) \\ u_b^{-}\,\underline{(-\;-\;+\;+)} \\ n_2^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array} &
\begin{array}{l} i_w^{-}\,(-\;-\;-\;-) \\ d_b^{+}\,(+\;-\;+\;+) \\ u_g^{-}\,(-\;+\;-\;+) \\ d_r^{+}\,\underline{(+\;+\;+\;-)} \\ n_3^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array} &
\begin{array}{l} i_w^{-}\,(-\;-\;-\;-) \\ u_g^{-}\,(-\;+\;-\;+) \\ d_b^{+}\,(+\;-\;+\;+) \\ d_r^{+}\,\underline{(+\;+\;+\;-)} \\ n_4^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array} \\
\\
\begin{array}{l} i_w^{+}\,(+\;+\;+\;+) \\ d_b^{-}\,(-\;+\;-\;-) \\ u_r^{+}\,(+\;-\;-\;+) \\ d_g^{-}\,\underline{(-\;-\;+\;-)} \\ n_5^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array} &
\begin{array}{l} i_w^{+}\,(+\;+\;+\;+) \\ d_g^{-}\,(-\;-\;+\;-) \\ d_r^{-}\,(-\;-\;-\;+) \\ u_b^{+}\,\underline{(+\;+\;-\;-)} \\ n_6^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array} &
\begin{array}{l} i_w^{+}\,(+\;+\;+\;+) \\ d_b^{-}\,(-\;+\;-\;-) \\ u_g^{+}\,(+\;-\;+\;-) \\ d_r^{-}\,\underline{(-\;-\;-\;+)} \\ n_7^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array} &
\begin{array}{l} i_w^{+}\,(+\;+\;+\;+) \\ u_g^{+}\,(+\;-\;+\;-) \\ d_b^{-}\,(-\;+\;-\;-) \\ d_r^{-}\,\underline{(-\;-\;-\;+)} \\ n_8^{0}\,(0\;\;0\;\;0\;\;0)_{+} \end{array}
\end{array} \tag{103}$$

Let's recall that each signature in the rankings (103) corresponds to a "quark" or "antiquark" from Table 1, and each of them is described by 10 metrics of the form (72) – (80) with the corresponding signature.

In these rankings, in addition to the d- and u-"quarks" known in quantum chromodynamics, there are two exotic white i_w-"quarks" (i from the word invisible):

a white i_w^{+}-"quark", i.e. 10 metrics of the type (71) with the signature (+ + + +);

a white i_w^{-}-"antiquark", i.e. 10 metrics of the type (71) with the signature (– – – –).

These i_w-"quarks" are called white because they are practically invisible inside the "neutron" core, since from the point of view of topology, they represent a "dot" and an "anti-dot" (see §2.4 in (Batanov-Gaukhman, 2023b)). Apparently, this is why their presence in the "neutron" core was not detected experimentally and was not taken into account by the Standard Model.

Thus, within the framework of the Algebra of signature, the eight possible states of the "neutron" can be represented as rankings (103) or in a more traditional form:

$$\begin{array}{llll}
n_1^0 = i_w^{-}d_b^{+}d_g^{+}u_r^{-}, & n_2^0 = i_w^{-}d_r^{+}d_g^{+}u_b^{-}, & n_3^0 = i_w^{-}d_r^{+}d_b^{+}u_g^{-}, & n_4^0 = i_w^{-}d_r^{+}d_b^{+}u_g^{-}, \\
n_5^0 = i_w^{+}d_b^{-}d_g^{-}u_r^{+}, & n_6^0 = i_w^{+}d_g^{-}d_r^{-}u_b^{+}, & n_7^0 = i_w^{+}d_b^{-}d_r^{-}u_g^{+}, & n_8^0 = i_w^{+}d_b^{-}d_r^{-}u_g^{+}.
\end{array} \tag{104}$$

This designation of possible nodal states of the "neutron", however, differs from the notation of the neutron composition in quantum chromodynamics (102) by the presence of barely distinguishable i_w^{+}-"quark" and i_w^{-}-"antiquark".

Due to the complex intranuclear topological metamorphoses, any combination of 4 "quarks" and "antiquarks" (103) can be rebuilt in such a way that within a given vacuum formation a p_i^{-}-"proton" and an "electron" (i.e. a hydrogen "atom") are obtained:

$$\boxed{n_1^0\text{-"neutron"}} \quad \begin{array}{c} (-\,-\,-\,-) \\ (+\,-\,+\,+) \\ (-\,+\,+\,-) \\ \underline{(+\,+\,-\,+)} \\ (0\;0\;0\;\;0)_{+} \end{array} \longrightarrow \begin{array}{c} (+\,-\,+\,+) \\ (-\,+\,+\,-) \\ (-\,+\,-\,+) \\ \underline{(+\,-\,-\,-)} \\ (0\;\;0\;0\;0)_{+} \end{array} \begin{array}{l} \leftarrow \boxed{p_i^{-}\text{-"proton"}} \\ \\ \leftarrow \boxed{\text{"electron"}} \end{array} \tag{105}$$

It is logical to assume that such a restructuring (i.e. untying of the topological knot) inside the core of the "neutron" in some cases leads to a decay reaction

$$n \to p^{-} + e^{+} + \nu_{e+}, \qquad (106)$$

where ν_{e+} is the electron "neutrino".

It is obvious that in such processes the law of conservation of signs "+" and "−" is in effect. For example, in the ranking expression (105) before the transformation 8 "+" and 8 "−" and after the transformation 8 "+"and 8 "−".

The relationship between the signature of the metric extension and its topology is shown in §2.4 in (Batanov-Gaukhman, 2023b)

Another significant difference of the proposed theory from modern nuclear physics is that as a result of intranuclear transformations the configuration of "quarks" inside the nucleus of the "neutron" can be formed in the form of a p_1^{+}-"antiproton" and a "positron" (i.e. an "anti-atom" of hydrogen)

$$\boxed{n_1^0\text{-"neutron"}} \quad \begin{array}{l} (-\ -\ -\ -) \\ (+\ -\ +\ +) \\ (-\ +\ +\ -) \\ \underline{(+\ +\ -\ +)} \\ (0\ \ 0\ \ 0\ \ 0)_{+} \end{array} \longrightarrow \begin{array}{l} (+\ -\ +\ -) \\ (-\ +\ -\ -) \\ (+\ -\ -\ +) \\ \underline{(-\ +\ +\ +)} \\ (0\ \ 0\ \ 0\ \ 0)_{+} \end{array} \begin{array}{l} \Leftarrow \boxed{p_1^{+}\text{-"antiproton"}} \\ \\ \leftarrow \boxed{\text{"positron"}} \end{array} \qquad (107)$$

This can lead to the process of decay of the "neutron" into p_1^{+}-"antiproton" and "positron"

$$n \to p^{+} + e^{-} + \nu_{e-}, \qquad (108)$$

where ν_{e-} is the positron "neutrino".

Such decays should be registered in practice. If this prediction of the Algebra of signature is not confirmed, then it is necessary to look for the reason for the absence of decays of the type (108).

One of such reasons may be the following: in the case of the transformation of the "neutron" of the type (105), 10 signs change, and in the case of the (107) type transformation, 12 signs change. A change in sign means a restructuring of the intranuclear topology (i.e. a change in the convex-concave state of the local region of the $\lambda_{-12,-15}$-vacuum inside, and possibly outside, the core of the "neutron"), which requires energy expenditure. Therefore, the probability of a transformation with a change in 10 signs of the (105) type is less energy-consuming and therefore more probable than a transformation of the type (107) with a change in 12 signs.

Such an obvious asymmetry can be compensated by considering the transformation of all 8 possible states of the "neutron" (103). In addition, a lower probability does not exclude the possibility of a decay of the type (108). Therefore, the prediction about the possibility of the decay of the neutron not only into a "proton" and "electron", but also into an "antiproton" and "positron" should be studied in detail and experimentally verified.

Intranuclear $\lambda_{-12,-15}$-vacuum fluctuations are so rapidly changing that for a macroscopic observer a "neutron" is the result of averaging all its possible states

$$n = 1/8\,(n_1^0 + n_2^0 + n_3^0 + n_4^0 + n_5^0 + n_6^0 + n_7^0 + n_8^0) =$$
$$= 1/8\,(i_w^- d_b^+ d_g^+ u_r^- + i_w^- d_r^+ d_g^+ u_b^- + i_w^- d_r^+ d_b^+ u_g^- + i_w^- d_r^+ d_b^+ u_g^- + i_w^+ d_b^- d_g^- u_r^+, + i_w^+ d_g^- d_r^- u_b^+, + i_w^+ d_b^- d_r^- u_g^+ + i_w^+ d_b^- d_r^- u_g^+).$$

A separate study should be devoted to the Nuclear Algebra of signatures (i.e. the geometrized physics of "protons" and "neutrons").

4.5 Metric-dynamic model of the deuterium "atom"

Compared to the "neutron" and the "atom" of hydrogen, the "atom" of deuterium is a much more stable neutral spherical vacuum formation.

The deuterium atom can consist of one "proton", one "neutron" and one "electron". The ranking (topological) equivalent of the nodal configuration of such a region of $\lambda_{-12,-15}$-vacuum has the following form:

$$\begin{array}{c|c c c}
 & (+\ +\ +\ -) & & (+\ +\ -\ +) \\
\text{“proton”} & (-\ +\ -\ +) & & (-\ -\ +\ +) \\
 & (-\ -\ +\ +) & & (-\ +\ +\ -) \\
+ & (-\ -\ -\ -) & & (+\ +\ +\ +) \\
\text{"neutron"} & (+\ -\ +\ +) & \text{or} & (+\ -\ +\ -) \quad \text{or} \ldots \\
 & (-\ +\ +\ -) & & (-\ +\ -\ -) \\
\underline{\pm} & (+\ +\ -\ +) & & (-\ -\ -\ +) \\
\underline{\text{“electron”}} & \underline{(+\ -\ -\ -)} & & \underline{(+\ -\ -\ -)} \\
= & {}^2H(0\ 0\ 0\ 0)_+ & & {}^2H(0\ 0\ 0\ 0)_+
\end{array} \qquad (109)$$

where each signature corresponds to a "quark" from Table 1, i.e. a set of 10 metric-solutions of type (71) of the second Einstein’s vacuum equation (7).

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

$$\begin{array}{c|c c c}
 & (-\ -\ -\ +) & & (-\ -\ +\ -) \\
{}^{+}\text{-"antiproton"} & (+\ -\ +\ -) & & (+\ +\ -\ -) \\
 & (+\ +\ -\ -) & & (+\ -\ -\ +) \\
+ & (+\ +\ +\ +) & & (-\ -\ -\ -) \\
\text{"neutron"} & (-\ +\ -\ -) & \text{or} & (-\ +\ -\ +) \quad \text{or} \ldots \\
 & (+\ -\ -\ +) & & (+\ -\ +\ +) \\
+ & (-\ -\ +\ -) & & (+\ +\ +\ -) \\
\underline{\text{"positron"}} & \underline{(-\ +\ +\ +)} & & \underline{(-\ +\ +\ +)} \\
= & {}^2H(0\ 0\ 0\ 0)_+ & & {}^2H(0\ 0\ 0\ 0)_+
\end{array} \qquad (110)$$

Each nodal (topological) configuration (109) or (110) can be realized with some probability, and can eventually pass from one state to another due to intranuclear processes while maintaining the overall result: ${}^2H(0\ 0\ 0\ 0)$.

Within the framework of the hypothesis developed here, there is no "atom" of deuterium and "anti-atom" of deuterium, but only one "atom" of deuterium, in which "quarks" and "antiquarks" are so constantly transformed into each other that for some time this on average spherical $\lambda_{-12,-15}$-vacuum formation is in the state of "atom", and at another time interval it exists in the form of "anti-atom". This concerns all the studied local and global $\lambda_{m,n}$-vacuum formations. Thus, as already noted above, in the proposed hypothesis there is no problem of the baryon asymmetry of the Universe. However, there is another no less complex question: – Why do "matter" and "anti-matter" on average compensate for each other's manifestations (i.e. are absent on average), but at the same time exist?

It is possible to compose many combinations of signatures similar to (109) and (110), which reflect the possibilities of the "color" combinatorics of intranuclear metamorphoses. But the topological configuration of a given "knot" always remains the same: three u-"quarks", three d-"quarks", one i-"quark" and one e-"quark". Therefore, we agree to denote such a topological "knot" as follows:

$$^{2}H = 3u3die, \tag{111}$$

Taking into account the topological properties of metrics with the corresponding signatures (see §2.4 in (Batanov-Gaukhman, 2023b)), we find that this "knot" consists of 3 intertwined tori, 4 oval surfaces and one point.

4.6 Metric-dynamic models of "atoms"

In the previous paragraphs, metric-dynamic models of the "electron", "positron", "proton", "atom" of hydrogen and "atom" of deuterium were obtained from "quarks" and "antiquarks" (see Table 1). In a similar way, all known chemical elements of the Mendeleev periodic table can be "constructed" ("woven") from "quarks" and "antiquarks". In this case, the average sizes of the core of "atoms" r_a should depend on the number of quarks A, forming these "topological nodes"

$$r_a \approx \tfrac{1}{2} A^{1/3} r_6 \approx \tfrac{1}{2} A^{1/3} \cdot 10^{-13}\,\text{cm}. \tag{112}$$

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

$$\begin{array}{ll}
\begin{matrix}(+ & + & - & +)\\(- & - & + & +)\\(- & + & + & -)\end{matrix} & p_2^{-}\text{-“proton”} \\[2ex]
\begin{matrix}(- & + & - & -)\\(+ & - & - & +)\\(+ & - & + & -)\end{matrix} & p_3^{+}\text{-“antiproton”} \\[2ex]
\begin{matrix}(- & + & + & +)\end{matrix} & \text{"positron"} \\[2ex]
\begin{matrix}(- & - & - & -)\\(+ & + & - & +)\\(+ & + & + & -)\\(- & - & + & +)\end{matrix} & n_2^{0}\text{-"neutron"} \\[2ex]
\begin{matrix}(+ & + & + & +)\\(+ & - & + & -)\\(- & + & - & -)\\(- & - & - & +)\end{matrix} & n_8^{0}\text{-"neutron"} \\[2ex]
\begin{matrix}(+ & - & - & -)\end{matrix} & \text{“electron”} \\
\hline
{}^{4}He\ (0\ \ 0\ \ 0\ \ 0)_{+} & \text{helium "atom"}
\end{array} \tag{113}$$

As already noted, the atomic Algebra of signatures (in particular, one of its sections: "vacuum knot topology") requires a separate extensive study, but already now it is possible to formulate some laws of this direction of research:

1) Extended Pauli rule: there are no identical configurations of "quarks" and "antiquarks" in an "atom";
2) "Protons" and "antiprotons", as well as opposite "neutrons" are present in the "atom" in different signature (or color, or topological) configurations;

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

4.7 Metric-dynamic 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_α^- is the color triplet of a quark ($\alpha = r, b, g$); q_α^+ is the color triplet of an antiquark.

Baryons consist of 3 quarks and are given by the formula

$$B = \frac{1}{\sqrt{6}} q_\alpha q_\beta q_\gamma \varepsilon_{\alpha\beta\gamma}, \tag{115}$$

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

"Mesons" and "baryons" are composed in almost the same way within the framework of the Algebra of signature. Let's consider a specific example: three varieties of π-mesons in the theory of strong interactions have the following quark structure

$$\pi^+ = u^- d^+, \quad \pi^0 = \frac{1}{\sqrt{2}}(u^- u^+ - d^+ d^-), \qquad \pi^- = u^+ d^-. \tag{116}$$

In the Algebra of signature, for example, the meson $\pi^+ = u^- d^+$ is represented as rankings (i.e. topological nodes):

$$\begin{array}{lll}
d_r^+\ (+\ +\ \ +\ -) & \qquad d_g^+\ (+\ \ +\ -\ \ +) & \qquad d_b^+(\ +\ -\ \ +\ \ +) \\
\underline{u_g^-\ (-\ \ +\ \ -\ +)} & \qquad \underline{u_b^-\ (-\ -\ \ +\ \ +)} & \qquad \underline{u_r^-\ (\ -\ +\ \ +\ \ -)} \\
\pi_1^+\ (0\ 2+\ 0\ 0)\ _+ & \qquad \pi_2^+\ (0\ \ 0\ 0\ 2+)_+ & \qquad \pi_3^+(0\ \ 0\ 2+\ 0)\ _+
\end{array} \tag{117}$$

where each signature corresponds to a set of 10 metrics of type (71).

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

In turn, the quark construction of the neutral π-meson

$$\pi^0 = \frac{1}{\sqrt{2}}(u^- u^+ - d^+ d^-) \tag{118}$$

may have the following ranking (topological) analogues:

$$\begin{array}{llllll}
 & u_r^+\ (+--+) & & u_g^+\ (+-+-) & & u_b^+\ (++--) \\
 & u_g^-\ (-+-+)_+ & & u_b^-\ (--++)_+ & & u_r^-\ (-++-)_+ \\
- & & - & & - & \\
 & d_r^+\ (+++-) & & d_g^+\ (++-+) & & d_b^+\ (+-++) \\
 & \underline{d_g^-\ (--+-)}_+ & & \underline{d_b^-\ (-+--)}_+ & & \underline{d_r^-\ (-\ --+)}_+ \\
 & \pi_1^0\ (0\ 0\ 0\ 0) & & \pi_2^0\ (0\ 0\ 0\ 0) & & \pi_3^0\ (0\ 0\ 0\ 0)
\end{array} \tag{119}$$

Also, within the framework of the Algebra of signature, all known mesons and baryons of the Standard Model can be constructed (or "braided").

The constructions of the Algebra of signature (AS) differ from the constructions of the Standard Model of elementary particles only by the presence of additional i_w^+-«quark" and i_w^--"antiquark", as well as by the fact that most of the studied multilayer spherical $\lambda_{-12,-15}$-vacuum formations consist of intertwining x_i^+-"quarks" and x_i^--"antiquarks", which allows us to outline ways to solve the problem of baryon asymmetry of the Universe.

4.8 Models of "bosons" in the Algebra of signatures

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

$$ds_в^{(+)2} = g_{ij}^{(+)} dx^i dx^j, \tag{120}$$

where $g_{ij}^{(+)} = \eta_{ij}^{(+)} + h_{ij}^{(+)}$, (121)

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

is a symmetric tensor of the second rank, which is considered as a tensor field on the background of a flat 4-dimensional metric Minkowski space with signature (+ − − −), and all operations of raising and lowering tensor indices are carried out using the unperturbed metric tensor $\eta_{ij}^{(+)}$.

$$\eta_{ij}^{(+)} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} \text{ is metric tensor of Minkowski space with signature } (+\,-\,-\,-). \tag{122}$$

In this case, as shown in (Landau & Lifshitz, 1971; Weinberg, 1972)), the first Einstein vacuum equation $R_{ij} = 0$ is reduced to the wave equation for small perturbations $h_{ij}^{(+)}$:

$$R_{ij} \approx \left(\nabla - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right) h_{ij}^{(+)} = 0. \tag{123}$$

In the Algebra of signatures (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e) at least a two-sided consideration is admissible. That is, in addition to the perturbation of the external side of the vacuum, i.e. the Minkowski space with the signature (+ − − −), it is necessary to take into account the perturbation of the internal side of the vacuum, i.e. the Minkowski anti-space with the signature (− + + +) and the metric

$$ds_в^{(-)2} = g_{ij}^{(-)} dx^i dx^j, \tag{124}$$

where $g_{ij}^{(-)} = \eta_{ij}^{(-)} + h_{ij}^{(-)}$; (125)

$$h_{ij}^{(-)} = \begin{pmatrix} h_+^{(-)} & h_\times^{(-)} \\ h_\times^{(-)} & -h_+^{(-)} \end{pmatrix}, \quad \eta_{ij}^{(-)} = \begin{pmatrix} -1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}. \tag{126}$$

In the case of perturbations of the two-sided $\lambda_{-12,-15}$-vacuum, the equation $R_{ij} = 0$ is reduced to a wave equation of the form

$$R_{ij} \approx \left(\nabla - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}\right)\left(h_{ij}^{(+)} + ih_{ij}^{(-)}\right) = 0. \tag{127}$$

A separate study should be devoted to the geometrized theory of perturbations of the $\lambda_{-12,-15}$-vacuum from the standpoint of the Algebra of signatures (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e). In this article, we will only note that, under small perturbations, the vacuum behaves as an elastic medium in which waves can propagate. In this section, we will present the main mathematical models of Signature Algebra for these wave perturbations.

Based on spectral-stignature analysis (see §2.6 in (Batanov-Gaukhman, 2023a)), we introduce concepts of color photons

Table 2: Colored "photons" and "antiphotons"

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

where $\lambda_{m,n} = \lambda$ is the wavelength of harmonic vacuum disturbances.

The objects ζ_m satisfy the anticommutative relations of the Clifford algebra

$\zeta_m\zeta_k + \zeta_k\zeta_m = 0$ for $m \neq k$, $\zeta_m\zeta_m = 1$,

or $\zeta_m\zeta_k + \zeta_k\zeta_m = 2\delta_{km}$, (128)

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

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

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

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

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

$$\delta_{km}=\begin{pmatrix}1&0&0&0&0&0&0&0\\0&1&0&0&0&0&0&0\\0&0&1&0&0&0&0&0\\0&0&0&1&0&0&0&0\\0&0&0&0&1&0&0&0\\0&0&0&0&0&1&0&0\\0&0&0&0&0&0&1&0\\0&0&0&0&0&0&0&1\end{pmatrix}. \qquad (129)$$

a) "Photon" and "antiphoton"

Harmonic vacuum disturbance, as a special case of the solution of wave equations (127), is described by a complex exponential

(130)

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

We will conventionally call e-"photon" with the stignature $\{+\ -\ -\ -\}$ (see Table 2), (the concept of stignature see in §4 in (Batanov-Gaukhman, 2023a)).

Then the spiral harmonic disturbance, propagating in the opposite side,

(131)

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

we will call e-"antiphoton" with signature {− + + +}.

The level of elementary particles corresponds to the wavelength of harmonic $\lambda_{-12,-15}$-vacuum disturbances in the range $\lambda_{m,n}=\lambda_{-12,-15}=10^{-12}-10^{-15}$ cm.

b) W±-«бозоны»

In the framework of the developing geometrized vacuum physics based on the Algebra of signatures, the three color states of the W+-"boson" are given by the following expressions and the corresponding rankings, which determine a more complex version of the wave disturbance of the $\lambda_{-12,-15}$-vacuum, consisting of three color "photons" and "antiphotons" (here $\lambda_{m,n}=\lambda$)

$$\begin{array}{rl} \exp\{i\,2\pi/\lambda\,(-ct-x-y+z)\}\times & \{-\ -\ -\ +\} \\ \times\exp\{j\,2\pi/\lambda\,(\ \ ct-x+y-z)\}\times & \{+\ -\ +\ -\} \\ \times\exp\{k\,2\pi/\lambda\,(\ \ ct+x-y-z)\} & \underline{\{+\ +\ -\ -\}} \\ & \{+\ -\ -\ -\}_+ \end{array} \tag{132}$$

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

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

Three color states of the W−-"boson": (133)

$$\begin{array}{rl} \exp\{i\,2\pi/\lambda\,(\ \ ct+x+y-z)\}\times & \{+\ +\ +\ -\} \\ \times\exp\{j2\pi/\lambda\,(-ct+x-y+z)\}\times & \{-\ +\ -\ +\} \\ \times\exp\{k\,2\pi/\lambda\,(-ct-x+y+z)\} & \underline{\{-\ -\ +\ +\}} \\ & \{-\ +\ +\ +\}_+ \end{array}$$

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

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

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

$$i^2=j^2=k^2=ijk=-1 \quad \text{and} \quad ij+ji=0. \tag{134}$$

This is a special version of the objects ζ_m (128) – (129).

c) Z^0-"bosons"

The six color states of the Z^0-"boson" are given by the following expressions and their corresponding rankings, consisting of 4-color "photons" and "antiphotons"

(135)

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

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

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

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

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

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

d) "Gluons"

There are 8 types of gluons in quantum chromodynamics:

- colored gluons:

$$g_1 = (r\bar{b} + b\bar{r})/\sqrt{2}\,, \qquad g_2 = -i(r\bar{b} - b\bar{r})/\sqrt{2}, \tag{136}$$
$$g_3 = (r\bar{g} + g\bar{r})/\sqrt{2}, \qquad g_4 = -i(r\bar{g} - g\bar{r})/\sqrt{2},$$

$g_5 = (b\bar{g} + g\bar{b})/\sqrt{2}, \qquad g_6 = -i(b\bar{g} - g\bar{b})/\sqrt{2};$

- colorless gluons:

$$g_7 = (r\bar{r} + b\bar{b})/\sqrt{2}, \qquad g_8 = (r\bar{r} + b\bar{b} - 2g\bar{g})/\sqrt{2}. \tag{137}$$

In the Algebra of stignatures there are 6 stignatures with two identical signs (see (34) in §5.10 in (Batanov-Gaukhman, 2023a))

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

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

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: Selected "photons" and "antiphotons"

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 (136) and (137) using the methods of the Algebra of signature (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e). For example,

$$g_1 = \frac{r\bar{b} + b\bar{r}}{\sqrt{2}} = \left(e^{i\frac{2\pi}{\lambda}(\mathrm{ct}-x-y+z)} \times e^{k\frac{2\pi}{\lambda}(-\,\mathrm{ct}-x+y+z)} + e^{k\frac{2\pi}{\lambda}(\mathrm{ct}+x-y-z)} \times e^{i\frac{2\pi}{\lambda}(-\,\mathrm{ct}-x+y-z)}\right)/\sqrt{2}\,, \tag{138}$$

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

$$g_5 = \frac{b\bar{g} + g\bar{b}}{\sqrt{2}} = \left(e^{k\frac{2\pi}{\lambda}(\mathrm{ct}+x-y-z)} \times e^{j\frac{2\pi}{\lambda}(-\,\mathrm{ct}+x-y+z)} + e^{j\frac{2\pi}{\lambda}(\mathrm{ct}-x+y-z)} \times e^{k\frac{2\pi}{\lambda}(-\,\mathrm{ct}-x+y+z)}\right)/\sqrt{2}\,.$$

These are wave disturbances that are toroidal in nature.

e) "Landscape"

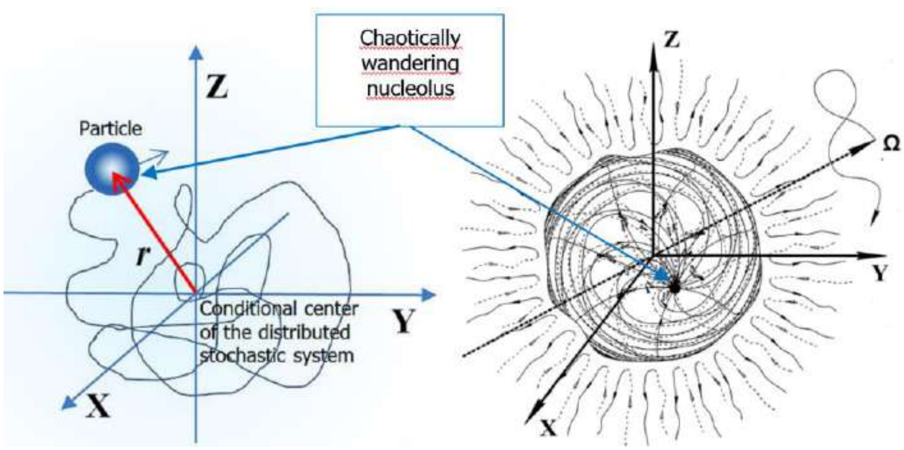
In the geometrized vacuum physics based on the Algebra of signature, there is another "boson" which we call "landscape":

$$
\begin{array}{ll}
\exp\{\zeta_1\, 2\pi/\lambda\,(\;ct + x + y + z)\} & \{+\;\;+\;\;+\;\;+\} \\
\times\exp\{\zeta_3\, 2\pi/\lambda\,(\;ct - x - y + z)\}\times & \{-\;\;-\;\;-\;\;+\} \\
\times\exp\{\zeta_4\, 2\pi/\lambda\,(-ct - x + y - z)\}\times & \{+\;\;-\;\;-\;\;+\} \\
\times\exp\{\zeta_5\, 2\pi/\lambda\,(\;ct + x - y - z)\}\times & \{-\;\;-\;\;+\;\;-\} \\
\times\exp\{\zeta_6\, 2\pi/\lambda\,(-ct + x - y - z)\}\times & \{+\;\;+\;\;-\;\;-\} \\
\times\exp\{\zeta_7\, 2\pi/\lambda\,(\;ct - x + y - z)\}\times & \{-\;\;+\;\;-\;\;-\} \\
\times\exp\{\zeta_8\, 2\pi/\lambda\,(-ct + x + y + z)\}\times & \{+\;\;-\;\;+\;\;-\} \\
\times\exp\{\zeta_1\, 2\pi/\lambda\,(-ct - x - y - z)\}\times & \{-\;\;+\;\;+\;\;+\} \\
\times\exp\{\zeta_2\, 2\pi/\lambda\,(\;ct + x + y - z)\}\times & \{-\;\;-\;\;-\;\;-\} \\
\times\exp\{\zeta_3\, 2\pi/\lambda\,(-ct + x + y - z)\}\times & \{+\;\;+\;\;+\;\;-\} \\
\times\exp\{\zeta_4\, 2\pi/\lambda\,(\;ct + x - y + z)\}\times & \{-\;\;+\;\;+\;\;-\} \\
\times\exp(\zeta_5\, 2\pi/\lambda\,(-ct - x + y + z)\}\times & \{+\;\;+\;\;-\;\;+\} \\
\times\exp\{\zeta_6\, 2\pi/\lambda\,(\;ct - x + y + z)\}\times & \{-\;\;-\;\;+\;\;+\} \\
\times\exp\{\zeta_7\, 2\pi/\lambda\,(-ct + x - y + z)\}\times & \{+\;\;-\;\;+\;\;+\} \\
\times\exp\{\zeta_8\, 2\pi/\lambda\,(\;ct - x - y - z)\} & \{-\;\;+\;\;-\;\;+\} \\
 & \underline{\{+\;\;-\;\;-\;\;-\}} \\
 & \{0\;\;0\;\;0\;\;0\}_+
\end{array}
\tag{139}
$$

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

4.9 Geometrized models of "muons", τ-"leptons", c^+,s^+,b^+,t^+-"quarks" and c^-,s^-,b^-,t^--"antiquarks"

Let us consider the internal nucleus of the "electron" (see Figures 2 and 4). On the one hand, the internal nucleolus of the "electron" is the result of a strong curvature of the $\lambda_{-18,-24}$-vacuum, i.e. it is its local convexity (see § 4 in (Batanov-Gaukhman, 2023e)). On the other hand, the nucleolus can be unwound as a particle with a radius $r_7 \sim 10^{-24}$ cm that wanders chaotically in the vicinity of the conventional center of the “electron” core due to the many random force effects from the fluctuating elastic-plastic medium (i.e., the seething, complexly curved $\lambda_{-18,-24}$-vacuum) and elastic forces that tend to return the nucleolus to the conventional center (see Figure 4).



a) b)

Fig. 4: A simplified representation of the **inner nucleolus** as a solid particle with a radius $r_7 \sim 10^{-24}$ cm, which wanders chaotically in the vicinity of the center of the core of an elementary particle (in particular, an “electron”) due to random force effects from the fluctuating elastic-plastic medium and elastic forces tending to return the nucleolus to the conditional center of the stochastic system under consideration.

The stochastic system shown in Figure 4 is discussed in detail in the author's article (Batanov-Gaukhman, 2024). We repeat some of the main aspects of this article.

The total mechanical energy of the nucleolus at a point with coordinates x, y, z and at time t is equal to

$$E(x,y,z,t) = T(v,x,y,z,t) + U(x,y,z,t), \tag{140}$$

where $T(\mathbf{v},x,y,z,t)$ is the kinetic energy of the nucleolus (particle); $U(x,y,z,t)$ is the potential energy of the nucleolus associated with the elasticity of the environment surrounding it, tending on average to return the given particle to the conditional center of the considered distributed stochastic system (see Figure 4).

All three energies of the nucleolus: $E(x,y,z,t)$, $T(v,x,y,z,t)$ and $U(x,y,z,t)$ are random variables, but such that at each point the considered region of space holds the averaged equality (Batanov-Gaukhman, 2024c)

$$<E(x,y,z,t)> = <T(v,x,y,z,t)> + <U(x,y,z,t)>, \text{ or } <T(v,x,y,z,t)> + <U(x,y,z,t)> - <E(x,y,z,t)> = 0. \tag{141}$$

Let's integrate equation (141) over time

$$\int_{t_1}^{t_2}\left[< T\left(p_x, p_y, p_z, x, y, z, t\right) > + < U(x, y, z, t) > - < E(x, y, z, t) >\right] dt = 0, \tag{142}$$

this is expression the locally averaged balance of the stochastic system.

We will perform global averaging of the locally averaged balance (142) over the entire region in which the nucleolus wanders chaotically (see Figure 4) (Batanov-Gaukhman, 2024)

$$\overline{< S_x >} = \overline{\int_{t_1}^{t_2}\left(T\left(p_x, p_y, p_z, x, y, z, t\right) > + < U(x, y, z, t) > - < E(x, y, z, t) >\right) dt}. \tag{143}$$

When all averaged characteristics of a wandering nucleolus with mass m_k do not depend on time, then the averaged integral (143) can be expressed through the probability amplitudes $\psi(x, y, z)$ (Batanov-Gaukhman, 2024)

$$w = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left(-\frac{\eta_r^2}{2}\psi(x, y, z)\nabla^2\psi(x, y, z) + \psi^2(x, y, z)[< u(x, y, z) > - < \varepsilon(x, y, z) >]\right) dxdydz, \tag{144}$$

where $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ – Laplace operator; $u(x, y, z) = \frac{U(x,y,z,t)}{m_k}$; $\varepsilon(x, y, z) = \frac{E(x,y,z)}{m_k}$; (145)

$\eta_r = \frac{2\sigma_r^2}{\tau_{rcor}}$ is constant scale parameter; (146)

$$\sigma_r = \frac{1}{\sqrt{3}}\sqrt{\sigma_x^2 + \sigma_y^2 + \sigma_z^2} \tag{147}$$

is standard deviation of random 3-dimensional trajectory of chaotically wandering nucleolus relative to conditional center of considered stochastic system (Figure 4);

$$\tau_{rcor} = \frac{1}{3}\left(\tau_{xcor} + \tau_{ycor} + \tau_{zcor}\right) \tag{148}$$

is the autocorrelation interval of this 3-dimensional stationary random process.

The Euler-Poisson equation for the extremal $\psi(x, y, z)$ of the functional (144) turned out to be the stationary Schrödinger equation (Batanov-Gaukhman, 2024)

$$-\frac{3\eta_r^2}{2}\left\{\frac{\partial^2\psi(x,y,z)}{\partial x^2} + \frac{\partial^2\psi(x,y,z)}{\partial y^2} + \frac{\partial^2\psi(x,y,z)}{\partial z^2}\right\} + 2[< u(x, y, z) > - < \varepsilon(x, y, z) >]\psi(x, y, z) = 0, \tag{149}$$

where $\eta_r = \frac{2\sigma_r^2}{\tau_{rcor}} = \sqrt{\frac{2}{3}\frac{\hbar}{m_k}}$, $\hbar$ –is the reduced Planck constant ($\hbar$ = 1,055×10^{-34} J/Hz). (150)

If the elastic tensions of the $\lambda_{-13,-20}$-vacuum surrounding a chaotically wandering nucleolus, on average, increase proportionally to its distance $r = \sqrt{x^2+y^2+z^2}$ from the center of the "electron" core, then the averaged potential energy of the nucleolus has the form (see § 3.6 in (Batanov-Gaukhman, 2020)), devoted to a similar problem)

$$< u(r) > \approx -\frac{1}{2}k_u r^2, \quad (151)$$

where k_u is the coefficient of elastic tension of the deformed $\lambda_{-13,-20}$-vacuum.

Substituting Ex. (151) into the Schrödinger-Euler-Poisson equation (149), we obtain the equation of an isotropic three-dimensional harmonic oscillator known in quantum mechanics (Batanov-Gaukhman, 2024)

$$\nabla^2\psi(r,\theta,\varphi) + \frac{2}{\eta_{nr}^2}\left[\varepsilon_n - \frac{k_u r^2}{2}\right]\psi(r,\theta,\varphi) = 0, \quad (152)$$

where $\nabla^2 = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right) + \frac{\nabla_{\theta,\phi}^2}{r^2}$ is Laplace operator in spherical coordinates. (153)

The solutions of this equation are known to be probability amplitudes (Fradkin, 1965)

$$\psi_{klm}(r,\theta,\phi) = \sqrt{\sqrt{\frac{2}{\pi}\left(\frac{\sqrt{k_u}}{2\eta_{n1}}\right)^3}\frac{2^{k+2l+3}k!}{(2k+2l+1)!!}\left(\frac{\sqrt{k_u}}{2\eta_{n1}}\right)^l} r^l \, exp\left\{-\frac{\sqrt{k_u}r^2}{2\eta_{n1}}\right\} L_l^{(l+1/2)}\left(2\sqrt{\frac{\sqrt{k_u}}{2\eta_{nx1}}r^2}\right) Y_{lm}(\theta,\phi), \quad (154)$$

where

$L_l^{(l+1/2)}\left(2\sqrt{\frac{\sqrt{k_u}}{2\eta_{nx1}}r^2}\right)$ is generalized Laguerre polynomials;

$Y_{lm}(\theta,\phi) = (-1)^m\left[\frac{(2l+1)(l-m)!}{4\pi(l+m)!}\right]^{\frac{1}{2}} e^{im\phi}P_{lm}(cos\,\theta)$ is spherical harmonic functions;

$P_{lm}(cos\,\theta) = \frac{d}{2^l l!}(1-\xi^2)^{m/2}\frac{d^{l+m}}{d\xi^{l+m}} + (\xi^2-1)^l$ is associated Legendre functions;

ξ = cosθ ;
k is principal quantum number;
l is orbital quantum number;
m is peripheral quantum number.

The probability amplitudes (154) correspond to the eigenvalues of the total mechanical energy of the nucleolus (Batanov-Gaukhman, 2020)

$$\varepsilon_{nkl} = \eta_{nr1}\sqrt{k_{ur}}\left(2k+l+\frac{3}{2}\right) = \eta_{nr1}\sqrt{k_{ur}}\left(N+\frac{3}{2}\right), \quad (155)$$

where $N = 2k + l$.

The squares of the modulus of the probability amplitudes (154) $|\psi_{klm}(r,\theta,\phi)|^2$ are the probability distribution density functions (PDFs) of the possible location of a chaotically wandering nucleolus inside the core of an "electron" depending on its discrete energy level (155). The PDF data for φ = 0 and different values of the quantum numbers k, l, and m are shown in Figure 5.

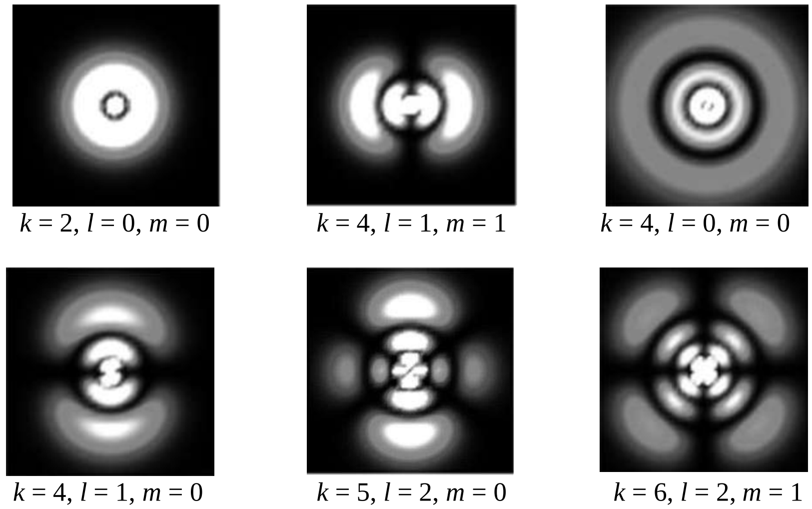


Fig. 5: Probability density functions (PDF) $|\psi_{klm}(r,\theta,\phi)\ |^2$ of the possible location of a chaotically wandering nucleolus inside the core of an "electron" at $\varphi = 0$ and different values of the quantum numbers k, l and m. The lighter the spot, the greater the probability of the nucleolus appearing in this area. The calculations are performed using expressions (154) and are presented on the web page: Spherical_Harmonic_Orbitals.png

From Figure 5 it is evident that each set of three quantum numbers k, l and m corresponds to a unique probability distribution density of the location of a chaotically wandering nucleolus, i.e. a spatial configuration of the average state of the stochastic system under consideration (see § 3.6 in (Batanov-Gaukhman, 2020)).

Thus, we come to the necessity of taking into account that a chaotically wandering nucleolus inside the core of an "electron" (Figure 4) can, on average, be in different average states (see Figure 5).

Now we can put forward the hypothesis that the "electron" is a stable spherical vacuum formation, inside the core of which the chaotically wandering nucleolus is in the ground (i.e. unexcited) state with quantum numbers $k = 0$, $l = 0$, $m = 0$. In this case, the "muon" and τ-"leptons" are an "electron", in which the chaotically wandering nucleolus is in the first and second excited states, respectively.

The same applies to the "positron" and all other "quarks" and "antiquarks". For example, we can assume that the c^+-"quark" and t^+-"quark" are the first and second excited states of the u^+-"quark", respectively, and the s^+-"quark" and b^+-"quark" are the first and second excited states of the d^+-"quark", respectively.

The difference between this hypothesis and the Standard Model of elementary particles is that in the geometrized vacuum physics developed here, the "electron", "positron" and all other "quarks" (see Table 1) may have an infinite number of excited averaged states depending on the quantum numbers k, l and m.

4.10 Metric-dynamic model of "neutrino"

Chapters 6 and 7 in (Batanov-Gaukhman, 2017) are devoted to metric-dynamic models of a moving "electron" and "neutrino". In this article we will only repeat the main conclusions made in (Batanov-Gaukhman, 2017).

With rectilinear and uniform motion of the "electron", for example, along the x-axis with a velocity V_x, its outer shell and core begin to rotate around the direction of motion (see Figure 6a), which is described by Kerr metrics

$$ds_1^2 = \left(1 - \frac{r_6 r}{\rho^2}\right) c^2 dt^2 - \frac{\rho^2 dr^2}{r^2 - r_6 r + a^2} - \rho^2 d\theta^2 - \left(r^2 + a^2 + \frac{r_6 r a^2}{\rho^2} \sin^2\theta\right) \sin^2\theta\, d\phi^2 + \frac{2 r_6 r a}{\rho^2} \sin^2\theta\, d\phi c dt, \quad (156)$$

were $\rho^2 = r^2 + a^2\cos^2\theta$, $a^2 = \frac{r_6^2 V_x^2}{2c^2}$ is ellipticity parameter.

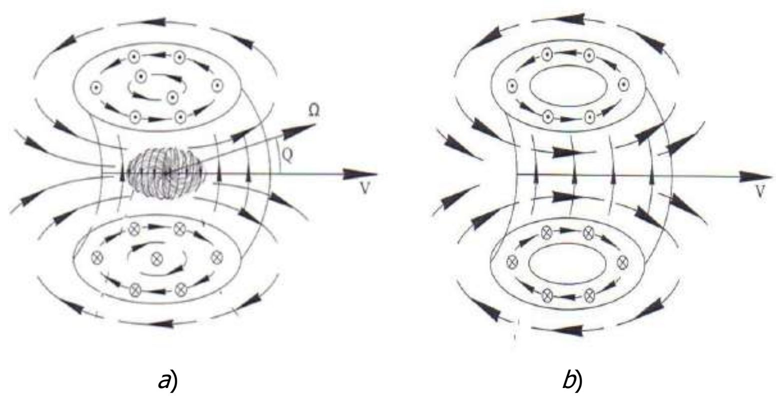


Fig. 6: *a*) The core and outer shell of a moving "electron" rotate around the direction of its motion. *b*) A "neutrino" is a toroidal vortex disturbance of the vacuum without a core in the middle, moving at a speed close to the speed of light.

If the core of a moving "electron" collides, for example, with the core of an "atom" or the core of another "electron" and stops abruptly, a toroidal vortex (Figure 6b) may break away from it, accelerating to a speed close to the speed of light. In the framework of geometrized vacuum physics, such a vacuum vortex is called an electron "neutrino". The metric-dynamic model of the electron "neutrino", presented in Chapters 6 and 7 in (Batanov-Gaukhman, 2017), is much more complex, but in this article, we will limit ourselves to only such a simplified mention of this stable vacuum formation. All other types of "neutrinos" are similar toroidal vacuum vortices moving at the speed of light, which are formed during the rapid movement of other elementary particles, for example, "protons", "neutrons", etc.

4.11 Raqiya of the "electron"

We consider the abyss-crack (raqiya) around the nucleus of an elementary particle using the example of the raqiya of the "electron". The raqiyas of all other "quarks" and "nucleons" are arranged similarly.

Let’s consider the outer shell of the "electron" (see Figure 2), or more precisely the region of $\lambda_{-12,-15}$-vacuum around its core.

The study will be carried out based on the metric (51)

$$ds_1^{(+---)2} = \left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2). \quad (157)$$

According to the hierarchy of radii (44a), $r_5 \sim 10^{-3}$ cm is ten orders of magnitude greater than $r_6 \sim 10^{-13}$ cm. Therefore, near the core of the “electron” (i.e., at $r \geq r_6 \sim 10^{-13}$ cm), the second term $\sim r_6^2/r_5^2$ in the components of the metric tensor of metric (150) can be neglected. In this case, this metric can be simplified

$$ds_1^{(+---)2} = \left(1 - \frac{r_6}{r}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2). \quad (158)$$

From this metric it is clear that at $r = r_6$ there is a singularity, since

$$1-\frac{r_6}{r}=1-\frac{r_6}{r_6}=0. \tag{159}$$

It turns out that $r = r_6$ is the radius of the spherical abyss-crack r_g, that separates the outer shell of the "electron" from its core (see Figures 2 or 4). This region of $\lambda_{-12,-15}$-vacuum is considered in more detail in §4 in (Batanov-Gaukhman, 2023e).

However, upon closer examination, according to the metric (150), the radius of the spherical abyss-crack r_g is determined by the expression.

$$1-\frac{r_6}{r_g}+\frac{r_g^2}{r_5^2}=0, \tag{160}$$

which can be represented as a cubic equation

$$r_g^3+r_5^2r_g-r_5^2r_6=0. \tag{161}$$

This equation, as is known, has three roots $r_{g1},\ r_{g3},\ r_{g3}$ (which are determined by the Tartaglia-Cardano formula). This means that the spherical abyss-crack separating the outer shell from the core is divided into three spherical layers.

Similarly, it is necessary to study the three-remaining metrics (52), (53) and (54), which together with the metric (52) determine the metric-dynamic model of the outer shell of the "electron". As a result, we obtain three more equations for determining the radius of the spherical abyss abyss-crack

$$r_g^3-r_5^2r_g-r_5^2r_6=0,\quad r_g^3-r_5^2r_g+r_5^2r_6=0,\qquad r_g^3+r_5^2r_g+r_5^2r_6=0. \tag{162}$$

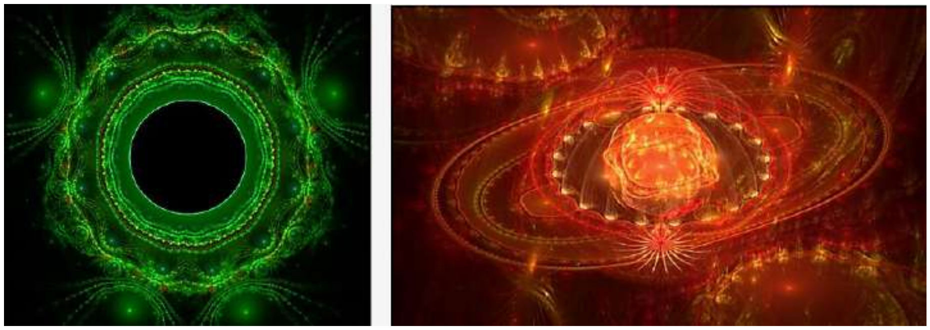
.

This means that in the spherical abyss-crack surrounding the core of the "electron", there are 3×4 =12 intertwined spherical layers.

If the core of the "electron" is located not only inside the "biological cell", but also inside other spherical vacuum formations, for example, in the "Universe", etc., then in this situation, according to (35) – (38), the cubic equations (161) and (162) will take the form

$$\begin{aligned}
&1-\frac{r_6}{r_g}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)r_g^2=0 \quad \text{or} \quad r_g^3+\frac{1}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}r_g-\frac{r_6}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}=0,\\
&1+\frac{r_6}{r_g}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)r_g^2=0 \quad \text{or} \quad r_g^3-\frac{1}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}r_g-\frac{r_6}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}=0,\\
&1-\frac{r_6}{r_g}-\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)r_g^2=0 \quad \text{or} \quad r_g^3-\frac{1}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}r_g+\frac{r_6}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}=0,\\
&1+\frac{r_6}{r_g}+\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)r_g^2=0 \quad \text{or} \quad r_g^3+\frac{1}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}r_g+\frac{r_6}{\left(\frac{1}{r_1^2}+\frac{1}{r_2^2}+\frac{1}{r_5^2}\right)}=0.
\end{aligned} \tag{163}$$

In this case, the 12 outer layers of the spherical abyss-crack surrounding the core of the "electron" are connected with all spherical formations inside which the core of the "electron" is located, in this case with the radii of the "Universe" and the mega-Universe. This means that if these big radii change over time, then the properties of the environment around the core of the "electron" also change. Figure 7 shows an attempt to illustrate the multi-layer environment of the core of the "electron".



a) b)

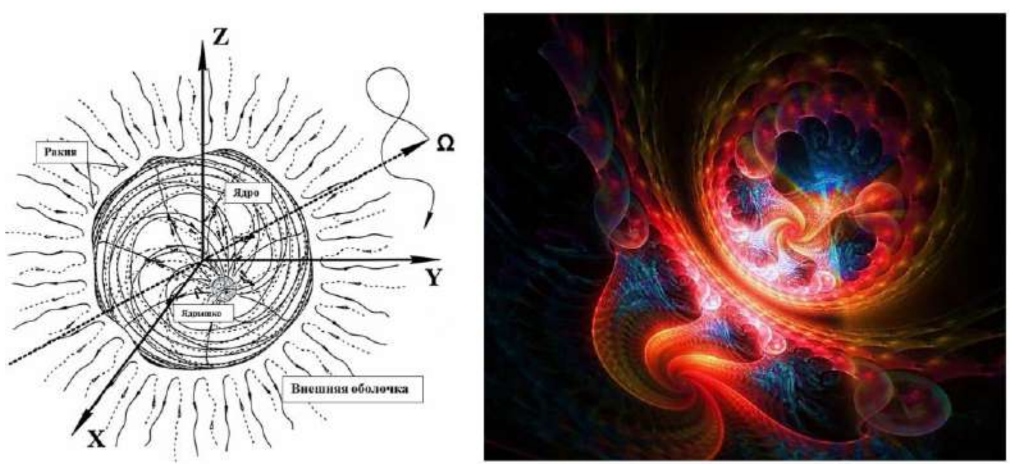
Fig. 7: Fractal illustrations of the multilayered environment (raqiya) of the core of an elementary particle.
Benoit Mandelbrot discovered that fractals inexplicably visualize the essence of many open and hidden aspects of reality

A similar analysis of the set of metrics (55) – (58), which determine the metric-dynamic state of the "electron" core, taking into account expression (35) – (38) leads to four cubic equations

$$1-\frac{r_7+r_8+r_9+r_{10}}{r_g}+\frac{r_g^2}{r_6^2}=0, \quad 1+\frac{r_7+r_8+r_9+r_{10}}{r_g}-\frac{r_g^2}{r_6^2}=0, \tag{164}$$
$$1-\frac{r_7+r_8+r_9+r_{10}}{r_g}-\frac{r_g^2}{r_6^2}=0, \quad 1+\frac{r_7+r_8+r_9+r_{10}}{r_g}+\frac{r_g^2}{r_6^2}=0.$$

Therefore, on the side of the core there are 3×4=12 more internal layers of the spherical abyss-crack.

Thus, in the spherical boundary between the outer shell and the core of the "electron" there are 12 external and 12 internal layers. In total, there are 24 spherical layers, which we will call raqiya (see Figures 2, 7 and 8).

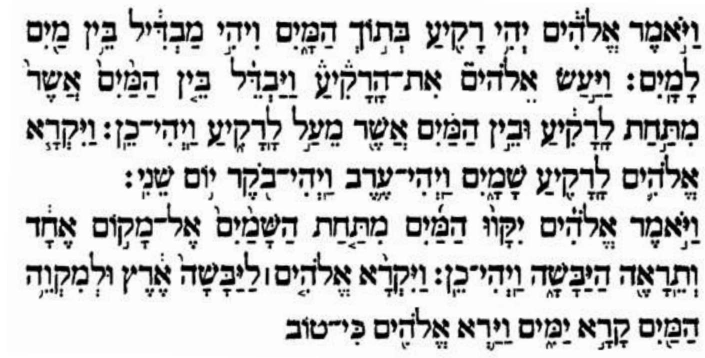


a) *b*)

Fig. 8: a) Raqiya of the "electron" is a 24-layer abyss-crack surrounding the core of this elementary "particle";
b) Fractal illustration of the outer and inner layers of the raqiya of "electron".

In the hierarchical cosmological model under consideration, similar raqiya surround the nuclei of all stable spherical vacuum formations of "positrons", "protons", "neutrons", "atoms", "planets", "galaxies", etc.

*The concept of **raqiya** is taken from the TORAH, Breishit, 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.*


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

And* אלהים *(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.

This utterance of the TORAH tells how אלהים (ELOHIM – GOD) divided the waters. Studying and deciphering this utterance will allow us to extract information about both the raqiya (i.e. the multi-layered spherical shell of the corpuscle cores) and the entire Universe filled with corpuscles (spherical vacuum formations) of various sizes. Who are we to interpret the Text of the TORAH? But we can, at the level of guesses (hypotheses), state some coincidences. For example, the gematria (i.e. the digital value) of the word הרקיע (a- raqiya) is 200+100+10+70+5=385. If we divide 385 by 13 (the greatest number of months), we get 29.6, which corresponds to the average number of solar days in a month. We interpret the word המים (a-maim) as ה(5)-waters and in the metric-dynamic model of the outer shell (51) – (54) and (59) and the core (55) – (58) and (59) of the "electron" (and all the other "quarks") there are five metrics, which describe vacuum flows. There are ימים (י(10)-waters) of these waters. In the statement: "GOD Created 5- raqiya and Separated the 5-waters under the raqiya from the 5-waters above the raqiya, and it became so." The TORAH reports on the 5+5=10-level structure of the Universe. It is possible that there are Five Levels of Spiritual Worlds (Adam Kadmon, Atzilut, Beria, Yetzira and Assiya) and five levels of hell (gehenom, shaar hashtika, bor, abadon, sheol), but it is possible that the same structure is repeated in our material world). The gematria of the word רקיע (raqiya:200+100+10+70=380), and the gematria of the word שמים (shamayim 300+40+10+40 = 380+10=380 and 10).

4.12 Free "electron" and "positron"

It is obvious that in the world around us there are "electrons" and "positrons" with core radii $r_6 \sim 10^{-13}$ cm, which are not located inside any other spherical vacuum formations (for example, "atoms", "planets", "stars", "galaxies") except the Universe with $r_2 \sim 10^{29}$ cm. Such "electrons" and "positrons" will be called free.

At this stage of the study, it is very difficult to judge the size of the inner nucleolus of a free "electron" and "positron" (Figure 2). From symmetry considerations, it can be assumed that since the ratio of radii $r_2/r_6 \sim 10^{42}$ cm, the ratio $r_6/r_x \sim 10^{42}$ cm should be approximately the same. From which it follows that $r_x = r_{10} \sim 10^{-55}$ cm is a radius commensurate with the size of the instanton nucleus (see the hierarchy of radii (44a)).

If we adhere to this hypothesis, then for a free "electron" and "positron" the vacuum equations (20) are simplified

$$\begin{cases} R_{ik} + g_{ik}\Lambda_2 + g_{ik}\Lambda_6 + g_{ik}\Lambda_{10} = 0, \\ R_{ik} - g_{ik}\Lambda_2 - g_{ik}\Lambda_6 - g_{ik}\Lambda_{10} = 0. \end{cases} \quad (165)$$

In this case, the metric-dynamic models of free "electrons" and "positrons" remain the same (50) – (59) and (60) – (99), only in these metric-solutions instead of r_5 it is necessary to substitute $r_2 \sim 10^{29}$ cm, and instead of r_7 it is necessary to substitute $r_{10} \sim 10^{-55}$ cm.

4.13 Correspondence between the Algebra of Signature and the Standard Model of Elementary Particles

Geometrized vacuum physics within the Riemannian approximation (see the beginning of the Introduction in [5]) using all 16 possible signatures

$$\begin{array}{cccc} (++++) & (+++-) & (-++-) & (++-+) \\ (---+) & (-+++) & (--++) & (-+-+) \\ (+--+) & (++--) & (+---) & (+-++) \\ (--+-) & (+-+-) & (-+--) & (----) \end{array} \qquad (166)$$

allowed us to form ideas about 16-colored "quarks" and "actiquarks" (see Table 1) and 16-colored "photons" and "antiphotons" (see §4.6), from which it is possible to combine metric-dynamic models of all known "leptons", "baryons", "mesons" and "bosons" (except for the Higgs boson), which are part of the Standard Model of elementary particles and antiparticles (see Figure 9)

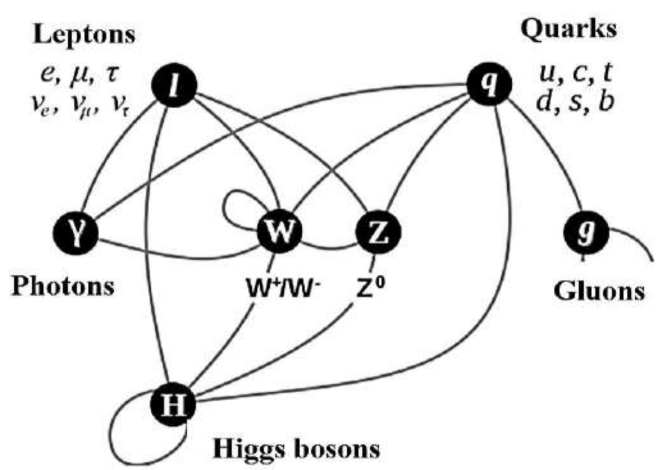


Fig. 9: Elements of the Standard Model of Elementary Particles

The hierarchical model proposed here does not have the concept of "mass", so there is no need to introduce concepts of a field that provides a mechanism for spontaneous breaking of electroweak symmetry, and, accordingly, of the quanta of this field - Higgs bosons. However, it is possible that in a completely geometrized theory, metric-dynamic models of vacuum formations with characteristics similar to those of these bosons will arise. For example, the essence of the "landscape" (130) has not been clarified.

Also, all "atoms" included in the Mendeleyev periodic table of chemical elements can be constructed from colored "quarks" and "antiquarks", and all "molecules" can be composed from "atoms".

At the same time, the theory proposed here differs significantly from modern physical views, since in the geometrized physics of vacuum all stable and unstable vacuum formations are built from colored "quarks" and "antiquarks" and from colored "photons" and "antiphotons". That is, in the proposed hypothesis the problem of baryon asymmetry of the Universe is initially absent. However, we are far from answering the question: – Why does not the World, which is on average completely symmetrical and balanced relative to zero (i.e. vacuum) annihilate?

5 The "stellar-planetary" level

In the previous §4, contours of the model metric-dynamic description of the level of elementary particles were outlined, since this level is the most thoroughly studied.

Within the framework of the geometrized vacuum physics based on the Algebra of Signatures developed here, all other levels of the Universe are conceptually structured in exactly the same way. Only from the components of the metric tensor (35) – (38) of the metrics-solutions (23) – (32) of the vacuum equations (22) it is necessary to select the terms containing r_5 (then this will be the "stellar-planetary" level of consideration) or r_3 (then this will be the "galactic" level of consideration) or r_7 (then this will be the "protoquark" level of consideration), etc. Then, with the selected metrics, it is necessary to perform all the actions that were given in §4.

Let's explain the above at the «planetary» level. We consider a "planet" with a core radius of $r_5 \sim 10^8$ cm, which is located in the Universe with a radius of $r_2 \sim 10^{29}$ cm.

In this case, all 16 planetary colored "quarks" and "antiquarks" shown in Table 1 are obtained. As an example, we will give one of the "antiquarks":

PLANETARY u_r^--"ANTIQUARK" (167)

Unstable "convex-concave" multilayer $\lambda_{7,12}$-vacuum formation
with signature: (– + + –), consisting of:

Outer shell of planetary u_r^--"antiquark"

in the interval $[r_2, r_5]$

$$ds_1^{(-++-)2} = -\left(1-\frac{r_5}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_5}{r}+\frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_2^{(-++-)2} = -\left(1+\frac{r_5}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_5}{r}-\frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_3^{(-++-)2} = -\left(1-\frac{r_5}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_5}{r}-\frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2,$$

$$ds_4^{(-++-)2} = -\left(1+\frac{r_5}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_5}{r}+\frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2;$$

The core of the planetary u_r^--"antiquark"

in the interval $[r_2, r_5]$

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

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

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

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

The substrate of the planetary u_r^--"antiquark"

in the interval $[0, \infty]$

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

From 16 planetary "quarks" and "antiquarks" are formed planetary "nucleons" (i.e., "planets") and planetary "mesons", etc. In turn, "stars" are obtained from clusters of "planets" similarly to how in §4 "nucleons", "mesons" and "atoms" are formed from "quarks" and "antiquarks" of the level of elementary particles, and "molecules" are synthesized from "atoms", etc.

Planetary and stellar "neutrinos" are toroidal magnetic fields of "planets" and "stars". Apparently, planetary and stellar "neutrinos" can also propagate without the cores of "planets" and "stars" inside, as toroidal vacuum vortices of planetary or stellar scale. If such space-time distortions (i.e. toroidal vacuum vortices) can be detected, then this will be a tangible argument in favor of the hypothesis developed here.

Planetary "bosons" are also composed of planetary color "photons" and "antiphotons" listed in Table 2, but with wavelengths in the range λ = 10^7 – 10^{12} cm.

6 Zero Cosmology

"Beauty will save the world"
F.M. Dostoevsky

Based on the metrics-solutions (23) – (32) of the simplified vacuum equation (20)

$$R_{ik} \pm ½\, g_{ik} \sum_{m=1}^{10} \Lambda_m = 0, \qquad (168)$$

above, the metric-dynamic model of a hierarchical chain of 10 spherical vacuum formations ("corpuscles") with characteristic radii (44a) successively nested into each other was considered.

Now we understand that inside the largest "corpuscle", which we call the mega-Universe with r_1~ 10^{39} cm, there are countless such hierarchical sequences with different numbers of "corpuscles" in different chains (Figure 10).

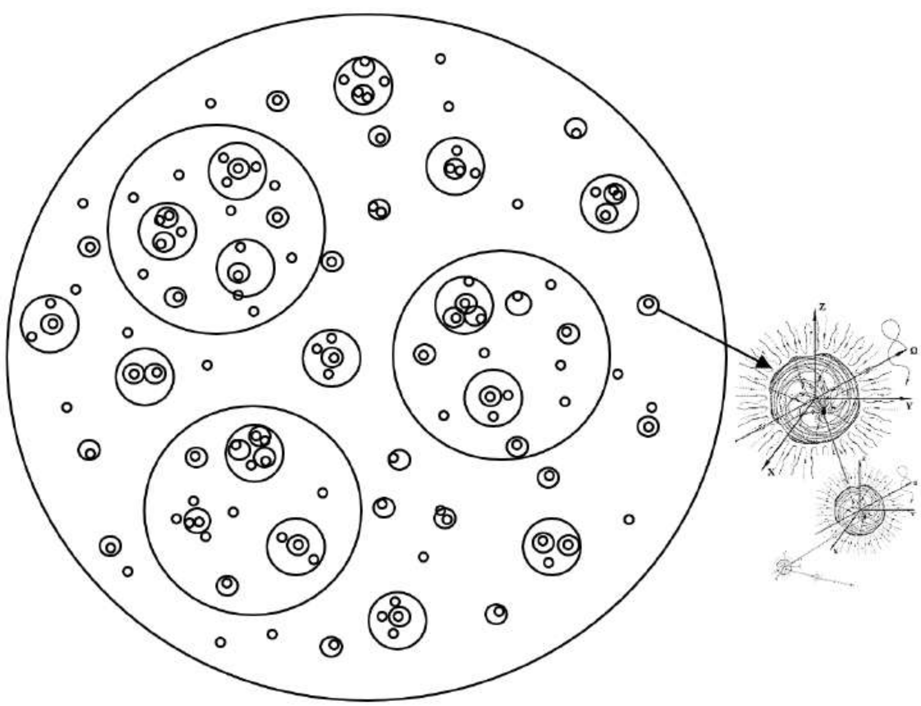
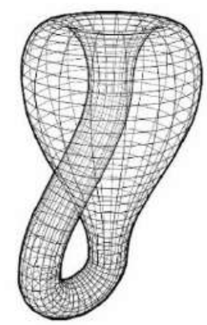


Fig. 10: Illustration of a hierarchical cosmological model consisting of a set of spherical vacuum formations (corpuscles) differently nested into each other

That is, we need to consider a system with an infinite number of equations.

$$R_{ik} + ½\, g_{ik} \textstyle\sum_{m=1}^{10} \Lambda_m - ½\, g_{ik} \sum_{n=1}^{10}\, \Lambda_n = 0,$$
$$R_{ik} + ½\, g_{ik} \textstyle\sum_{m=1}^{5} \Lambda_m - ½\, g_{ik} \sum_{n=1}^{5}\, \Lambda_n = 0,$$
$$R_{ik} + ½\, g_{ik} \textstyle\sum_{m=1}^{7} \Lambda_m - ½\, g_{ik} \sum_{n=1}^{7}\, \Lambda_n = 0,$$
$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
$$R_{ik} + ½\, g_{ik} \textstyle\sum_{m=1}^{g} \Lambda_m - ½\, g_{ik} \sum_{n=1}^{g}\, \Lambda_n = 0. \qquad (169)$$

All this countless number of equations are united by three circumstances:
1) In all equations (169) the Ricci tensor R_{ik} is the same, more precisely, this tensor is the same at all points of the mega-Universe (see Figure 10), which corresponds to the homogeneity and isotropy of such a World;
2) In all vacuum equations (13) there is a discrete hierarchical set of spheres with radii from the series: …, $r_1 \sim 10^{39}$, $r_2 \sim 10^{29}$, $r_3 \sim 10^{19}$, $r_4 \sim 10^{8}$, $r_5 \sim 10^{-3}$, $r_6 \sim 10^{-13}$, $r_7 \sim 10^{-24}$, $r_8 \sim 10^{-34}$, $r_9 \sim 10^{-45}$, $r_9 \sim 10^{-55}$, …
3) Following cardinal Nicholas of Cusa, it is assumed that the center of such a mega-Universe is located inside each hierarchical chain of “corpuscles”, wherever it is located.



From these three circumstances it follows that for all hierarchical chains of "corpuscles" both the largest "corpuscle" (possibly with $r_1 \sim 10^{39}$ cm) and the smallest "corpuscle" (possibly with $r_{10} \sim 10^{-55}$ cm) are common. That is, all the countless hierarchical chains of "corpuscles" begin with one largest "corpuscle" (mega-Universe) and end with one smallest "corpuscle" (instantone). This can still be imagined, but the following statement is beyond common sense. If the vacuum formation under consideration is closed (and from religious sources, in particular from the Luranian Kabbalah, it follows that it is closed), then we are forced to conclude that the largest "corpuscle" (mega-Universe) is inside the smallest "corpuscle" (instantone), i.e. the mega-Universe turns inside out. As it is planned to show in the following articles, vacuum currents first flow along all the hierarchical chains of "corpuscles" from the "mega-Universe" brandy to the "instanton" brandy, where they turn around and flow in the opposite direction along the same chains from the "instanton" brandy to the "mega-Universe" brandy. What was below ends up above, and vice versa. Some aspects of the vacuum "odyssey" can be found in (Batanov-Gaukhman, 2017). The system of equations (169) can only be solved by statistical methods. Therefore, we average all these equations

$$\frac{1}{\infty} R_{ik} + \frac{1}{\infty}\, g_{ik}\left(\textstyle\sum_{m=1}^{\infty} k_m \Lambda_m + \sum_{n=1}^{\infty} - k_n \Lambda_n\right) = 0, \qquad (170)$$

where k_i is the total number of spheres ("corpuscle") with radius r_i.

Both parts of this equation can be multiplied by ∞, as a result we get

$$R_{ik} + \, g_{ik}\left(\textstyle\sum_{m=1}^{\infty} k_m \Lambda_m + \sum_{n=1}^{\infty} - k_n \Lambda_n\right) = 0. \qquad (171)$$

The vacuum balance condition (which states that only mutually opposite objects can emerge from the vacuum, see Introduction in (Batanov-Gaukhman, 2023a)) requires that the expression in brackets be zero

$$\textstyle\sum_{m=1}^{\infty} k_m \Lambda_m + \sum_{n=1}^{\infty} - k_n \Lambda_n = 0. \qquad (172)$$

Therefore, the averaged cosmological equation (171) returns to its original form, i.e. to Einstein's first vacuum equation (6)

$$R_{ik} = 0. \qquad (6')$$

In a certain (sort of fractal) sense, the idea of a self-closed Universe was repeated in this great formula: – "What was in the beginning – is in the end."

The metrics-solutions of the first vacuum equation (6) were already considered in §2 in (Batanov-Gaukhman, 2023e)

- with the signature (+ − − −):

$$ds_1^{(+)2} = \left(1 - \frac{r_o}{r}\right) c^2 dt^2 - \frac{1}{\left(1 - \frac{r_o}{r}\right)} dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2, \tag{173}$$

$$ds_2^{(+)2} = \left(1 + \frac{r_o}{r}\right) c^2 dt^2 - \frac{1}{\left(1 + \frac{r_o}{r}\right)} dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2, \tag{174}$$

$$ds_3^{(+)2} = c^2 dt^2 - dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2; \tag{175}$$

- with the signature (− + + +):

$$ds_1^{(-)2} = -\left(1 - \frac{r_o}{r}\right) c^2 dt^2 + \frac{1}{\left(1 - \frac{r_o}{r}\right)} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2, \tag{176}$$

$$ds_2^{(-)2} = -\left(1 + \frac{r_o}{r}\right) c^2 dt^2 + \frac{1}{\left(1 + \frac{r_o}{r}\right)} dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2, \tag{177}$$

$$ds_3^{(-)2} = -c^2 dt^2 + dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2. \tag{178}$$

The metric-solutions (173), (174) and (176), (177) are problematic, since they lead to a metric-dynamic description of two mutually opposite spherical vacuum formations with a completely inexplicable cavity in the middle (see §2.8 in [5]). Therefore, only the metric solutions (175) and (178) remain

$$ds_3^{(+)2} = c^2 dt^2 - dr^2 - r^2 d\theta^2 - r^2 \sin^2\theta\, d\phi^2, \tag{179}$$

$$ds_3^{(-)2} = -c^2 dt^2 + dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta\, d\phi^2,$$

which define, on average, the uncurved state of the bilateral 2^3-$\lambda_{m,n}$-vacuum (see (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e)).

Metrics (175) and (178) also, on average, completely compensate each other's manifestations

$$½\left(ds_3^{(+)2} + s_3^{(-)2}\right) = 0. \tag{180}$$

The signature (i.e. ranking) analogue of this expression

$$\begin{array}{l} (+ - - -): \\ \underline{(- + + +)} \\ (0\ \ 0\ 0\ \ 0)_+ \end{array} \tag{181}$$

A more detailed consideration in the Algebra of signature shows (see §§2,3,5 in (Batanov-Gaukhman, 2023a)) that the solution of the vacuum equation (6) is a split zero:

$$
\begin{array}{lcccl}
0 = & \underline{(0\ \ 0\ \ 0\ \ 0)} & + & \underline{(0\ \ 0\ \ 0\ \ 0)} & = 0 \\
0 = & (+\ \ +\ \ +\ \ +) & + & (-\ \ -\ \ -\ \ -) & = 0 \\
0 = & (-\ \ -\ \ -\ \ +) & + & (+\ \ +\ \ +\ \ -) & = 0 \\
0 = & (+\ \ -\ \ -\ \ +) & + & (-\ \ +\ \ +\ \ -) & = 0 \\
0 = & (-\ \ -\ \ +\ \ -) & + & (+\ \ +\ \ -\ \ +) & = 0 \\
0 = & (+\ \ +\ \ -\ \ -) & + & (-\ \ -\ \ +\ \ +) & = 0 \\
0 = & (-\ \ +\ \ -\ \ -) & + & (+\ \ -\ \ +\ \ +) & = 0 \\
0 = & (+\ \ -\ \ +\ \ -) & + & (-\ \ +\ \ -\ \ +) & = 0 \\
0 = & \underline{(-\ \ +\ \ +\ \ +)} & + & \underline{(+\ \ -\ \ -\ \ -)} & = 0 \\
0 = & (0\ \ 0\ \ 0\ \ 0)_+ & + & (0\ \ 0\ \ 0\ \ 0)_+ & = 0.
\end{array}
\tag{182}
$$

Thus, vacuum (zero) cosmology shows that despite the fact that the World is filled with an infinite number of spherical vacuum formations (convexity, or "corpuscles") and anti-formations (concavities, or "anticorpuscles") of various scales, on average they completely compensate each other's manifestations.

How does such a World exist (i.e. why does it not annihilate)? Apparently, we will not find an answer to this question within the framework of Riemann's differential geometry. The condition of maintaining vacuum balance will always lead us to a logical dead end.

It is possible that the existence of such an on average empty and flat World is due to its constant change, for example, expansion or compression, since static emptiness inevitably annihilates. However, inside the average emptiness there is no resource for its expansion.

7 Zero Cosmogony

"Science without religion is lame, religion without science is blind"
A. Einstein, "Science and Religion", 1941

A hierarchical cosmological model was proposed above, which, due to the condition of vacuum balance, describes an empty and flat world on average. This world is filled with "corpuscles" and "anti-corpuscles" of different scales, but it has neither a Goal nor an Energy resource for development. Such a corpuscular world is similar to a dead (i.e. soulless) body, which can only strive for a state of thermodynamic equilibrium (i.e., heat death).

Up to this point, we are at the level of hypothesis, but we tried to follow the basics of the scientific worldview and scientific methodology. At this point, some aspects of religious metaphysics are introduced.

Can a scientist build model ideas about the surrounding world based on religious mythology? It is possible that the legends of the ancient sages do not meet Popper's falsification. However, the knowledge of ancestors can ultimately be verified, i.e. confirmed in practice. In this paragraph, hypotheses are put forward that correspond to the picture of the world of Lurianic Kabbalah. Will these a priori ideas be confirmed in practice? It is unknown, but it is not advisable to discard them without verification.

It was implied above that the components of the metric tensors $g_{ij}^{(p)}$ of the metric solutions (35) – (42) should be functions not only of the deformable spherical coordinates (ct,r,θ,φ) themselves, but also of the coordinates (X_0, X_1, X_2, X_3) or (c_1T_1, X_1, Y_1, Z_1), determining the location of the considered hierarchical chain of "corpuscles" in the Universe (see Figure 10).

Background two-sided space with metrics

$$dS^{(+)2}= c_1dT_1^2 - dX_1^2 - dY_1^2 - dZ_1^2, \tag{183}$$

$$dS^{(-)2}= - c_1dT_1^2 + dX_1^2 + dY_1^2 + dZ_1^2.$$

can be considered as the second $\lambda_{m,n}^{(2)}$-Vacuum, which is illuminated from the "emptiness" by probing it with the rays of Light with the speed c_2, which is much greater than the speed of light $c_1 = c$ in the first $\lambda_{m,n}^{(1)}$-vacuum (i.e., $c_2 \gg c_1$).

The second $\lambda_{m,n}^{(2)}$-Vacuum can be curved and is located inside the third $\lambda_{m,n}^{(3)}$-VAcuum, which is illuminated from the same "emptiness" by the rays of LIght with the speed c_2, which is much greater than the speed of Light c_2 in the second $\lambda_{m,n}^{(2)}$-Vacuum (i.e., $c_3 \gg c_2 \gg c_1$) (see Figure 11).

Such a sequential embedding: $\lambda_{m,n}^{(1)}$-vacuum into $\lambda_{m,n}^{(1)}$-Vacuum into $\lambda_{m,n}^{(1)}$-VAcuum into … can continue until the speed of propagation of wave disturbances c_n in $\lambda_{m,n}^{(n)}$-VACUUM reaches infinity ($c_n = \infty$), i.e. to such a level where time stops, since $t = L/c_n = L/\infty = 0$.

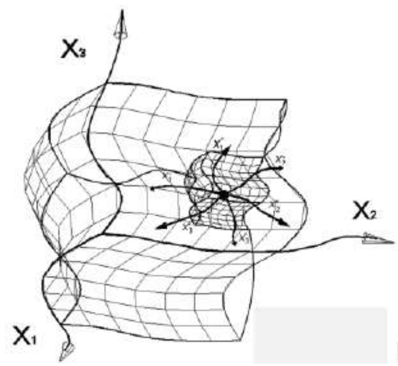


Fig. 11: Illustration of embedding of one curved $\lambda_{m,n}^{(k)}$-vacuum into another thinner curved $\lambda_{m,n}^{(k+1)}$-vacuum

Lurianic Kabbalah distinguishes from all the many Spiritual Levels and sub-Levels of Existence only five main Created worlds: Adam Kadmon, Atzilut, Beria, Yetzira and Asiya, corresponding to the five symbols present in the Great Name of the MOST HIGH י-ה-ו-ה (kotz-Yud-Key-Vav-Key). The Cause and Source of all created worlds is the Original EIN SOF, Barihu (ENDLESS, Blessed is HE). The author has not encountered any information in Kabbalistic sources about the speed of propagation of disturbances (information) in the Spiritual worlds. However, it is quite reasonable to assume that the higher the World, the greater the speed of propagation of information in it, and at the Highest Level of EIN SOF, Barihu, the Speed of Reactions and Perception is infinite (which means stopping time). Let us recall that Isaac Newton (a graduate of Trinity College, Cambridge University) associated the Absolute frame of reference with the Absolute OBSERVER (i.e. with the MOST HIGH), and he called Space the "Sensory Receptacle of the One GOD". Homogeneity and Monotheism according to Newton mean that the same DIVINE Establishments and Laws operate at all Levels of Existence.

t should be expected that all $\lambda_{m,n}^{(i)}$-vacuums obey the same Laws, i.e. are described by one universal differential geometry, but with two differences:
- each $\lambda_{m,n}^{(i)}$-vacuum corresponds to a characteristic speed of light c_i (i.e., the speed of propagation of wave disturbances or information transfer), while $c_n \gg \ldots \gg c_3 \gg c_2 \gg c_1 = c$;
- each $\lambda_{m,n}^{(i)}$-vacuum has its own parametric radius of the Universe R_{vi}, while $R_{vn} \gg \ldots \gg R_{v3} \gg R_{v2} \gg R_{v1} \gg R_v$.

Thus, the components of the metric tensor that determine the metric-dynamic state of local sections of the first $\lambda_{m,n}$-vacuum also depend on the state of all other thinner $\lambda_{m,n}^{(i)}$-vacuums nested

$$g_{ij}^{(p)} = g_{ij}^{(p)}(ct,r,\theta,\varphi;\ c_1T_1,X_1,Y_1,Z_1;\ c_2T_2,X_2,Y_2,Z_2;\ \ldots;\ c_nT_n,X_n,Y_n,Z_n). \tag{184}$$

To realize that the background space is real, we suggest doing two experiments:

Experiment 1: Close your eyes, spin around your axis ten times, and open your eyes. You will see how the background space rotates relative to the outside world.

Experiment 2: Raise your outstretched arm to eye level and hold it in this position. On the one hand, the muscles of your arm are an extremely complex intertwined state of deformed vacuum in the form of millions of "corpuscles". On the other hand, your arm is held in a raised state by the volitional effort of your consciousness. That is, at this time, two main forces influence your arm: the force of gravity, which pulls your arm toward the ground, and the force of will, which makes your arm remain motionless. It turns out that your consciousness, within its competence, is able to control the "corpuscles". Skeptics will say that it is not the consciousness itself that controls the arm. It only communicates its desire to the brain, and the brain (i.e., neural network) gives the command to the nervous system to contract the muscles of the arm so that it remains raised. That is true, but your imagination (non-material thought), which forms the state of the background space, still cannot be excluded from the situation under consideration, since there is no other reason forcing the "atoms" of the brain to give the command to the nervous system to hold the hand at a given height.

It is necessary to understand: –"How does Reason influence the metric-dynamic state of space?" This is the key to answering many questions, for example:

- how was the first biological cell formed?
- how are different biological organisms formed from one type of protocells?
- Why does the same stem cell develop in one case into one tissue or organ, and in other cases into other tissues and organs?

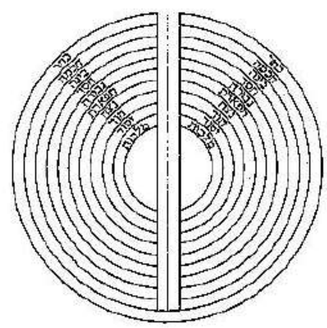
In relation to cosmological problems, it is possible that the UNIVERSAL MIND twists the second $\lambda_{m,n}{}^{(2)}$-Vacuum (i.e. the background space c_1T_1, X_1, Y_1, Z_1, i.e. Pneuma (Breath, Spirit)), which leads to the emergence of centrifugal forces of inertia, which, ultimately, lead to the expansion of the first $\lambda_{m,n}{}^{(1)}$-vacuum, i.e. the mega-Universe of our World (see Figure 10).

In the period from March 20 to March 23, 2014, in the city of Voronezh, the author, in the presence of V. Khramikhin, took part in several sessions of "connection" of the medium Sergei Prokhorov to a certain cosmic entity. Through. Prokhorov S.G. the following was reported:

1). The metric of "Emptiness" has two types of manifestations:
– on the one hand, "Emptiness" has the signs of extended corporeality (substantiality), subject to deformations and fluidity;
– on the other hand, the metric of "Emptiness" is capable of reflecting the changing manifestations of Thought-forms formed by the Currents of Reason, just as our reason forms images in our consciousness.
2) The Current of Reason does not affect the metric of emptiness itself, but such a characteristic of it as torsion. The mind generates pseudo-forces of inertia (similar to the Coriolis forces), which ultimately distort local areas of the vacuum.
3) Upon closer examination, the Currents of the Mind affect not the torsion and curvature of the vacuum itself, but a certain complex "layer" that is divided into 10 levels. The highest (1st) of them is the emotional level of manifestations of four types of temperament: melancholic, phlegmatic, sanguine and choleric; and the lowest (10th) level corresponds to the four types of elements: earth, water, air and fire (earth and water tend downwards upwards, etc., according to Aristotle).
4) The connection between the Worlds of high subtlety with this World is carried out through raqiyas (spherical multi-layered abyss-cracks surrounding the cores of stable vacuum formations). In particular, rational humanity is one of the local-nodal layers of the planet Earth's raqiya. Each person is a complex material-spiritual node (see the illustration in Figures 7b and 12), through the existence of which the Highest BEING is illuminated into this World (according to Heidegger - the thought of man gives the Word to BEING).

Fig. 12: Fractal illustration of the "planet" raqiya through which Spirituality shines through

Apparently, without solving the problem of psychophysical parallelism, which Descartes, Malebranche, Leibniz and many other philosophers and scientists pondered, we will not be able to make progress in solving the problems of cosmology.



In relation to the Big Bang theory, we note the following. Lurianic Kabbalah reports that the SUPREME BEING Creates everything through the Birth, Nourishment, Cultivation and Education of a living Entity. Everything in nature is created through birth: cells generate cells and are built into organisms. The entire Universe is the First Biological Cell. It is also the Original Mother's Womb, inside which the Universal Human Embryo gradually develops (Figure 13).

In any case, it is useful to compare the stages of the Universe's development, considered within the framework of the Standard Cosmological Model, with the periods of development of the human embryo in the mother's womb.

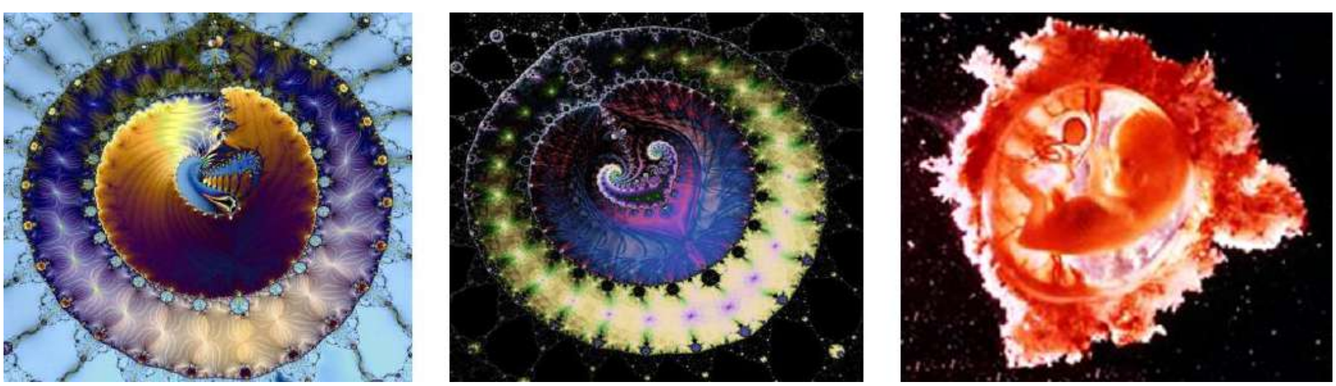


Fig. 13**:** Fractal illustrations and photos of an embryo in the mother's womb

Perhaps it is not dark matter and dark energy, but the Light Spirit that sets everything into conscious motion.

CONCLUSIONS

The hierarchical (multi-level) cosmological model proposed in this article is only a preliminary hypothesis that requires detailed elaboration. Each point of this article requires significant expansion and study based on the mathematical apparatus and methods of the Algebra of signature, presented in Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e). Some additional aspects of the topics covered in this article are described in (Batanov-Gaukhman, 2023a).

Note that the model concept of space (κόσμος – beauty, order) developed here is based on the simplest version of differential Riemannian geometry (see the beginning of the Introduction in (Batanov-Gaukhman, 2023e)). That is, the cosmological model proposed here is only a rough framework on which an innumerable number of more complex and subtle processes are strung. Moreover, it is already clear that Riemann's geometry is very poor for resolving a number of problems arising in the proposed cosmological model.

According to the hypothesis presented in this article, the world around us consists of a practically infinite set of spherical vacuum formations ("corpuscles"), nested in different ways like matryoshka dolls (see Figure 10).

Such a multilayered model easily fits our sensory experience. Whatever fruit or vegetable we take, the same idea is always repeated fractally. Inside each fruit there are one or more seeds, inside each seed there are biological cells, inside the cells there are nuclei and other organelles, etc.

In this article, we tried to trace only one chain of 10 consecutively nested spherical vacuum formations ("corpuscles", see the hierarchy of radii (44a) and Figure 1) based on the metric-solutions (23) – (32) of the extended vacuum equation (20), simplified to 10 lambda terms.

In a broader view, such hierarchical chains of "corpuscles" are countless, but they are all located inside the largest "corpuscle", which we call the mega-Universe.

The conditions of the limitedness and closedness of the World around us force us to come to an extraordinary assumption that all the countless hierarchical chains of "corpuscles" begin with one largest "corpuscle" (mega-Universe, possibly with $r_1 \sim 10^{39}$ cm) and end with one smallest "corpuscle" (instanton, possibly with $r_{10} \sim 10^{-55}$ cm).

In fact, we do not know how many nested "corpuscles" are in a hierarchical chain. As of today, only a discrete series of six local spherical formations with characteristic radii from the hierarchy (44a) are available to our observation:

$r_2 \sim 10^{29}$ 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.

The problem of the hierarchical cosmological model developed on the basis of simplified Riemannian geometry is that the chain of nested "corpuscles" cannot end. If this hierarchical chain breaks, then a paradoxical situation arises when the largest "corpuscle" turns out to be inside the smallest "corpuscle" (see expressions (35) – (42)).

Another no less complex problem in the proposed hierarchical cosmological model is that all stable local vacuum formations consist of "quarks" and "antiquarks". That is, in other words, matter and antimatter in the proposed model are mixed. On the one hand, the problem of baryon asymmetry of matter is solved, but on the other hand, it is unclear: – why mutually opposite curvatures of the vacuum do not annihilate, i.e. are not smoothed out. Within the framework of Riemannian geometry, this problem is not solved. Apparently, the search for a "trigger" is associated with a significant complication of differential geometry. In this article, the assumption is made that the possibility of the existence of an absent on average World is due to its expansion due to the expansion of the background space.

The third difficulty is related to the fact that this article does not present exactly cosmology, but rather geometrized ideas about the structural organization of matter. Cosmological issues, the direction of studying the origin of the "Universe" and its accelerated expansion are touched upon only in the form of metaphysical discussions. To discuss these problems within the framework of the proposed fully geometrized hierarchical cosmological model, many other additional tasks will need to be solved, such as a geometrized description of electromagnetic, electro-weak, strong and gravitational interactions, etc. It is assumed that these issues will be considered in subsequent articles of the proposed project. In part, some aspects of solving these problems can be found in (Batanov-Gaukhman, 2017).

The original extended vacuum equation (13) contains discrete "corpuscles" with different radii r_m, but it is impossible to find out what these radii are from this equation. To determine the hierarchy rm, that article used the heuristic formula (43) with three constants: $c \approx 3 \cdot 10^{10}$ cm/sec is the speed of light in a vacuum, $R_v \sim 10^{25}$ cm is the parametric radius of the Universe, and $t_c \approx 1$ sec is the period of the human heartbeat. The presence of the speed of light in formula (43) is justified by the fact that this is the maximum speed in a vacuum, and the parametric radius of the Universe is an adjustable parameter.

A significant advantage of the proposed hypothesis, according to the author, are two circumstances that distinguish the hierarchical cosmological model from numerous other cosmological theories, including the Standard Cosmological Model

First, the hierarchical model at the picoscopic ($10^{12} – 10^{16}$ cm) level of consideration offers metric-dynamic models of all elements of the Standard Model of elementary particles: "leptons", "mesons", "baryons" and "bosons" (with the exception of the Higgs boson).

Secondly, the proposed hypothesis easily resolves the contradictions between the general theory of relativity and quantum mechanics. Vacuum has the properties of an elastic-plastic medium in which various local and global curvatures arise and a multitude of wave disturbances propagate, so the cores of stable vacuum formations ("corpuscles") of any scale constantly wander chaotically near the equilibrium point. Averaging the total mechanical energy of any chaotically wandering cores or nucleus (136)

$$\overline{< S_x >} = \overline{\int_{t_1}^{t_2} (T(p_x, p_y, p_z, x, y, z, t) > + < U(x, y, z, t) > - < E(x, y, z, t) >) \, dt},$$

it can be expressed in terms of probability amplitudes $\psi(x, y, z)$ of the location of their center (137)

$$w = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \left(-\frac{\eta_r^2}{2} \psi(x, y, z) \nabla^2 \psi(x, y, z) + \psi^2(x, y, z) [< u(x, y, z) > - < \varepsilon(x, y, z) >] \right) dx dy dz.$$

The Euler-Poisson equation, for the extremal $\psi(x, y, z)$ of this functional, turned out to be the Schrodinger equation (Batanov-Gaukhman, 2023e)

$$-\frac{3\eta_r^2}{2} \left\{ \frac{\partial^2 \psi(x,y,z)}{\partial x^2} + \frac{\partial^2 \psi(x,y,z)}{\partial y^2} + \frac{\partial^2 \psi(x,y,z)}{\partial z^2} \right\} + 2[< u(x, y, z) > - < \varepsilon(x, y, z) >] \psi(x, y, z) = 0.$$

This equation describes the averaged quantum states of chaotically wandering core (or nuclei) of all sizes, from the core of a "proto-quark" and an "electron" to the cores of "biological cells", "planets", "stars" and "galaxies". Only the averaging time of their chaotic behavior differs. For example, it will take hours to average the chaotic fluctuations of the core of a biological cell, centuries for the cores of a "planet", and thousands of years for the core of a "galaxy".

Analysis of the chaotic behavior of the inner nucleolus (proto-quark) allowed us to hypothesize that the "muon" and τ-"lepton" are the first and second excited states of the "electron". In this case, the c^{+}-"quark" and t+-"quark" are the first and second excited states of the u^{+}-"quark", respectively, and the s^{+}-"quark" and b^{+}-"quark" are the first and second excited states of the d^{+}-"quark", respectively.

Thus, within the framework of the cosmological hypothesis proposed in the article, the general theory of relativity and quantum mechanics only complement each other.

In the following articles of this project, under the general title "Geometrized Vacuum Physics Based on the Algebra of signature" (Batanov-Gaukhman, 2023a, 2023b, 2023c, 2023d, 2023e), it is proposed to consider the metric-dynamic models of the moving "electron" and "neutrino", to develop geometrized models of electromagnetic, weak, nuclear and gravitational interactions. Preliminary materials on these topics can be found in (Batanov-Gaukhman, 2017).

ACKNOWLEDGEMENTS

I sincerely thank Gavriel Davidov, David Reid, Tatiana Levi, Eliezer Rachman and David Kogan for their assistance.

REFERENCES

Batanov-Gaukhman, M. (2017). *Fully geometrized physics from the standpoint of the Algebra of signature* (Stochastic metrophysics). https://metraphysics.ru/content/.

Batanov-Gaukhman, M. (2020). *Derivation of the Generalized Time-independent Schrodinger Equation. The New Stochastic Quantum Mechanics: Think and calculate* arXiv:1702.01880v4**.**

Batanov-Gaukhman, M. (2023a). Geometrized Vacuum Physics. Part I. Algebra of Stignatures. *Avances en Ciencias e Ingeniería, 14* (1), 1-26, https://www.executivebs.org/publishing.cl/avances-en-ciencias-e-ingenieria-vol-14-nro-1-ano-2023-articulo-1/ ; and viXra:2403.0035, and Preprints, 2023060765. https://doi.org/10.20944/preprints202306.0765.v3,

Batanov-Gaukhman, M. (2023b). Geometrized Vacuum Physics. Part II. Algebra of Signatures. *Avances en Ciencias e Ingeniería, 14* (1), *27-55,* https://www.executivebs.org/publishing.cl/avances-en-ciencias-e-ingenieria-vol-14-nro-1-ano-2023-articulo-2/:and Preprints, 2023070716, https://doi.org/10.20944/preprints202307.0716.v1 and viXra:2403.0034.

Batanov-Gaukhman, M. (2023c). Geometrized Vacuum Physics. Part III. Curved Vacuum Area. *Avances en Ciencias e Ingeniería, 14* (2), *51-81*, https://www.executivebs.org/publishing.cl/avances-en-ciencias-e-ingenieria-vol-14-nro-2-ano-2023-articulo-5/; and Preprints 2023, 2023080570. https://doi.org/10.20944/preprints202308.0570.v4. and viXra:2403.0033.

Batanov-Gaukhman, M. (2023d). Geometrized Vacuum Physics. Part IV: Dynamics of Vacuum Layers. *Avances en Ciencias e Ingeniería, 14* (3), 1-29, https://www.executivebs.org/publishing.cl/avances-en-ciencias-e-ingenieria-vol-14-nro-3-ano-2023-articulo-1/, and Preprints.org. https://doi.org/10.20944/preprints202310.1244.v3. and viXra:2403.0032.

Batanov-Gaukhman, M. (2023e). Geometrized Vacuum Physics. Part V: Stable Vacuum Formations. *Avances en Ciencias e Ingeniería, 14* (3), 31-87 https://www.executivebs.org/publishing.cl/avances-en-ciencias-e-ingenieria-vol-14-nro-3-ano-2023-articulo-2/ and Geometrized Vacuum Physics Part 5: Stable Vacuum Formations, viXra.org e-Print archive, viXra:2405.0002.

Batanov-Gaukhman M. (2024). Development of the Stochastic Interpretation of Quantum Mechanics by E. Nelson. Derivation of the Schrödinger-Euler-Poisson Equations. *Recent Progress in Materials*; *6* (2): 014; 10.21926/rpm.2402014, or arXiv:2011.09901v10 .

Fradkin D.M. (1965). Three-dimensional isotropic harmonic oscillator and SU3. American Journal of Physics 33 (3) 207–211, https://en.wikipedia.org/wiki/Quantum_harmonic_oscillator.

Landau, L.D. & Lifshitz, E.M. (1971). *The Classical Theory of Fields* / Course of theoretical physics, V. 2 Translated from the Russian by Hamermesh M. University of Minnesota – Pergamon Press Ltd. Oxford, New York, Toronto, Sydney, Braunschwei, p. 387.

Weinberg, S. (1972). *Gravitation and Cosmology. Principles And Applications Of The General Theory Of Relativity*, Wiley, ISBN 0471925675, 685s.