GEOMETRIZED VACUUM PHYSICS. PART 12: NAKED "GALAXIES" - "PARTICLES" OF DARK MATTER?

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ABSTRACT

This article is the twelfth part of the scientific project under the general title "Geometrized Vacuum Physics Based on the Algebra of Signature " [1,2,3,4,5,6,7,8,9,10,11]. In this article, metric-dynamic models of naked "galaxies" of various classes are proposed based on the hierarchical cosmological model, the fundamentals of which are outlined in the previous articles of this project. Naked "galaxies" are considered as various sets of galactic G_k-"quarks" and G_k-"antiquarks", and represent giant resting (or rotating and moving) gravitational funnels, in which there are no small-scale "corpuscles" (i.e. any "stars", "planets", "molecules", "atoms" and "elementary particles"). Within the framework of this theory, when all types of small "corpuscles" enter the outer shells of naked "galaxies" (i.e., into gravitational funnels of various types), models of galaxies with the observed properties are formed. It is proposed to consider naked "galaxies" as giant "particles" of dark matter, and we also propose to supplement the Standard Model of elementary "particles" consisting of E_k-"quarks" and E_k-"antiquarks" (see Table 1 in [6]), with planetary P_k-"quarks" and P_k-"antiquarks" (see Table 1 in [6]), as well as galactic G_k-"quarks" and G_k-"antiquarks" (see Table 1 in this article).

Keywords: galaxy, dark matter, vacuum physics, algebra of signature, geometrization of physics

BACKGROUND AND INTRODUCTION

This article continues the refinement and development of the hierarchical cosmological model (HCM) proposed in the article [6], assuming that the reader is thoroughly familiar with all the previous works from the series of articles under the general title "Geometrized Vacuum Physics Based on the Algebra of Signatures" (GVPh&AS) [1,2,3,4,5,6,7,8,9,10,11].

Recall that the HCM is based on the hierarchical solution of the third (extended) Einstein vacuum equation (11) in [6] with an infinite number of $\pm\Lambda_k$-terms

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

More precisely, the article [6] proposed a set of exact metric solutions (23) – (42) in [6] of the truncated third Einstein vacuum equation (20) in [6] with a limited, closed hierarchical chain of ten $\pm\Lambda_k$-terms

$$\begin{cases} R_{ik} + g_{ik}\sum_{m=1}^{10}\Lambda_m = 0, \\ R_{ik} - g_{ik}\sum_{m=1}^{10}\Lambda_m = 0. \end{cases} \quad (2)$$

These solutions made it possible to propose a metric-dynamic model of one of an infinite number of hierarchical chains, within which ten stable spherical $\lambda_{m,n}$-vacuum formations of different scales are nested inside each other like nesting dolls, as shown in Figure 1 (see Appendix 1).

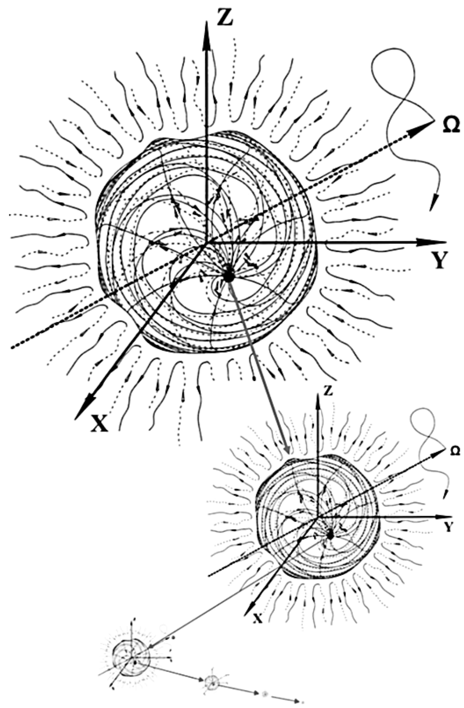

Fig. 1. (Repeat of Figure 1 in [6]) Sequence of nested spherical $\lambda_{m,n}$-vacuum formations of different scales

Figure 1 shows a hierarchical 10-level sequence of nested stable spherical $\lambda_{m,n}$-vacuum formations with characteristic radii (44a) in [6]:

$r_1 \sim 10^{39}$ cm is radius commensurate with the radius of the "mega-Universe" core; (3)
$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of an "observable Universe" core;
$r_3 \sim 10^{17}$ cm is radius commensurate with the radius of a naked "galactic" core;
$r_4 \sim 10^{7}$ cm is radius commensurate with the radius of the core of a naked "planet" or "star";
$r_5 \sim 10^{-3}$ cm is radius commensurate with the radius of a naked "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 a "proto-plankton" core;
$r_{10} \sim 10^{-55}$ cm is radius commensurate with the size of the "instanton" core.

In the framework of the Hierarchical cosmological model based on the Algebra of Signatures (HCM&AS), each of these 10 levels is filled with an infinite number of spherical $\lambda_{m,n}$-vacuum formations (i.e., “corpuscles”) of the corresponding scale, which can be considered separately (see Figure 10 in [6]).

In this case, within the framework of the HCM&AC, spherical $\lambda_{m,n}$-vacuum formations of different scales from the hierarchical sequence (3) are similar to each other. That is, when studying stable spherical $\lambda_{m,n}$-vacuum formations of one of these levels, we partially obtain information about all other spherical $\lambda_{k,l}$-vacuum formations of all other scales from this hierarchy. At the same time, each 4D-landscape (i.e., $\lambda_{m,n}$-vacuum) of the 10-level hierarchical cosmological model (HCM&AC) is unique in its own way and requires a separate detailed study.

For example, in the articles [7,8,9] stable spherical $\lambda_{-12,-15}$-vacuum formations of picoscopic scale (i.e., “corpuscles” with characteristic core radii of the order of $r_6 \sim 10^{-12} - 10^{-15}$ cm) were considered: “electrons”, “positrons”, “protons”, “neutrons”, “mesons”, “atoms”, etc. In this case, a practically complete (surprising) coincidence with the Standard Model of elementary particles was obtained.

In turn, the articles [10,11] presented metric-dynamic models of stable spherical $\lambda_{6,7}$-vacuum formations of stellar-planetary scale (i.e., “corpuscles” with characteristic radii of cores of the order of $r_4 \sim 10^6 - 10^7$ cm). These models were called naked “planets” and naked “stars”.

In this article, stable spherical $\lambda_{m,n}$-vacuum formations of another level of HCM&AS on a galactic scale are investigated, i.e. metric-dynamic models of giant “corpuscles” with characteristic core radii of the order of $r_3 \sim 10^{17} - 10^{21}$ cm are proposed.

We will call these giant "corpuscles" naked "galaxies". By analogy with the concept of naked "planets" and "stars" (see §1 in [10]), a naked "galaxy" is a stable spherical curvature of the $\lambda_{16,20}$vacuum, in the vicinity of the core of which any other smaller stable spherical $\lambda_{m,n}$-vacuum formations are conditionally absent: "stars", "planets", "molecules", "atoms", elementary "particles", etc. In other words, a naked "galaxy" is a huge $\lambda_{16,20}$vacuum gravitational funnel surrounding the naked galactic core (see Figure 2), conditionally cleared of all "corpuscles" of a smaller scale.

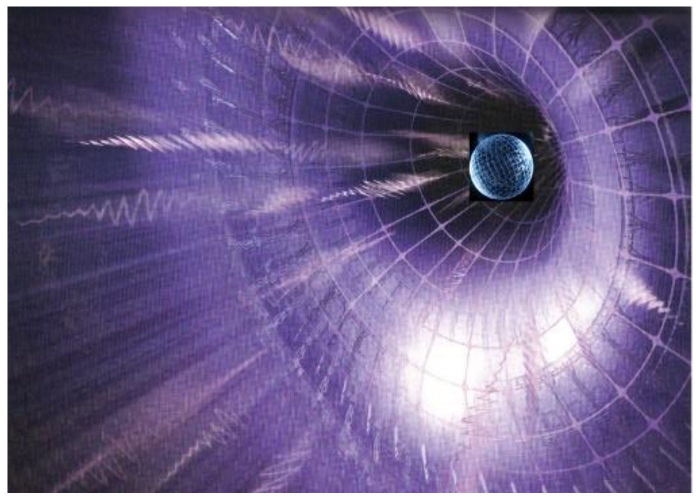

Fig. 2. Illustration of a naked “galaxy”, i.e. a giant spherical $\lambda_{16,20}$-vacuum funnel surrounding a core with a characteristic radius $r_3 \sim 10^{17} - 10^{19}$ cm

In the future, we will consider how all the other smaller stable spherical $\lambda_{m,n}$-vacuum formations (i.e. “corpuscles” of stellar-planetary and micro- and picoscopic scales) are collected into this giant funnel.

By analogy with how it was done in §4.1 in [6] for the “electron” and “positron”, in order to obtain a metric-dynamic model of the smallest non-rotating naked “galaxy”, we select from the set of metrics (23) – (27) in [6] taking into account (35) – (38) in [6] only those terms that contain radii $r_3 \sim 10^{17} - 10^{18}$ cm from hierarchy (3) (or (44a) in [6]). As a result, we obtain the following multi-layer metric-dynamic model of a stable “convex” spherical $\lambda_{16,20}$-vacuum formation of a galactic scale, which is part of a chain consisting of 10 stable spherical $\lambda_{m,n}$-vacuum formations nested inside each other (Figure 1) (see also metrics (A8) – (A16) in Appendix 1):

The smallest non-rotating
naked "GALAXY$_{10}$", (4)
or galactic G_k-"electron"
Stable "convex" multilayer spherical $\lambda_{16,20}$-vacuum formation
with signature $(+\,-\,-\,-)$, consisting of:

The outer shell
in the interval $[r_3, r_2]$ (see Figures 2 and 3), with signature $(+\,-\,-\,-)$

I $$ds_1^{(+---)2} = \left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (5)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (6)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (7)$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (8)$$

The core

in the interval $[r_4, r_3]$ (see Figures 2 and 3), with signature $(+ - - -)$

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (9)$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (10)$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (11)$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (12)$$

The substrate

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

i $$ds_5^{(+---)2} = c^2dt^2 - dr^2 - r^2(d\theta^2 + \sin^2\theta\, d\phi^2). \quad (13)$$

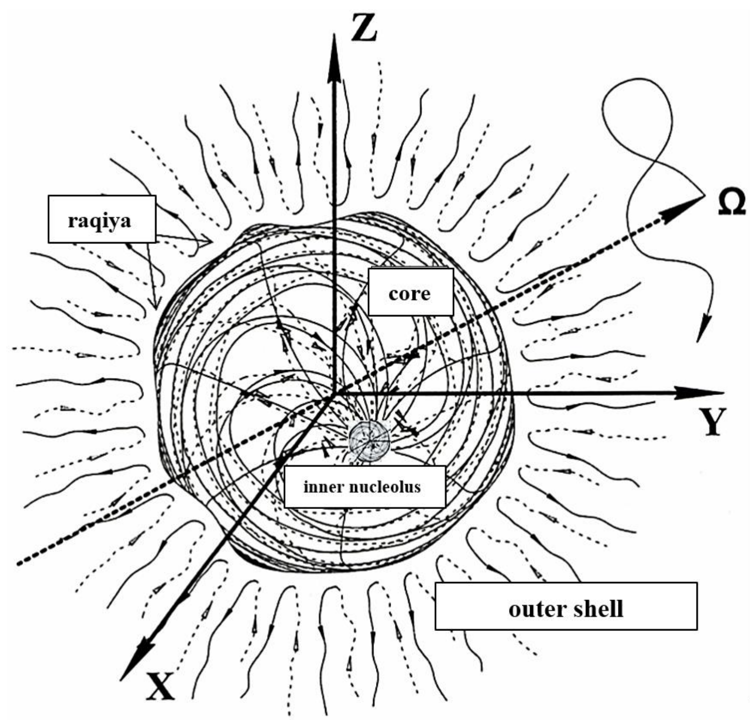

Fig. 3. Illustration of a stable spherical $\lambda_{16,20}$-vacuum formation (in particular, the smallest naked "galaxy"). This is a galactic-scale "corpuscle" extracted from the chain of 10 nested "corpuscles" shown in Figure 1

Figure 3 shows four clearly defined regions of the metric-dynamic model of the smallest naked “galaxy”: **the core** of the naked “galaxy” is the central closed spherical region of $\lambda_{16,20}$-vacuum; **the outer shell** of the naked “galaxy” is the region of $\lambda_{16,20}$-vacuum surrounding its core; **the raqiya** of the naked “galaxy” is a spherical abyss-crack separating the core of the naked “galaxy” from its outer shell; **the inner nucleolus** is a small closed spherical region of $\lambda_{7,9}$-vacuum inside the core of the naked “galaxy”; the **substrate** of the naked “galaxy” is the original undeformed region of vacuum in which the naked “galaxy” is located. This is a kind of memory of what this region of $\lambda_{16,20}$-vacuum was like before it was deformed and took on the stable form of a naked “galaxy”

Similarly, in metrics (28) – (32) in [6], taking into account (39) – (42) in [6], we will also leave only those terms that contain the radii r_3. As a result, we will obtain the following multilayer metric-dynamic model of a stable "concave" spherical $\lambda_{16,20}$-vacuum formation, which we will call the smallest naked "antigalaxy" (see also metrics (A57) – (A65) in Appendix 1):

:

The smallest non-rotating naked "ANTIGALAXY$_{10}$", (4)

or galactic G_k-"positron"

Stable "concave" multilayer spherical $\lambda_{16,20}$-vacuum formation
with signature (– + + +), consisting of:

The outer shell

in the interval [r_3, r_2] (negative of the Figures 2 and 3), with signature (– + + +)

I $$ds_1^{(-+++)2} = -\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (15)$$

H $$ds_2^{(-+++)2} = -\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (16)$$

V $$ds_3^{(-+++)2} = -\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (17)$$

H′ $$ds_4^{(-+++)2} = -\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2 + \frac{dr^2}{-\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2); \quad (18)$$

The core

in the interval [r_4, r_3] (negative of the Figures 2 and 3), with signature (– + + +)

I $$ds_1^{(-+++)2} = -\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (19)$$

H $$ds_2^{(-+++)2} = -\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (20)$$

V $$ds_3^{(-+++)2} = -\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (21)$$

H′ $$ds_4^{(-+++)2} = -\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2); \quad (22)$$

The substrate

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

i $$ds_5^{(-+++)2} = -c^2dt^2 + dr^2 + r^2(d\theta^2 + sin^2\theta\, d\phi^2). \quad (23)$$

The sets of metrics (4) and (14) differ only in signature. That is, the smallest naked "galaxy" and the smallest naked "antigalaxy" are completely identical, but antipodal (mutually opposite) copies of each other. If the naked "galaxy" (4) is conventionally called a "convex" stable spherical $\lambda_{16,20}$-vacuum formation (see Figure 3), then the naked "antigalaxy" (14) is exactly the same conventionally "concave" stable spherical $\lambda_{16,20}$-vacuum formation. Such a mutually opposite pair of $\lambda_{16,20}$-vacuum formations completely corresponds to the vacuum balance condition formulated in [1,2].

The analysis of the sets of metrics-solutions of the Kottler - de Sitter - Schwarzschild (4) and (15) of the second vacuum equation of Einstein (46) in [5], using the mathematical apparatus of the Algebra Signature [1,2,3,4,5], completely coincides with the analysis of the sets of metrics (1) and (11) in [7], defining the metric-dynamic models of the smallest picoscopic "corpuscles": "electron" and "positron". If we substitute $r_3 \sim 10^{17}$ cm instead of $r_6 \sim 10^{-13}$ cm in all expressions in the articles [6,7,8,9], we will obtain a description of the metric-dynamic models of the smallest naked "galaxy" and the smallest naked "antigalaxy". Therefore, in this article we will not dwell on the already studied aspects of these models, referring to the similarity of all stable spherical $\lambda_{m,n}$-vacuum formations regardless of their scale.

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This paper mainly considers additional questions that are characteristic of stable spherical $\lambda_{16,20}$-vacuum objects, the sizes of the cores of which are in the range of $r_3 \sim 10^{17} - 10^{21}$cm, but to one degree or another these questions are also relevant for all other smaller "corpuscles": stellar-planetary (i.e. macro-), milli-, micro- and picoscopic scales, due to the principle of similarity: - "As below, so above".

All terms and definitions used in this paper are given in the previous articles of this project [1,2,3,4,5,6,7,8,9,10,11], aimed at the complete geometrization of our ideas about the surrounding reality and, in particular, at the development of vacuum physics.

It should be noted that this article is more programmatic in nature, aimed at the further development of GVPh&AS. Each hypothesis put forward in this work requires additional detailed consideration and comparison with observed data.

MATERIALS AND METHOD

1 Classification of galaxies

Let's note the well-known information about galaxies that will be needed for further presentation. According to modern estimates made on the basis of data collected using radio astronomical telescopes such as Hubble, RATAN-600 and New Horizons, there are about a trillion galaxies of various types and sizes in the observable Universe.

There are various branched schemes for classifying galaxies. But in this article we will adhere to the simplified morphological classification of Hubble, which distinguishes the following types of galaxies (see Figure 4) [12,13,14]: elliptical (classes E0 – E7), lenticular (class S0), spiral (classes Sa, Sb, Sc), barred spiral (classes SBa, SBb, SBc) and irregular.

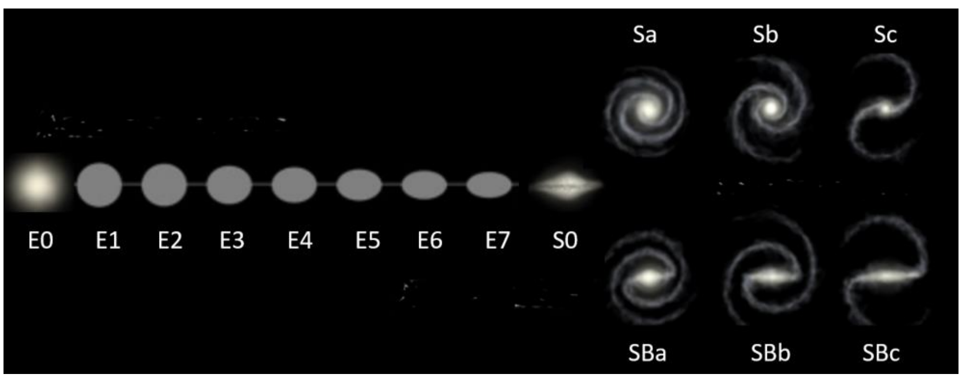


Fig. 4. Hubble's morphological classification of galaxies (or "Hubble's tuning fork").
In this classification, Edwin Powell Hubble in 1926 took into account: the twist angle and the raggedness of the spiral arms, the prominence of the bulge relative to the disk and the presence of a bar

2 Naked colored valence galactic G_k-"quarks" and G_k-"antiquarks"

Within the framework of the Hierarchical cosmological model based on the GVPh&AS (see [6]), the galactic level of organization of the Universe is not fundamentally different from the level of elementary "particles" (see [6,7,8,9]) and the "stellar-planetary" level (see [10,11]). This means that, similarly to Table 1 in §4.2 in [6] and Table 1 in §4 in [10], all naked "galaxies" and "antigalaxies" consist of a different set (i.e., an additive superposition) of colored*, valence** galactic G_k-"quarks_{10}" and G_k-"quarks_{10}"***.

**, The concepts of the color of "quarks" and "antiquarks" correspond to the colors of quantum chromodynamics, see §4.3 in [7].*
*** The concept of the valence of "quarks" and "antiquarks" is introduced in §1 in [7].*
**** Below, for brevity, we omit the index 10 in the designation of G_k-"quarks_{10}". Recall that this index means that these galactic "quarks" are part of a hierarchical chain of 10 nested corpuscular $\lambda_{m,n}$-vacuum formations (see Figure 1 and Appendix 1). Of course, it is important which hierarchical chain of "corpuscles" a naked "galaxy" is part of, since this affects many of its secondary properties and characteristics (§4.11 in [6] and §6 in [7]). But in this article, we study the most crude (primary) morphological characteristics of naked "galaxies"*

inherent in all local stable and unstable objects of galactic scale. Therefore, at this stage of the study, the place in the hierarchical chain occupied by naked G_k-"quarks" and G_k-"antiquarks" and naked "galaxies" consisting of them is of no tangible importance.

Table 1 – Resting colored valence naked galactic G_k-“quarks” and G_k-“antiquarks”

Signature type, i.e. number of + and –	**G_k-"quarks"**		**G_k-"antiquarks"**		Color G_k-"**quark**$_3$" or G_k-"**antiquark**$_3$"
	10 metrics of the type (4) with signature:	Designation G_k -"**quark**" naked, valent	10 metrics of the type (14) with signature:	Designation P_k-"**antiquark**" naked, valent	
1–3	(+ – – –)	Ge_y^+-"quark" (or G_k -"electron")	(– + + +)	Ge_y^--"antiquark" (or $G_k{}^+$-"positron")	yellow
1–3	(+ + + –)	Gd_r^+-"quark"	(– – – +)	Gd_r^--"antiquark"	red
	(+ + – +)	Gd_g^+-"quark"	(– – + –)	Gd_g^--"antiquark"	green
	(+ – + +)	Gd_b^+-"quark"	(– + – –)	Gd_b^--"antiquark"	blue
2–2	(+ – – +)	Gu_r^+-"quark$_3$"	(– + + –)	Gu_r^--"antiquark"	red
	(+ – + –)	Gu_g^+ -"quark"	(– + – +)	Gu_g^--"antiquark"	green
	(+ + – –)	Gu_b^+-"quark"	(– – + +)	Gu_b^--"antiquark"	blue
4	(+ + + +)	Gi_w^+-"quark"	(– – – –)	Gi_w^--"antiquark"	white

For example, let’s imagine a resting valence naked galactic Gu_r^--“antiquark” in expanded form:

Resting valence naked galactic Gu_r^--“ANTIQUARK” (24)

unstable "convex-concave" (sphere-like) multilayer curvature of $\lambda_{16,20}$-vacuum with signature (– + + –), consisting of:

Outer shell of Gu_r^--“antiquark”

in the interval $[r_3,r_2]$, with signature (– + + –)

$$ds_1^{(-++-)2} = -\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)}+r^2d\theta^2-r^2sin^2\theta\, d\phi^2, \quad (25)$$

$$ds_2^{(-++-)2} = -\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)}+r^2d\theta^2-r^2sin^2\theta\, d\phi^2, \quad (26)$$

$$ds_3^{(-++-)2} = -\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)}+r^2d\theta^2-r^2sin^2\theta\, d\phi^2, \quad (27)$$

$$ds_4^{(-++-)2} = -\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)}+r^2d\theta^2-r^2sin^2\theta\, d\phi^2; \quad (28)$$

The core of the Gu_r^-–"antiquark"

in the interval $[r_4,r_3]$, with the signature (– + + –)

$$ds_1^{(-++-)2} = -\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2 \quad (29)$$

$$ds_2^{(-++-)2} = -\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (30)$$

$$ds_3^{(-++-)2} = -\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (31)$$

$$ds_4^{(-++-)2} = -\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2; \quad (32)$$

The substrate of the Gu_r^-–"antiquark"

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

$$ds_5^{(-++-)2} = -c^2dt^2 + dr^2 + r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (33)$$

where, according to hierarchy (3):

$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of the observable Universe core;

$r_3 \sim 10^{17}$ cm is radius commensurate with the radius of the core of the smallest galaxy, consisting of the core of one G_k-"quark" (for example, a G_k-"electron") or G_k-"antiquark" (for example, a G_k-"positron"); (33a)

$r_4 \sim 10^7$ cm is radius comparable to the radius of the core of the smallest planet (see [10,11]).

The metric-dynamic models of all other resting, colored, valence naked galactic G_k-"quarks" and G_k-"antiquarks" listed in Table 1 are based on a set of metrics of the form (25) - (33), but with the corresponding signature.

Recall that based on the Algebra of signature using the models of valence "quarks" and "antiquarks" (or E_k-"quarks" and E_k-"antiquarks") presented in Table 1 in [6], the metric-dynamic models of the entire diversity of elementary "particles", "atoms" and "molecules" were obtained in articles [6,7] (almost in full accordance with the Standard Model of elementary particles).

We assume that, similar to the level of "atoms" and "molecules", it will be possible to construct metric-dynamic models of all classes and types of naked "galaxies" (partially shown in Figure 4) based on similar valence galactic G_k-"quarks" and G_k-"antiquarks" from Table 1.

3 Metric-dynamic models of stable spherical $\lambda_{m,n}$-vacuum formations galactic scale

Except for the on average convex galactic G_k-«electron» (i.e., Ge_y^+-«quark») with the signature (+ – – –) and the on average concave galactic G_k-«positron» (i.e., Ge_y^--«antiquark») with the signature (– + + +), all other galactic G_k-«quarks» are unstable convex-concave (sphere-like) curvatures of the $\lambda_{16,20}$-vacuum, since all metrics, for example, of the form (25) – (33) with the signature (– + + –), are not solutions of the Einstein vacuum equation (46) in [5]. That is, when substituting the components of the metric tensors from the metrics of the form (25) – (33), with any other signature except (+ – – –) and (– + + +), into the second vacuum equation of Einstein (46) in [5], equality to zero does not occur.

Just as it was done in §§4.3 – 4.7 in [6] for the level of elementary "particles", and in §5 in [10] for objects of the "stellar-planetary" scale, from the full set of 16-color valence galactic G_k-"quarks" and G_k-"antiquarks", presented in Table 1, the following can be composed:

1] Three states of the valence naked galactic Gp_i^--"proton" (i = 1, 2, 3) with the total signature (– + + +):

$Gd_{к}^{+}(+\ +\ +\ -)$
$Gu_{з}^{-}(-\ +\ -\ +)$ (34)
$Gu_{г}^{-}\underline{(-\ -\ +\ +)}$
$Gp_1^{-}(-\ +\ +\ +)_{+}$

$Gd_{з}^{+}(+\ +\ -\ +)$
$Gu_{г}^{-}(-\ -\ +\ +)$ (35)
$Gu_{к}^{-}\underline{(-\ +\ +\ -)}$
$Gp_2^{-}(-\ +\ +\ +)_{+}$

$Gd_{г}^{+}(+\ -\ +\ +)$
$Gu_{к}^{-}(-\ +\ +\ -)$ (36)
$Gu_{з}^{-}\underline{(-\ +\ -\ +)}$
$Gp_3^{-}(-\ +\ +\ +)_{+}$

- three states of the valence naked galactic Gp_i^{+}-"antiproton" with the total signature (+ – – –):

$Gd_{к}^{-}(-\ -\ -\ +)$
$Gu_{з}^{+}(+\ -\ +\ -)$ (37)
$Gu_{г}^{+}\underline{(+\ +\ -\ -)}$
$Gp_1^{+}(+\ -\ -\ -)_{+}$

$Gd_{з}^{-}(-\ -\ +\ -)$
$Gu_{г}^{+}(+\ +\ -\ -)$ (38)
$Gu_{к}^{+}\underline{(+\ -\ -\ +)}$
$Gp_2^{+}(+\ -\ -\ -)_{+}$

$Gd_{г}^{-}(-\ +\ -\ -)$
$Gu_{к}^{+}(+\ -\ -\ +)$ (39)
$Gu_{з}^{+}\underline{(+\ -\ +\ -)}$
$Gp_3^{+}(+\ -\ -\ -)_{+}$

see §4.3 in [6]. For example, in the unfolded state, the valence naked galactic Gp_i^{-}-"proton" in configuration (34) has the form

Resting Gp_1^{-}-"PROTON" (40)

stable on average concave multilayer spherical $\lambda_{16,20}$-vacuum formation
with a common signature (– + + +), consisting of:

Resting galactic Gd_r^{+}-"quark"

unstable convex-concave (sphere-like) multilayer $\lambda_{16,20}$-vacuum formation
with a signature (+ + + –), consisting of:

Outer shell of galactic Gd_r^{+}-"quark" (41)

in the interval $[r_3, r_2]$ (see Figure 5), with a signature (+ + + –)

$$ds_1^{(+++-)2} = \left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2,$$
$$ds_2^{(+++-)2} = \left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2,$$
$$ds_3^{(+++-)2} = \left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2,$$
$$ds_4^{(+++-)2} = \left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2;$$

The core of the Gd_r^{+}-"antiquark"

in the interval $[r_4, r_3]$ (see Figure 5), with the signature (+ + + –) (42)

$$ds_1^{(+++-)2} = \left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2,$$
$$ds_2^{(+++-)2} = \left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2,$$
$$ds_3^{(+++-)2} = \left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2,$$
$$ds_4^{(+++-)2} = \left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} + r^2d\theta^2 - r^2 \sin^2\theta\, d\phi^2;$$

The substrate of the Gd_r^{+}-"antiquark"

in the interval $[0,\infty]$, with signature (+ + + –) (43)

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

Resting galactic Gu_g^--"quark"

unstable convex-concave (sphere-like) multilayer $\lambda_{16,20}$-vacuum formation
with a signature (– + – +), consisting of:

Outer shell of galactic Gu_g^--"quark" (44)

in the interval $[r_3,r_2]$ (see Figure 5), with a signature (– + – +)

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

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

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

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

The core of the Gu_g^--"antiquark" (45)

in the interval $[r_4,r_3]$ (see Figure 5), with the signature (– + – +)

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

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

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

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

The substrate of the Gu_g^--"antiquark" (46)

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

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

Resting galactic Gu_b^--"quark»

unstable convex-concave (sphere-like) multilayer $\lambda_{16,20}$-vacuum formation
with a signature (– – + +), consisting of:

Outer shell of galactic Gu_b^--"quark" (47)

in the interval $[r_3,r_2]$ (see Figure 5), with a signature (– – + +)

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

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

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

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

The core of the Gu_b^--"antiquark" (48)

in the interval $[r_4,r_3]$ (see Figure 5), with the signature (– – + +)

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

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

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

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

The substrate of the Gu_b^--"antiquark"

in the interval [0,∞], with signature (– – + +) (49)

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

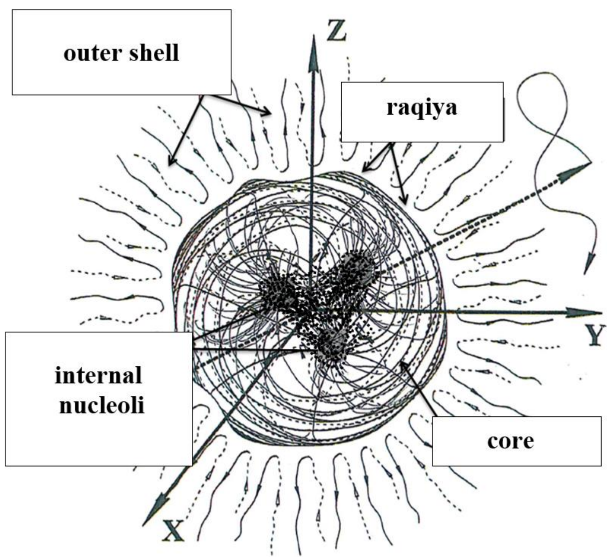


Fig. 5. On the outside, on average, at rest, but on the inside, seething, on average, stable spherical $\lambda_{16,20}$-vacuum formation of galactic scale (G_k-"proton"), consisting of one G_k-"quark" and two G_k-"antiquarks". The inner nucleoli (i.e. P_k-"stars") of these G_k-"quark" and G_k-"antiquarks" are in constant chaotic motion relative to each other

2] Eight states of the valence naked galactic Gn_i^0-"neutron", where i = 1,2,3,..,8, with a total signature (0 0 0 0) (see §4.4 in [6]): (50)

$Gi_{\text{б}}^{-}$ (– – – –)	$Gi_{\text{б}}^{-}$ (– – – –)	$Gi_{\text{б}}^{-}$ (– – – –)	$Gi_{\text{б}}^{-}$ (– – – –)
$Gd_{\text{г}}^{+}$ (+ – + +)	$Gd_{\text{з}}^{+}$ (+ + – +)	$Gd_{\text{г}}^{+}$ (+ – + +)	$Gu_{\text{з}}^{-}$ (– + – +)
$Gu_{\text{к}}^{-}$ (– + + –)	$Gd_{\text{к}}^{+}$ (+ + + –)	$Gu_{\text{з}}^{-}$ (– + – +)	$Gd_{\text{г}}^{+}$ (+ – + +)
$Gd_{\text{з}}^{+}$ (+ + – +)	$Gu_{\text{г}}^{-}$ (– – + +)	$Gd_{\text{к}}^{+}$ (+ + + –)	$Gd_{\text{к}}^{+}$ (+ + + –)
Gn_1^0 (0 0 0 0)$_+$	Gn_2^0 (0 0 0 0)$_+$	Gn_3^0 (0 0 0 0)$_+$	Gn_4^0 (0 0 0 0)$_+$
$Gi_{\text{б}}^{+}$ (+ + + +)	$Gi_{\text{б}}^{+}$ (+ + + +)	$Gi_{\text{б}}^{+}$ (+ + + +)	$Gi_{\text{б}}^{+}$ (+ + + +)
$Gd_{\text{г}}^{-}$ (– + – –)	$Gd_{\text{з}}^{-}$ (– – + –)	$Gd_{\text{г}}^{-}$ (– + – –)	$Gu_{\text{з}}^{+}$ (+ – + –)
$Gu_{\text{к}}^{+}$ (+ – – +)	$Gd_{\text{к}}^{-}$ (– – – +)	$Gu_{\text{з}}^{+}$ (+ – + –)	$Gd_{\text{г}}^{-}$ (– + – –)
$Gd_{\text{з}}^{-}$ (– – + –)	$Gu_{\text{г}}^{+}$ (+ + – –)	$Gd_{\text{к}}^{-}$ (– – – +)	$Gd_{\text{к}}^{-}$ (– – – +)
Gn_5^0 (0 0 0 0)$_+$	Gn_6^0 (0 0 0 0)$_+$	Gn_7^0 (0 0 0 0)$_+$	Gn_8^0 (0 0 0 0)$_+$

3] All naked valence galactic Gm_i^--"mesons". For example, a naked valence galactic $G\pi^+$-"meson" ($G\pi^+ = Gu^-Gd^+$) (51)

$Gd_{\text{к}}^{+}$ (+ + + –)	$Gd_{\text{з}}^{+}$ (+ + – +)	$Gd_{\text{г}}^{+}$ (+ – + +)
$Gu_{\text{з}}^{-}$ (– + – +)	$Gu_{\text{г}}^{-}$ (– – + +)	$Gu_{\text{к}}^{-}$ (– + + –)
$G\pi_1^+$ (0 2+ 0 0)$_+$	$G\pi_2^+$ (0 0 0 2+)$_+$	$G\pi_3^+$ (0 0 2+ 0)$_+$

or valence neutral galactic $G\pi^0$-«meson» $\{G\pi^0 = \frac{1}{\sqrt{2}}(Gu^-Gu^+ - Gd^+Gd^-)\}$ (see §4.7 in [6]):

(52)

$$
\begin{array}{lll}
Gu_{\text{к}}^+ \,(+ - - +) & Gu_{\text{з}}^+ \,(+ - + -) & Gu_{\text{г}}^+ \,(+ + - -) \\
Gu_{\text{з}}^- \,(- + - +) & Gu_{\text{г}}^- \,(- - + +) & Gu_{\text{к}}^- \,(- + + -) \\
- & - & - \\
Gd_{\text{к}}^+ \,(+ + + -) & Gd_{\text{з}}^+ \,(+ + - +) & Gd_{\text{г}}^+ \,(+ - + +) \\
\underline{Gd_{\text{з}}^- \,(- - + -)} & \underline{Gd_{\text{г}}^- \,(- + - -)} & \underline{Gd_{\text{к}}^- \,(- - - +)} \\
G\pi_1^0 \,(0\ 0\ 0\ 0)_+ & G\pi_2^0 \,(0\ 0\ 0\ 0)_+ & G\pi_3^0 \,(0\ 0\ 0\ 0)_+
\end{array}
$$

4) All valence naked galactic G_k-"atoms". For example, all states of valence naked galactic G_{H2}-"deuterium"

(53)

$$
\begin{array}{lccccc}
 & (+\ +\ +\ -) & & (+\ +\ -\ +) & & \\
Gp^-\text{-«proton»} & (-\ +\ -\ +) & & (-\ -\ +\ +) & & \\
+ & (-\ -\ +\ +) & & (-\ +\ +\ -) & & \\
 & (-\ -\ -\ -) & & (+\ +\ +\ +) & & \\
Gn^0\text{-«neutron»} & (+\ -\ +\ +) & \text{or} & (+\ -\ +\ -) & \text{or} & \dots \\
+ & (-\ +\ +\ -) & & (-\ +\ -\ -) & & \\
 & (+\ +\ -\ +) & & (-\ -\ -\ +) & & \\
\underline{Ge^+\text{-«electron»}} & \underline{(+\ -\ -\ -)} & & \underline{(+\ -\ -\ -)} & & \\
= & G_{H2}(0\ 0\ 0\ 0)_+ & & G_{H2}(0\ 0\ 0\ 0)_+ & &
\end{array}
$$

(54)

$$
\begin{array}{lccccc}
 & (-\ -\ -\ +) & & (-\ -\ +\ -) & & \\
Gp^+\text{-«antiproton»} & (+\ -\ +\ -) & & (+\ +\ -\ -) & & \\
 & (+\ +\ -\ -) & & (+\ -\ -\ +) & & \\
+ & (+\ +\ +\ +) & & (-\ -\ -\ -) & & \\
Gn^0\text{-«neutron»} & (-\ +\ -\ -) & \text{or} & (-\ +\ -\ +) & \text{or} & \dots \\
+ & (+\ -\ -\ +) & & (+\ -\ +\ +) & & \\
 & (-\ -\ +\ -) & & (+\ +\ +\ -) & & \\
\underline{Ge^-\text{-«positron»}} & \underline{(-\ +\ +\ +)} & & \underline{(-\ +\ +\ +)} & & \\
= & G_{H2}(0\ 0\ 0\ 0)_+ & & G_{H2}(0\ 0\ 0\ 0)_+ & &
\end{array}
$$

where each signature corresponds to a valence naked galactic G_k-“quark” from Table 1, i.e. a set of 10 metrics of type (24) with the corresponding signature (see §4.5 in [6]).

Or, for example, one of the many nodal (topological) configurations of the valence galactic G_k-“atom” of helium (or G_{He4}-“helium”), see §4.6 in [6]:

(55)

$$
\begin{array}{cl}
(+\ +\ -\ +) & \\
(-\ -\ +\ +) & Gp_2^-\text{-« proton»} \\
(-\ +\ +\ -) & \\
 & \\
(-\ +\ -\ -) & \\
(+\ -\ -\ +) & Gp_3^+\text{-«antiproton»} \\
(+\ -\ +\ -) & \\
 & \\
(-\ +\ +\ +) & G_e^-\text{-«positron»} \\
 & \\
(-\ -\ -\ -) & \\
(+\ +\ -\ +) & Gn_2^0\text{-«neutron»} \\
(+\ +\ +\ -) & \\
(-\ -\ +\ +) &
\end{array}
$$

$$\begin{matrix} (+ & + & + & +) \\ (+ & - & + & -) \\ (- & + & - & -) \\ (- & - & - & +) \end{matrix} \qquad Gn_8^0\text{-«neutron»}$$

$$\begin{matrix} (+ & - & - & -) \end{matrix} \qquad G_e^-\text{-«electron»}$$

$$\overline{\qquad\qquad\qquad}$$

$$G_{He4}\,(0 \quad 0 \quad 0 \quad 0)_+ \qquad \text{galactic } G_{He4}\text{-«helium».}$$

Thus, from the 16-color valence galactic G_k-"quarks" from Table 1, all galactic G_k-"atoms", G_k-"molecules", G_k-"ions", etc. can be constructed.

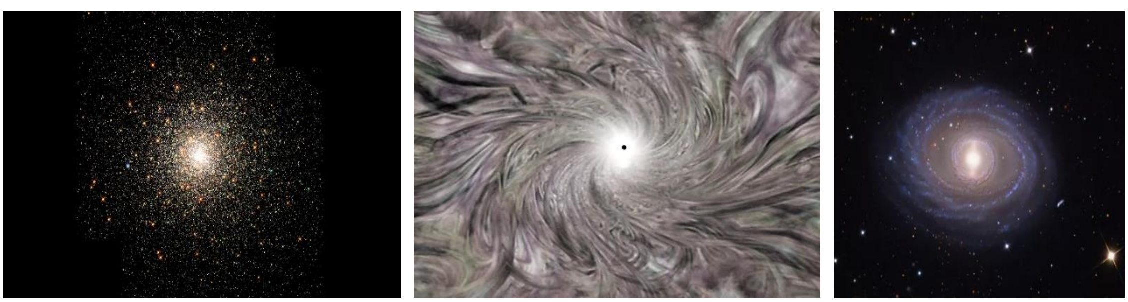
The models of naked galactic G_k-"bosons" almost completely coincide with the models of picoscopic E_k-"bosons", which are presented in §4.8 in [6]. The only difference is that in all Exs. (132) – (139) in [6] it is necessary to substitute the wavelength $\lambda = \lambda_{16,20}$ from the range $\Delta\lambda = 10^{16} – 10^{20}$ cm = $10^{12} – 10^{15}$ km.

4 Naked "globular star clusters" and naked "dwarf spheroidal galaxies"

At the first stage of the study, we are not interested in irregularly shaped star clusters, since they most likely do not have a naked "galaxy" of spherical shape at their base, or these disordered star clusters are at an early stage of formation. Only a spherically symmetrical, retracting spatial funnel (see Figure 2 and 6b), i.e. a spherical, attracting (gravitating) geometric base on a galactic scale, can give a star cluster a regular spherical shape for a long time. This is the same as naked "planets" attract smaller "corpuscles" and form dense spherical clusters from them, which we call planets and stars (see [10,11]).

In modern literature, such a hidden gravitational basis is usually called dark matter clots, without which it is impossible to explain many properties of the galaxies themselves and their clusters, as well as the evolution of stellar systems.

From the point of view of GVPh&AS, the mechanism of attraction of stars to the core of a naked "galaxy" largely coincides with the mechanism of attraction of small "corpuscles" to the core of a naked "planet", which is discussed in detail in [11].



a) b) c)

Fig. 6. a) Globular star cluster (GSC) with a characteristic diameter of ~ 20 pc; b) Illustration of a naked spatial gravitational funnel (i.e. a naked "galaxy") around its core, which pulls stars into a single cluster of an average spherical shape; c) Dwarf spheroidal galaxy with a diameter of ~ 160 pc

We start with small spherical cosmic objects of galactic scale, which are globular star clusters (GSC) with characteristic diameters of the order of 20 – 60 pc (see Figure 6a) and dwarf spheroidal galaxies (DSG) of class E0 (type dSph) with diameters of the order of 100 – 1500 pc = $3 \cdot 10^{20} – 4.7 \cdot 10^{21}$ cm (see Figure 6c).

As a rule, GSC rotate around the galactic center similar to how comets rotate around a star (see Figure 9), and the rotation of GSG around the core of a large galaxy is similar to the rotation of planets in a stellar system.

The GSC and the DSG rotate as a single whole very slowly, according to experts, this speed does not exceed 5 - 10 km/sec. For comparison, the Sun rotates around the center of our galaxy with an orbital speed of ~ 220 – 230 km/sec.

5 Metric-dynamic models of naked "GSC" and naked "DSG"

To construct metric-dynamic models of naked "globular star clusters" ("GSC") and naked "dwarf spheroidal galaxies" ("DSG"), we propose to apply the same method that was used in the article [10] for constructing metric-dynamic models of bare "planets" and "stars". In this case, we proceed from the fact that, according to the hierarchical cosmological model presented in [5,6], all levels of the Universe's organization are similar to each other. In particular, naked "GSCs" and naked "DSGs" are similar to the slowly rotating spherical naked "planets" described in [10,11], which, in turn, are similar to the stationary "elementary particles" and "atoms" described in [7,8,9], etc.

In the method used in [10], the first step is to find the smallest "globular star clusters", and then assign to this GSC a set of naked galactic G_k-quarks and G_k-antiquarks from Table 1.

Of the currently observed spherical objects on a galactic scale, the smallest are globular star clusters (GSCs) with a characteristic diameter of ~ 20 pc ≈ 62·1018 cm*.

**It is possible that smaller GSC (for example, with a characteristic diameter of ~ 12pc ≈ 37·10^{18} cm) may be found in the Universe, but this will not affect the discrete (i.e. quark) nature of $\lambda_{16,20}$-vacuum formations and the general methodology proposed in [10,11] and in this article. This will only lead to the need to refine the numerical parameters.*

By analogy with §6 in [10], it can be assumed that for the smallest, practically non-rotating, GSC the funnel-shaped suction spatial basis (i.e. the naked "galaxy") can be described by the metric-dynamic model of the 4-quark neutral galactic $G_{H1}{}^0$-"protium". Like the planetary $P_{H1}{}^0$-"protium" (89) in [10], the galactic $G_{H1}{}^0$-"protium" also consists of the galactic G_k-"proton" and G_k-"electron" or the galactic G_k-"antiproton" and G_k-"positron" (see §6.2 in [10]).

The six possible neutral topological (nodal) states of galactic $G_{H1}{}^0$-“protium”, composed of galactic G_k-“quarks” and G_k-“antiquarks” with the corresponding signatures (see Table 1), have the form:

$$
\begin{array}{lclcl}
Gd_r^+(+\ +\ +\ -) & & Gd_g^+(+\ +\ -\ +) & & Gd_b^+(+\ -\ +\ +)\\
Gu_g^-(-\ +\ -\ +) & & Gu_b^-(-\ -\ +\ +) & & Gu_r^-(-\ +\ +\ -)\\
Gu_b^-(-\ -\ +\ +) & \text{or} & Gu_r^-(-\ +\ +\ -) & \text{or} & Gu_g^-(-\ +\ -\ +)\\
Ge_y^+\ \underline{(+\ -\ -\ -)} & & Ge_y^+\ \underline{(+\ -\ -\ -)} & & Ge_y^+\ \underline{(+\ -\ -\ -)}\\
G_{H1}{}^1\ (0\ 0\ 0\ 0)_+ & & G_{H1}{}^2\ (0\ 0\ 0\ 0)_+ & & G_{H1}{}^3\ (0\ 0\ 0\ 0)_+\\
\\
Gd_r^-(-\ -\ -\ +) & & Gd_g^-(-\ -\ +\ -) & & Gd_b^-(-\ +\ -\ -)\\
Gu_g^+(+\ -\ +\ -) & & Gu_b^+(+\ +\ -\ -) & & Gu_r^+(+\ -\ -\ +)\\
Gu_b^+(+\ +\ -\ -) & \text{or} & Gu_r^+(+\ -\ -\ +) & \text{or} & Gu_g^+(+\ -\ +\ -)\\
Ge_y^-\ \underline{(-\ +\ +\ +)} & & Ge_y^-\ \underline{(-\ +\ +\ +)} & & Ge_y^-\ \underline{(-\ +\ +\ +)}\\
G_{H1}{}^4\ (0\ 0\ 0\ 0)_+ & & G_{H1}{}^5\ (0\ 0\ 0\ 0)_+ & & G_{H1}{}^6\ (0\ 0\ 0\ 0)_+
\end{array}
\qquad (56)
$$

These states constantly flow into each other so that each of them is realized with a probability of 1/6, while (similar to (90) in [10]) the average state of the galactic $G_{H1}{}^0$-"protium" is described by the expression

$$G_{H1}{}^0 = 1/6\ (G_{H1}{}^1 + G_{H1}{}^2 + G_{H1}{}^3 + G_{H1}{}^4 + G_{H1}{}^5 + G_{H1}{}^6). \qquad (57)$$

In this article, we will not consider in detail what consequences follow from the metric-dynamic model of the naked galactic $G_{H1}{}^0$-"protium" (57), since this has already been done earlier in articles [6,7,8,9], where instead of a set of radii:

$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of the observable Universe core;
$r_6 \sim 10^{-13}$ cm is radius commensurate with the radius of an elementary particle core; (58)
$r_7 \sim 10^{-24}$ cm is radius commensurate with the radius of a proto-quark core,

or in articles [10, 11] instead of a set of radii:

$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of the observable Universe core;
$r_4 \sim 10^{7}$ cm is radius commensurate with the radius of the core of a planet or star; (59)
$r_{10} \sim 10^{-55}$ cm is radius commensurate with the size of the instanton core,

you should substitute the radii (33a):

$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of the observable Universe core;
$r_3 \sim 10^{17}$ cm is radius commensurate with the radius of the core of the smallest galaxy, consisting of the core of one G_k-"quark" (for example, a G_k-"electron") or G_k-"antiquark" (for example, a G_k-"positron"); (60)
$r_4 \sim 10^{7}$ cm is radius comparable to the radius of the core of the smallest planet (see [10,11]).

As a result of such a replacement, a lot of information about the metric-dynamic model of the naked galactic $G_{H1}{}^0$- "protium" can be obtained, starting from the features of the curvature of the $\lambda_{16,20}$-vacuum at the location of the spherical star cluster, to the causes of the gravitational attraction of stars to the core of this $\lambda_{16,20}$-vacuum formation.

Similarly to Ex. (112) in [6] and Ex. (88) in [10], in this article, to estimate the number of valence galactic G_k -"quarks" and G_k-"antiquarks" in the metric-dynamic models of larger spherical $\lambda_{16,20}$-vacuum formations on a galactic scale (i.e., naked "galaxies"), we will use the following heuristic approximate equality

$$r_{cG} \approx ½\, A^{1/3} r_3 \approx ½\, A^{1/3} \cdot 3 \cdot 10^{17}\ \text{cm} \approx ½\, A^{1/3} \cdot 0{,}1\ \text{pc}, \qquad (61)$$

where
r_{cG} is the radius of the core of the naked "galaxy";
A is the number of galactic G_k-"quarks" and G_k-"antiquarks" that make up the naked "galaxy";
$r_3 \approx 3 \cdot 10^{17}$ cm $\approx$ 0.1pc is the radius of the core of the galactic G_k-"quark" or G_k-"antiquark" (in particular, the radius of the core of the galactic G_k-"electron", or another name for the $Ge_ж{}^+$-"quark").

Substituting the number of G_k-"quarks" and G_k-"antiquarks" of naked $G_{H1}{}^0$-"protium" $A = 4$ into Ex. (61), we obtain an estimate of the radius of the core of a non-rotating naked "globular star cluster" ("GSC"), which is based on the metric-dynamic model of naked galactic $G_{H1}{}^0$-"protium"

$$r_{cG} \approx ½\, A^{1/3} r_3 \approx ½\, 4^{1/3} \cdot 3 \cdot 10^{17}\ \text{cm} \approx 2{,}12 \cdot 10^{17}\ \text{cm} \approx 0{,}07\ \text{pc}, \qquad (62)$$

which is 0.7% of the characteristic radius of 10 pc of the entire smallest "GSC".

According to §6 in [10], the next neutral stable spherical $\lambda_{16,20}$-vacuum formation after the naked galactic $G_{H1}{}^0$-"protium" is the naked galactic G_k-"heavy hydrogen" (another name is naked galactic G_k-"deuterium") (see (93) and §6.2 in [10]). This metric-dynamic model consists of the following possible neutral (i.e., zero) sets of G_k-"quarks" and G_k-"antiquarks" from Table 1:

$$\begin{array}{lcccc}
 & (+\ +\ +\ -) & & (+\ +\ -\ +) & \\
Gp^{-}\text{-“proton”} & (-\ +\ -\ +) & & (-\ -\ +\ +) & \\
+ & (-\ -\ +\ +) & & (-\ +\ +\ -) & \\
 & (-\ -\ -\ -) & & (+\ +\ +\ +) & \\
Gn^{0}\text{-“neutron”} & (+\ -\ +\ +) & \text{or} & (+\ -\ +\ -) & \text{or} \quad \ldots \\
+ & (-\ +\ +\ -) & & (-\ +\ -\ -) & \\
 & (+\ +\ -\ +) & & (-\ -\ -\ +) & \\
Ge^{+}\text{-“}\underline{\text{electron}}\text{”} & \underline{(+\ -\ -\ -)} & & \underline{(+\ -\ -\ -)} & \\
G_D{}^{n}\text{-“deuterium”} & G_D{}^{1}\,(0\ 0\ 0\ 0)_{+} & & G_D{}^{2}(0\ 0\ 0\ 0)_{+} &
\end{array} \qquad (63)$$

	(+ + + –)		(+ + – +)		
Gp^{-}-“proton”	(– + – +)		(– – + +)		
+	(– – + +)		(– + + –)		
	(– – – –)		(+ + + +)		
Gn^{0}-“neutron”	(+ – + +)	or	(+ – + –)	or	…
+	(– + + –)		(– + – –)		
	(+ + – +)		(– – – +)		
Ge^{+}-“<u>electron</u>”	(+ – – –)		(+ – – –)		
G_D^{n}-“deuterium”	$G_D^{3}(0\ 0\ 0\ 0)_+$		$G_D^{4}(0\ 0\ 0\ 0)_+$		

The naked galactic G_D^0-"deuterium" is the result of averaging all n possible similar states, i.e. topological knots of type (63), into which the G_k-"quarks" and G_k-"antiquarks" from Table 1 are tied:

$$G_{H2}^0 = 1/n\ (G_D^1 + G_D^2 + G_D^3 + G_D^4 + \ldots + G_D^n). \qquad (64)$$

From the ranking expressions (63) it is evident that the galactic G_D^0-"deuterium" consists of 8 galactic G_k-"quarks" and G_k-"antiquarks". Substituting A = 8 into Ex. (61), we obtain an estimate of the radius of the core of the naked "globular star cluster" based on the metric-dynamic model of the naked galactic G_D^0-"deuterium"

$$r_{cG} \approx ½\ A^{1/3} r_3 \approx ½\ 8^{1/3} \cdot 3 \cdot 10^{17}\ \text{cm} \approx 2{,}52 \cdot 10^{17}\ \text{cm} \approx 0{,}084\ \text{pc}. \qquad (65)$$

If the ratio of the radius of the core of a naked "globular star cluster" to the radius of the entire "GSC" is preserved (i.e. equals 0.7% = 0.007), then we can obtain an estimate of the diameter of the globular star cluster in this case. Taking into account (61), we obtain

$$0{,}084 \cdot 100/0{,}7 = 12 \cdot 2 = 24\ \text{pc}. \qquad (66)$$

Now we can solve the inverse problem, i.e. estimate how many galactic G_k-"quarks" and G_k-"antiquarks" are contained in the base of a globular star cluster with a maximum diameter of ~ 60 pc. To do this, we first estimate the radius of its core

$$60 \cdot 0{,}7/(2 \cdot 100) = 0{,}21\ \text{pc}. \qquad (67)$$

Then we substitute this value into expression (61)

$$0{,}21\text{pc} \approx ½\ A^{1/3} \cdot 0{,}1\ \text{pc}. \qquad (68)$$

As a result, from Ex. (68) it follows that if the size of a globular star cluster is ~ 60 pc, then the approximate number of G_k-“quarks” and G_k-“antiquarks” in the metric-dynamic model of its naked “galaxy”

$$A \approx (0{,}21 \cdot 2/0{,}1)^3 \approx 74. \qquad (69)$$

In this case, the estimate of the number of galactic G_k-"nucleons" in such a stable $\lambda_{16,20}$-vacuum formation is approximately 74: 4 ≈ 18, and galactic G_k-"protons" 18/2 = 9. Such a $\lambda_{16,20}$-vacuum formation can be called galactic G_k-"Fluorine", since in the periodic table of chemical elements of D. Mendeleyev, atomic number 9 corresponds to Fluorine.

Let’s repeat operations (67) – (69) for one of the largest dwarf spheroidal galaxies (DSG) with an approximate diameter of 1.5 kpc. As a result, we first obtain

$$1500 \cdot 0{,}7/(2 \cdot 100) = 5{,}25\ \text{pc}. \qquad (70)$$

and then we obtain an estimate of the number of galactic G_k-“quarks” and G_k-“antiquarks” in the metric-dynamic model of a large DSG $A \approx (5{,}25 \cdot 2/0{,}1)^3 \approx 1\,157\,625$.

In this case, the number of naked galactic G_k-“protons” (or G_k-“antiprotons”) in such a $\lambda_{16,20}$-vacuum formation is approximately equal to $\frac{A}{4 \cdot 2} \approx \frac{1\,157\,625}{4 \cdot 2} \approx 144\,703$.

Applying the method (67) – (69) to estimate the number of galactic G_k-“quarks” and G_k-“antiquarks” that make up a naked “spiral galaxy” like the Milky Way, with a radius of ~ 16 kpc, we obtain the estimate

$$A \approx (56 \cdot 2/0{,}1)^3 \approx 1\,404\,928\,000. \qquad (71)$$

Thus, within the framework of the proposed method, naked “spiral galaxies” (as the basis of formed spiral galaxies like the Milky Way) can consist of approximately 1.5 billion galactic G_k-“quarks” and G_k-“antiquarks”.

6 Gravity of globular star clusters and dwarf spheroidal galaxies

In globular star clusters (GSC) and dwarf spheroidal galaxies (DSG), the orbital motion of stars around the core is chaotic, while the intensity of their motion is insignificant. The average orbital velocity of stars in GSC and DSG is ~ 20 km/sec.

Everything suggests that the mechanism of gravity (i.e. attraction) of stars, gas and dust to the cores of naked "GSC" and "DSG" almost completely coincides with the causes of attraction of small "corpuscles" to the cores of naked "planets" and "stars". The nature of stellar-planetary gravity from the standpoint of GVPh&AS was studied in the article [11], so in this article there is no point in repeating what was said earlier, only changing the scale of consideration. In other words, if in article [11] we replace the radii (59) with radii (60), we will obtain a description of the causes of gravity in the vicinity of the core of naked “GSC” and “DSG”.

7 Naked "elliptical galaxies" of classes E1 – E6

In elliptical galaxies (EG) of classes E1 – E6 (see Figure 4), part of the orbital motion occurs along circles located inside the common disk (we will call such motion of stars disk). The other part of the stars moves along chaotic orbits in the same way as in the GSC and DSG (we will call such motion of stars dispersed). The degree of ellipticity of the EG *b/a* (where *b* is the length of the minor axis of the ellipse, *a* is the length of its major axis) depends on the ratio of the number of stars rotating inside the common disk to the number of stars moving along chaotic orbits.

Fig. 7. Spiral-vortex rotation of the $\lambda_{16,20}$-vacuum in the outer shell surrounding the core of a naked “elliptical galaxy” leads to some of its stars being drawn into disk rotation.

Within the framework of the GVPh&AS, the disk motion of stars in an elliptical galaxy is due to the fact that the $\lambda_{16,20}$-vacuum rotates in the outer shell surrounding the core of such a naked “galaxy”. In this case, the rotation of the flattened outer shell of the naked “elliptical galaxy” (“EG”) entrains some of the stars participating in the disk rotation (see Figure 7).

In a similar way to what was done in §8 in [10], one can assume that the set of rotating galactic Gk-“quarks” are additively superimposed on each other in such a way that, on average, the metric-dynamic model of the outer shell of an electrically neutral valence rotating naked “elliptical galaxy” is determined by the following set of generalized Kerr metrics (in Boyer–Lindquist coordinates [8]):

In a similar way to §8 in [10], one can assume that the set of rotating galactic G_k-“quarks” and G_k-“antiquarks” are additively (or on average) superimposed on each other, so that on average the metric-dynamic model of the outer shell of an electrically neutral valence rotating naked “elliptical galaxy” is determined by the following set of generalized Kerr metrics (in Boyer–Lindquist coordinates [8]):

Averaged outer envelope of a slowly rotating neutral naked **"ELLIPTICAL GALAXY"** (72)

moving with velocity V_G

with overall signature (+ – – –) + (– + + +) = (0 0 0 0)

$$ds_1^{(+a1)2} = \left(1-\frac{r_{3,1}r}{\rho_1}\right)c^2dt^2 - \frac{\rho_1 dr^2}{\Delta^{(a1)}} - \rho_1 d\theta^2 - \left(r^2+a_1^2+\frac{r_{3,1}ra_1^2}{\rho_1}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{3,1}ra_1}{\rho_1}\sin^2\theta\, d\phi cdt, \quad (73)$$

$$ds_2^{(+a2)2} = \left(1-\frac{r_{3,2}r}{\rho_2}\right)c^2dt^2 - \frac{\rho_2 dr^2}{\Delta^{(a2)}} - \rho_2 d\theta^2 - \left(r^2+a_2^2+\frac{r_{3,2}ra_2^2}{\rho_2}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3,2}ra_2}{\rho_2}\sin^2\theta\, d\phi cdt, \quad (74)$$

$$ds_3^{(+b1)2} = \left(1+\frac{r_{3,3}r}{\rho_3}\right)c^2dt^2 - \frac{\rho_3 dr^2}{\Delta^{(b3)}} - \rho_3 d\theta^2 - \left(r^2+a_3^2-\frac{r_{3,3}ra_3^2}{\rho_3}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{3,3}ra_3}{\rho_3}\sin^2\theta\, d\phi cdt, \quad (75)$$

$$ds_4^{(+b1)2} = \left(1+\frac{r_{3,4}r}{\rho_4}\right)c^2dt^2 - \frac{\rho_4 dr^2}{\Delta^{(b4)}} - \rho_4 d\theta^2 - \left(r^2+a_4^2-\frac{r_{3,4}ra_4^2}{\rho_4}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3.4}ra_4}{\rho_4}\sin^2\theta\, d\phi cdt; \quad (76)$$

$$ds_1^{(-a1)2} = -\left(1-\frac{r_{3,5}r}{\rho_5}\right)c^2dt^2 + \frac{\rho_5 dr^2}{\Delta^{(a5)}} + \rho_5 d\theta^2 + \left(r^2+a_5^2+\frac{r_{3,5}ra_5^2}{\rho_5}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3,5}ra_5}{\rho_5}\sin^2\theta\, d\phi cdt, \quad (77)$$

$$ds_2^{(-a2)2} = -\left(1-\frac{r_{3,6}r}{\rho_6}\right)c^2dt^2 + \frac{\rho_6 dr^2}{\Delta^{(a6)}} + \rho_6 d\theta^2 + \left(r^2+a_6^2+\frac{r_{3,6}ra_6^2}{\rho_6}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{3,6}ra_6}{\rho_6}\sin^2\theta\, d\phi cdt, \quad (78)$$

$$ds_3^{(-b1)2} = -\left(1+\frac{r_{3,7}r}{\rho_7}\right)c^2dt^2 + \frac{\rho_7 dr^2}{\Delta^{(b7)}} + \rho_7 d\theta^2 + \left(r^2+a_7^2-\frac{r_{3,7}ra_7^2}{\rho_7}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3,7}ra_7}{\rho_7}\sin^2\theta\, d\phi cdt, \quad (79)$$

$$ds_4^{(-b2)2} = -\left(1+\frac{r_{3,8}r}{\rho_8}\right)c^2dt^2 + \frac{\rho_8 dr^2}{\Delta^{(b8)}} + \rho_8 d\theta^2 + \left(r^2+a_8^2-\frac{r_{3,8}ra_8^2}{\rho_8}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{E3,8}ra_8}{\rho_8}\sin^2\theta\, d\phi cdt; \quad (80)$$

The substrate

of a rotating naked valence "elliptical galaxy"

with a common signature (+ – – –) + (– + + +) = (0 0 0 0)

$$ds_5^{(+)2} = c^2dt^2 - \frac{\rho_i dr^2}{r^2+a_i^2} - \rho_i d\theta^2 - \left(r^2+a_i^2\right)\sin^2\theta\, d\phi^2, \quad (81)$$

$$ds_5^{(-)2} = -c^2dt^2 + \frac{\rho_i dr^2}{r^2+a_i^2} + \rho_i d\theta^2 + \left(r^2+a_i^2\right)\sin^2\theta\, d\phi^2, \quad (82)$$

where $\rho_i = r^2 + a_i^2\cos^2\theta$, $\Delta^{(ai)} = r^2 - r_{3,i}r + a_i^2$, $\Delta^{(bi)} = r^2 + r_{3,i}r + a_i^2$, i = 1,2,3,4,5,6,7,8, (83)

$a_i = \frac{r_{3,i}V_G}{2c}$ is ellipticity parameter of the i-th metric layer of the $\lambda_{16,20}$-vacuum in the vicinity of the core of the naked "EG"; (84)

$r_{3,i} \approx ½ A_i^{1/3} r_3$ is radius of the i-th spherical layer of raqiya surrounding the core of the bare "EG"; (85)

A_i is number of G_k-"quarks" and G_k-"antiquarks" forming the i-th spherical metric layer of the $\lambda_{16,20}$-vacuum in the vicinity of the core of the rotating naked "EG";

$r_3 \approx 3 \cdot 10^{17}$ cm is approximate radius of the core of one G_k-"quark" or G_k-"antiquark".

V_G is average velocity of motion of the naked "elliptical galaxy" as a whole, i.e. as a single $\lambda_{16,20}$-vacuum formation (see Figure 10).

Why do we think that the set of G_k-"quarks" and G_k-"antiquarks" in the naked "EG" (72) is distributed in this way? Because from experience, including the validity of quantum mechanics, we know that if there are different possibilities with a certain probability, then in nature they are realized in this way on average.

Depending on the ratio of the radii of the cores $r_{3,i}$ of the averaged G_k-"quark" (73) – (76) and G_k-"antiquark" (77) – (80), the outer shell of the naked "elliptical galaxy" rotates on average in a toroidal-helical vortex induced around an axis passing through the center of the core of this naked "elliptical galaxy" and indicating the direction of its general motion with an average velocity V_G (see Figure 10).

Toroidal-helical vortices of the $\lambda_{16,20}$-vacuum (more precisely, the subcont and antisubcont), described by a set of Kerr metrics of the type (73) – (76), were considered in [8].

The toroidal-helical rotation of the $\lambda_{16,20}$-vacuum in the outer shell of a naked "elliptical galaxy" of the E1 type is very weak, since the mutually opposite averaged galactic G_k-"quark" (73) – (76) and G_k-"antiquark" (77) – (80) almost completely compensate each other's manifestations. Therefore, the stars in such a naked "EG" mainly move around its core along chaotic orbital trajectories. The disk (i.e., carried away by the weak rotation of the $\lambda_{16,20}$-vacuum) component of the motion of the stars is small, therefore the visual ellipticity of such a galaxy is weakly expressed ($b/a = 0.95 \approx 1$).

The rotation velocity of the $\lambda_{16,20}$-vacuum in the galactic toroidal-helical vortex can increase due to the growing difference between the averaged galactic G_k-"quark" (73) – (76) and G_k-"antiquark" (77) – (80). This can be associated with both a change in the G_k-"quark" - "antiquark" ratio and an increase in the number of G_k-"quarks" and G_k-"antiquarks" in the composition of the naked "elliptical galaxy". Another reason for the increase in the rotation velocity of the $\lambda_{16,20}$-vacuum in the vicinity of the "galaxy" core, as follows from (84), is associated with an increase in the velocity of motion V_G of the entire naked "galaxy" as a whole.

In any case, the increase in the rotation velocity of the $\lambda_{16,20}$-vacuum in the outer shell of the naked "EG" leads to the fact that the number of stars carried away by this rotation increases. In this case, the disk part of the rotating stars becomes more pronounced. This also affects the visible ellipticity of such a galaxy.

The reverse logic is also acceptable: the smaller the degree of ellipticity of the galaxy b/a (i.e. the higher the ellipticity class of the galaxy E1 – E6), the greater the rotation speed of the $\lambda_{16,20}$-vacuum in the galactic toroidal-helical vortex in the vicinity of the core of such "elliptical galaxies".

8 Naked "galaxy" as a dark matter cluster

It is known that dwarf spheroidal galaxies and small elliptical galaxies (EG) contain a small number of stars compared to large lenticular and spiral galaxies, but the amount of dark matter in some of these galaxies is considered to be quite significant. This follows from the effect of gravitational lensing (see Figure 8).

Fig. 8. The gravitational lens effect created by a dark matter clump that forms an elliptical galaxy (EG)

Within the framework of the GVPh&AS developed here, a large amount of dark energy in small galaxies (i.e., in galaxies containing a relatively small number of stars) can be explained as follows.

By analogy with the nature of planetary gravity described in the article [11], the gravity of small galaxies is caused by an insignificant difference between the radii $r_{3,i}$ (85) of the averaged G_k-"quarks" and G_k-"antiquark". However, the counter intertwined subcont-antisubcont currents in the vicinity of the core of such naked "galaxies" significantly compensate each other's manifestations. Therefore, gravity in such electrically neutral galaxies is comparatively weak. As a consequence, such $\lambda_{16,20}$-vacuum funnels collect around themselves a comparatively small number of stars, gas and dust.

At the same time, for example, the averaged G_k-"quark" (73) – (76) and averaged G_k-"antiquark" (77) – (80) can consist of many G_k-quarks" and G_k-"antiquarks". For example, as was shown in §4, a dwarf spheroidal galaxy with an estimated diameter of 1.5 kpc can have at its core a naked "galaxy" consisting of $A \approx 1,157,625$ G_k-"quarks" and G_k-"antiquarks" (see Ex. (70)).

A large number of G_k-"quarks" and G_k-"antiquarks" determines the high energy saturation of the $\lambda_{16,20}$-vacuum region filled with them, since each of the G_k-"quarks" and G_k-"antiquarks" is associated with deformations and spiral-folded accelerated subcont-antisubcont currents (see [5,6,7,8,9,10,11], where similar processes are considered, but on smaller scales).

It is possible that the high concentration of G_k-"quarks" and G_k-"antiquarks" in the vicinity of the core of a naked "galaxy", and the associated colossal energy of internal $\lambda_{16,20}$-vacuum processes (with recalculation to mass) is the sought-after "dark matter". At the same time, as has already been noted earlier, naked "galaxies" as a whole are potential spatial funnels, where stars, planets, dust and gases flow through uncompensated gravity.

9 Naked "spiral galaxies"

Before constructing metric-dynamic models of naked "spiral galaxies" ("SG"), we will point out some features of these grandiose "corpuscles" (see Figure 9 and 9a).

a)

b)

Fig. 9. Illustration of a spiral galaxy: a) view from above; b) view from the side

1) Spiral galaxies (SGs) differ from GSCs, DSGs and EGs in that they have a strong gravitational attraction. In the framework of GVPh&AS, we have already become familiar with sources of strong fields (in particular, electric fields), see [6,7]. This suggests that naked "spiral galaxies" ("SG") are charged "particles" of galactic scale (i.e., stable spherical $\lambda_{16,20}$-vacuum formations similar to picoscopic electrically charged "corpuscles": "electrons" and "positrons", "protons" and "antiprotons", "ions", etc., described in [6,7].

2) Stars in spiral galaxies rotate around the galactic core with a relatively high orbital velocity of ~ 250 – 300 km/s. From the point of view of GVPh&AS, this means that the outer shell of a naked "SG" rotates with approximately the same velocity.

3) Spiral galaxies (SGs) are significantly larger in size than GSCs, DSGs and small EGs. In the framework of the GVPh&AS this means that the funnel-shaped substructure of the SG (i.e. naked "spiral galaxies") consists of a huge number of galactic G_k-quarks" and G_k-"antiquarks" (see expression (71)). This is similar to how a naked "star", for example, the Sun, consists of $1.6\cdot10^{11}$ planetary P_k-"quarks" and P_k-"antiquarks" (see Table 3 in [10]).

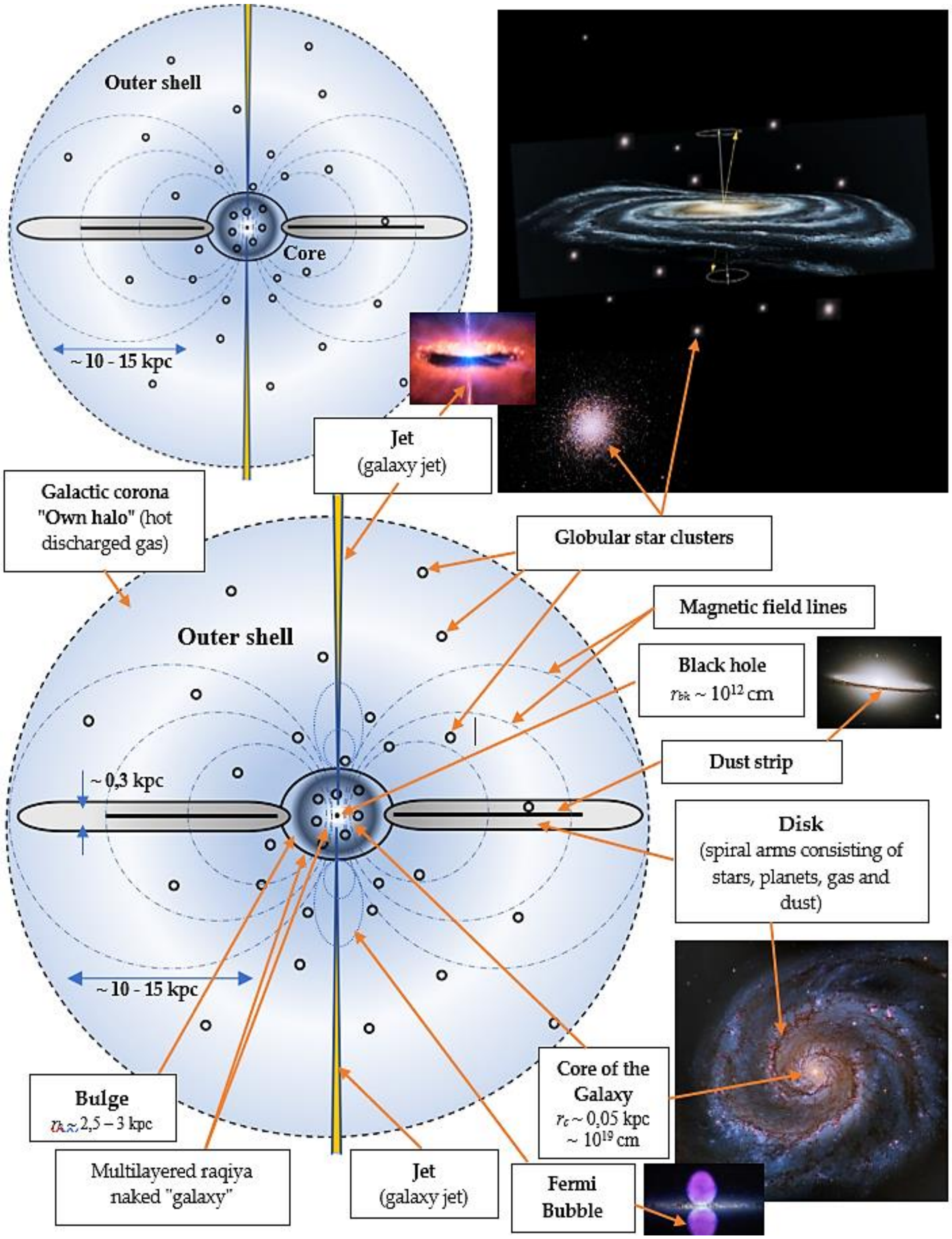


Fig. 9a. Schematic of a formed spiral galaxy (like the Milky Way or Andromeda Nebula),
1 kpc = 3.0856776·1019 m ≈ $3.1\cdot10^{21}$ cm

Based on the above arguments, the following metric-dynamic model of a naked "spiral galaxy" is proposed.

Let's assume that a huge number of rotating galactic G_k-"quarks" and G_k-"antiquarks" are additively superimposed on each other in such a way that (on average) the following simplified metric-dynamic model of a naked "spiral galaxy" is obtained as a result, with a rotating outer shell (described by four possible Kerr metrics-solutions to the first Einstein vacuum equation with the signature (+ – – –) corresponding to the signature of the "electron") and a stationary core (described by four possible Kottler metrics-solutions to the second Einstein vacuum equation (see expressions (146) – (149) in §3.2.1 in [5]) with the same signature (+ – – –):

The number of G_k-"quarks" and G_k-"antiquarks" included in the metric-dynamic model of a naked "spiral galaxy" has the value for the individual characteristics of each SG. But in this article, we will study only the most general properties of these giant "corpuscles", therefore we will temporarily leave the quantitative and qualitative quark composition of the naked "SG" outside the scope of consideration.

Naked "SPIRAL GALAXY" (88)

with a rotating outer shell and a conventionally stationary core (Figure 9 and 9a):

Rotating outer shell

of a naked "spiral galaxy" ("SG")

in the interval [r_3,r_2] (Figure 9a), signature (+ – – –)

I $$ds_1^{(+a1)2} = \left(1 - \frac{r_{3,1}r}{\rho_1}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(a,1)}} - \rho_1 d\theta^2 - \left(r^2 + a_1^2 + \frac{r_{3,1}ra_1^2}{\rho_1}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{3,1}ra_1}{\rho_1}\sin^2\theta\, d\phi cdt, \quad (89)$$

H $$ds_2^{(+a2)2} = \left(1 - \frac{r_{3,2}r}{\rho_2}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(a,2)}} - \rho_2 d\theta^2 - \left(r^2 + a_2^2 + \frac{r_{3,2}ra_2^2}{\rho_2}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3,2}ra_2}{\rho_2}\sin^2\theta\, d\phi cdt, \quad (90)$$

V $$ds_3^{(+b1)2} = \left(1 + \frac{r_{3,3}r}{\rho_3}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(b,3)}} - \rho_3 d\theta^2 - \left(r^2 + a_3^2 - \frac{r_{3,3}ra_3^2}{\rho_3}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{3,3}ra_3}{\rho_3}\sin^2\theta\, d\phi cdt, \quad (91)$$

H′ $$ds_4^{(+b1)2} = \left(1 + \frac{r_{3,4}r}{\rho_4}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(b,4)}} - \rho_4 d\theta^2 - \left(r^2 + a_4^2 - \frac{r_{3,4}ra_4^2}{\rho_4}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3,4}ra_4}{\rho_4}\sin^2\theta\, d\phi cdt; \quad (92)$$

The resting* core

of a naked "spiral galaxy"

in the interval [r_4,r_3] (Figure 9a), signature (+ – – –)

** In reality, the core of a "spiral galaxy" rotates, but here, for simplicity, a reference frame is chosen that rotates together with the core*

I $$ds_5^{(+a1)2} = \left(1 - \frac{r_{4,1}}{r} + \frac{r^2}{r_{3,1}^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_{4,1}}{r} + \frac{r^2}{r_{3,1}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (93)$$

H $$ds_6^{(+a2)2} = \left(1 + \frac{r_{4,2}}{r} - \frac{r^2}{r_{3,2}^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_{4,2}}{r} - \frac{r^2}{r_{3,2}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (94)$$

V $$ds_7^{(+b1)2} = \left(1 - \frac{r_{4,3}}{r} - \frac{r^2}{r_{3,3}^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_{4,3}}{r} - \frac{r^2}{r_{3,3}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2), \quad (95)$$

H′ $$ds_8^{(+b2)2} = \left(1 + \frac{r_{4,4}}{r} + \frac{r^2}{r_{3,4}^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_{4,4}}{r} + \frac{r^2}{r_{3,4}^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2); \quad (96)$$

4 layers of the substrate

rotating naked "spiral galaxy"

$r \in [0,\infty]$, signature (+ – – –)

$$ds_{9,1}^{(+)2} = c^2dt^2 - \frac{\rho_1 dr^2}{r^2 + a_1^2} - \rho_1 d\theta^2 - (r^2 + a_1^2)\sin^2\theta\, d\phi^2, \quad (97)$$

i $$ds_{9,2}^{(+)2} = c^2dt^2 - \frac{\rho_2 dr^2}{r^2 + a_2^2} - \rho_2 d\theta^2 - (r^2 + a_2^2)\sin^2\theta\, d\phi^2, \quad (98)$$

$$ds_{9,3}^{(+)2} = c^2dt^2 - \frac{\rho_3 dr^2}{r^2 + a_3^2} - \rho_3 d\theta^2 - (r^2 + a_3^2)\sin^2\theta\, d\phi^2, \quad (99)$$

$$ds_{9,4}^{(+)2} = c^2dt^2 - \frac{\rho_4 dr^2}{r^2 + a_4^2} - \rho_4 d\theta^2 - (r^2 + a_4^2)\sin^2\theta\, d\phi^2, \quad (100)$$

where $\rho_i = r^2 + a_i^2\cos^2\theta$, $\Delta^{(a,i)} = r^2 - r_{3,i}r + a_i^2$, $\Delta^{(b,i)} = r^2 + r_{3,i}r + a_i^2$, $i = 1,2,3,4$, (101)

$$a_i = \frac{r_{3,i}V_{zi}}{2c} \quad (102)$$

is ellipticity parameter of the *i*-th metric layer of $\lambda_{16,20}$-vacuum in the vicinity of the core of the naked "SG";

$r_{3,i} \approx ½\, B_i^{1/3} r_3 \sim 10^{19}$ cm (103)

is radius of the i-th spherical layer of raqia surrounding the core of the naked "SG" (Fig. 9); where $r_3 \approx 3 \cdot 10^{17}$ cm is the approximate radius of the core of one G_k-«quark» or G_k-«antiquark»;

B_i is the number of G_k-«quarks» and G_k-«antiquarks» forming the i-th spherical metric layer of the $\lambda_{16,20}$-vacuum in the vicinity of the core of the rotating outer shell of the naked «SG»;

$r_{4,i} \approx ½\, B_i^{1/3} r_4 \sim 10^9$ cm (104)

is the radius of the i-th spherical layer of raqiya surrounding the inner nucleolus of the naked «SG» (Figure 9a); where $r_4 \approx 10^7$ cm is the approximate radius of the inner nucleolus, which is the core of the planetary P_k-«quark» or P_k-«antiquark»**.

*** In fact, inside the core of a naked "SG" there may be many internal nucleoli (i.e. stars and globular star clusters (Figure 9) with radii*

$r_{4,ij} \approx ½\, B_{ij}^{1/3} r_4 \sim 10^8 – 10^{10}$ cm, (105)

as well as one or more black holes with a radius

$r_{4,ij} \approx ½\, B_{ij}^{1/3} r_4 \sim 10^{12}$ см, (106)

where B_{ij} is the number of G_k-"quarks" or G_k-antiquarks" participating in their formation, provided that $\sum_j B_{ij} = B_i$; (107)

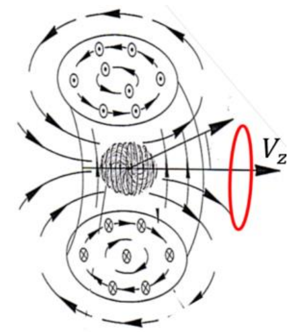


Fig. 10. Toroidal-helical vortex described by one of the Kerr metrics (89) – (92)

V_{zi} is a velocity that requires additional understanding:

1] on the one hand, V_{zi} can be interpreted as the velocity of the toroidal-helical subcont (or antisubcont) vortex described by one of the Kerr metrics (89) – (92) in the direction of the z_i axis perpendicular to the plane of rotation of the disk. In this case, $V_z \approx V_{z1} \approx V_{z2} \approx V_{z3} \approx V_{z4}$ (where V_z is the total velocity of the local ellipsoidal $\lambda_{16,20}$-vacuum formation consisting of all 4 toroidal-helical subcont-antisubcont vortices).

This assumption is supported by real observations of elliptical and spiral galaxies, which really move as shown in Figure 10. According to the SG image in Figure11 specialists conclude that it is moving in the direction of the upper right corner based on the internal clouds left behind, stripped by the pressure of the outer gas. Radio astronomers make a similar conclusion based on the condensation of the lines of constant surface radio brightness at a wavelength of 21 cm (neutral hydrogen emission line) (see Figure 12).

Fig. 11. Stripping of gas clouds of SG by pressure of the external environment

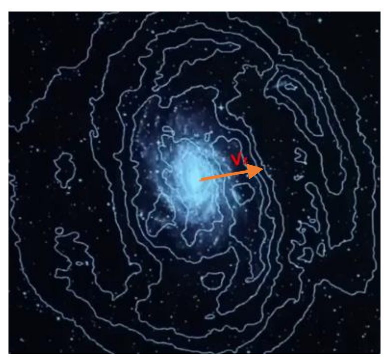
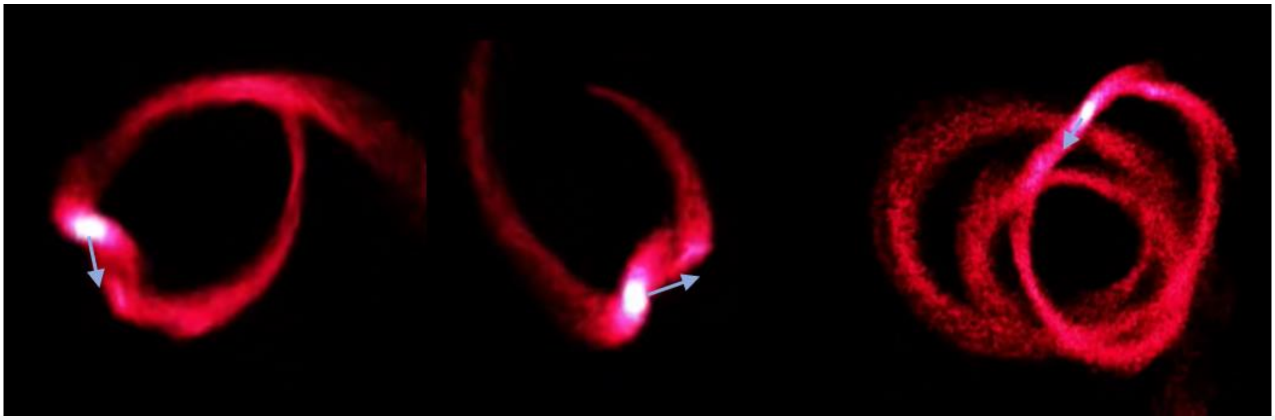


Fig. 12. Lines (equidinsites) of constant surface radio-brightness at a wavelength of 21 cm (neutral hydrogen emission line)

It should be noted, however, that the SG does not always move like a toroidal-helical vortex (shown in Figure 10). For example, in a computer simulation (see Figure 13), close to reality, it is clearly seen that sometimes the SG moves with the disk forward (see Figure 13c), but this happens when the SG needs to change the direction of movement. When turning, due *to its enormous inertia, it moves forward as a disk for some time and is slightly compressed. But then the SG still turns around and flies like a toroidal-helical vortex (see Figures 13a, b), as shown in Figure 10.*

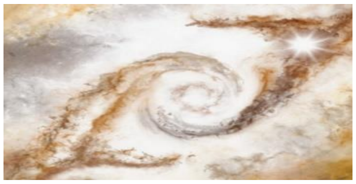


a) b) c)

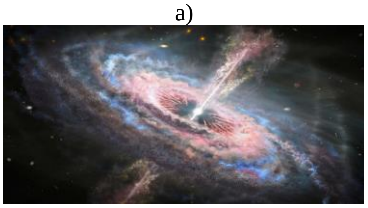
Fig. 13. Computer simulation of the trajectory of a small SG around a large massive object, such as a large galaxy

We recall that, as shown in the article [8], V_{zi} can be either the linear velocity of motion in the direction of the z_i axis of a local $\lambda_{m,n}$-vacuum formation in the resting $\lambda_{m,n}$-vacuum of which it consists, or the velocity of motion of the $\lambda_{m,n}$-vacuum along the z_i axis in the direction of the resting local $\lambda_{m,n}$-vacuum formation. Only in the first case, the moving local $\lambda_{m,n}$-vacuum formation is flattened, i.e., acquires the shape of a rotating ellipsoid, due to the fact that it encounters resistance from the resting section of the $\lambda_{m,n}$-vacuum; and in the second case, the oncoming $\lambda_{m,n}$-vacuum flattens and makes the resting local $\lambda_{m,n}$-vacuum formation rotate. In any case, within the framework of the GVPh&AS, the linear motion of a local section of the $\lambda_{m,n}$-vacuum is necessarily accompanied by a rotational component of its motion in a plane perpendicular to the direction of the linear motion. That is, any rectilinear motion of a local section of the $\lambda_{m,n}$-vacuum occurs in a spiral. In order to move, a local section of the $\lambda_{m,n}$-vacuum must, as it were, screw into the surrounding $\lambda_{m,n}$-vacuum. The reason for this property of the $\lambda_{m,n}$-vacuum is considered in the first articles of the GVPh&AS [1,2,3,4].

However, the two above-mentioned cases do not exhaust all the possibilities. A third situation may also take place, when a gas-dust cloud (i.e., a huge number of mini-, milli-, nano-, and picoscopic-scale "corpuscles") flows along spirals into a giant gravitational funnel created by a naked "galaxy" (see Figure 14a), then this rotation (or rather, the rotational moment) is transferred to the outer shell of the naked "galaxy". But the rotation of the outer shell of the bare "galaxy" cannot be arbitrary, it is determined by conservation laws, i.e., it must satisfy Einstein's vacuum equations (see [5]). In other words, the metric-dynamic model of the rotating outer shell of the naked "galaxy" is necessarily determined by the set of Kerr metrics (89) – (92). In this case, the rotational motion of the $\lambda_{16,20}$-vacuum is also necessarily accompanied by its linear motion in the form of jets being thrown off along the rotation axis (see Figure 14b). It should be noted that the galaxy's jets are not the relativistic jets of a quasar, but much slower flows of the $\lambda_{16,20}$-vacuum. Figure 14b shows two jets: one is a diffuse and slow jet of a spiral galaxy, and the other is a thin relativistic jet of a quasar. However, not all SGs have a quasar in their center, and therefore a relativistic jet, but all SGs should have a slow galactic jet.



a)



b)

Fig. 14. a) Gas and dust cloud flowing in a spiral into a gravitational funnel; b) Two jets are ejected from the center of the naked "SG": the relativistic jet of the quasar and the relatively slow jet of the galaxy.

This is also confirmed by real observations. In the X-ray and gamma ranges of radiation, it is seen that gas is ejected from the center of the SG at high speeds in a direction perpendicular to the plane of the galactic disk. Then this gas flow expands and as a result the so-called "Fermi Bubbles" are observed (see Figure 15). These bubbles are named after the Fermi gamma-ray space telescope, which discovered them in 2010.

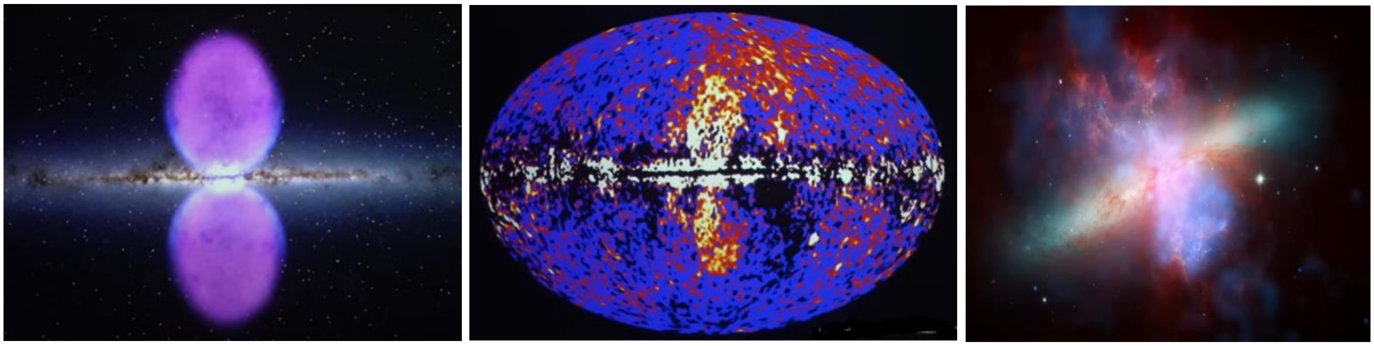


Fig. 15. Fermi bubbles – it is believed that this is a gas that breaks out from the center of the SG with high speeds, in the direction perpendicular to the plane of the galactic disk. Due to the high speeds of movement, this gas glows in the X-ray and gamma radiation ranges

2] therefore, on the other hand, V_{zi} – can be interpreted as the linear velocity of the subcont (or antisubcont) breaking out from the center of the toroidal-helical subcont (or antisubcont) vortex, described by one of the Kerr metrics (89) – (92) in the direction of the zi axis, perpendicular to the plane of rotation of the disk. Such a galactic subcont (or antisubcont) jet can carry away "gas", which glows in the X-ray and gamma radiation ranges (see Figures 15 and 16).

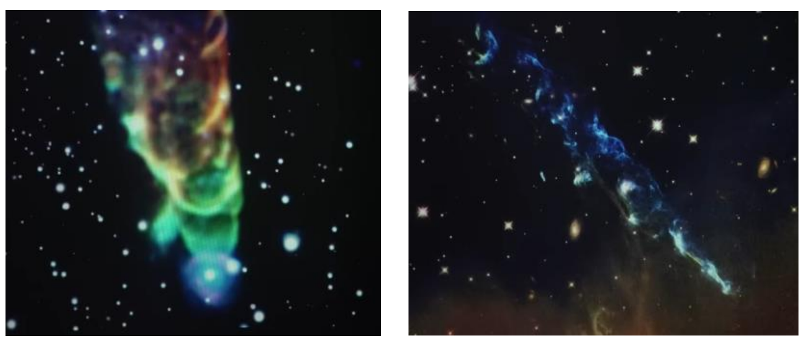


Fig. 16. Jets (i.e. fast gas spiral flows) escaping from the center of the galaxy, in a perpendicular direction relative to the galactic disk

3] a third situation is possible, when part of the velocities V_{zi} is associated with the motion of the SG as a whole, and the second part with the galactic subcont-antisubcont jet of the same SG.

10 Naked "spiral antigalaxies"

In addition to the naked "spiral galaxies" ("SG"), the model representation of which was proposed in the previous paragraph, a huge number of rotating galactic G_k-"quarks" and G_k-"antiquarks" can be additively superimposed on each other, so that the following simplified metric-dynamic model of a naked "spiral antigalaxy" ("SAG") is obtained with a rotating outer shell (described by four possible Kerr metrics-solutions of the first Einstein vacuum equation with the opposite signature (– + + +), corresponding to the signature of the "positron") and a conditionally stationary core, which is described by four possible Kottler metrics-solutions of the second Einstein vacuum equation (see Exs. (141) – (144) in §3.2.1 in [5]) with the same signature (– + + +):

Naked "SPIRAL ANTIGALAXY" (108)

with a rotating outer shell and a conventionally stationary core (negative Figure 9a):

Rotating outer shell

of a naked "spiral antigalaxy" ("SAG")

in the interval $[r_3, r_2]$ (negative Figure 9a), signature (– + + +)

I $$ds_1^{(-a1)2} = -\left(1 - \frac{r_{3,1} r}{\rho_1}\right) c^2 dt^2 + \frac{\rho dr^2}{\Delta^{(a,1)}} + \rho_1 d\theta^2 + \left(r^2 + a_1^2 + \frac{r_{3,1} r a_1^2}{\rho_1} \sin^2\theta\right) \sin^2\theta \, d\phi^2 - \frac{2 r_{3,1} r a_1}{\rho_1} \sin^2\theta \, d\phi c dt, \quad (109)$$

H $$ds_2^{(-a2)2} = -\left(1 - \frac{r_{3,2} r}{\rho_2}\right) c^2 dt^2 + \frac{\rho dr^2}{\Delta^{(a,2)}} + \rho_2 d\theta^2 + \left(r^2 + a_2^2 + \frac{r_{3,2} r a_2^2}{\rho_2} \sin^2\theta\right) \sin^2\theta \, d\phi^2 + \frac{2 r_{3,2} r a_2}{\rho_2} \sin^2\theta \, d\phi c dt, \quad (110)$$

V $$ds_3^{(-b1)2} = -\left(1 + \frac{r_{3,3} r}{\rho_3}\right) c^2 dt^2 + \frac{\rho dr^2}{\Delta^{(b,3)}} + \rho_3 d\theta^2 + \left(r^2 + a_3^2 - \frac{r_{3,3} r a_3^2}{\rho_3} \sin^2\theta\right) \sin^2\theta \, d\phi^2 - \frac{2 r_{3,3} r a_3}{\rho_3} \sin^2\theta \, d\phi c dt, \quad (111)$$

H′ $$ds_4^{(-b1)2} = -\left(1 + \frac{r_{3,4} r}{\rho_4}\right) c^2 dt^2 + \frac{\rho dr^2}{\Delta^{(b,4)}} + \rho_4 d\theta^2 + \left(r^2 + a_4^2 - \frac{r_{3,4} r a_4^2}{\rho_4} \sin^2\theta\right) \sin^2\theta \, d\phi^2 + \frac{2 r_{3,4} r a_4}{\rho_4} \sin^2\theta \, d\phi c dt; \quad (112)$$

The resting* core

of a naked "spiral antigalaxy"

in the interval $[r_4, r_3]$ (negative Figure 9a), signature (– + + +)

I $$ds_5^{(+a1)2} = -\left(1 - \frac{r_{4,1}}{r} + \frac{r^2}{r_{3,1}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_{4,1}}{r} + \frac{r^2}{r_{3,1}^2}\right)} + r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (113)$$

H $$ds_6^{(+a2)2} = -\left(1 + \frac{r_{4,2}}{r} - \frac{r^2}{r_{3,2}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_{4,2}}{r} - \frac{r^2}{r_{3,2}^2}\right)} + r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (114)$$

V $$ds_7^{(+b1)2} = -\left(1 - \frac{r_{4,3}}{r} - \frac{r^2}{r_{3,3}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_{4,3}}{r} - \frac{r^2}{r_{3,3}^2}\right)} + r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (115)$$

H′ $$ds_8^{(+b2)2} = -\left(1 + \frac{r_{4,4}}{r} + \frac{r^2}{r_{3,4}^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_{4,4}}{r} + \frac{r^2}{r_{3,4}^2}\right)} + r^2 (d\theta^2 + \sin^2\theta \, d\phi^2); \quad (116)$$

4 layers of the substrate

rotating naked "spiral antigalaxy"

$r \in [0,\infty]$, signature (– + + +)

$$ds_{5,1}^{(-)2} = -c^2 dt^2 + \frac{\rho_1 dr^2}{r^2 + a_1^2} + \rho_1 d\theta^2 + (r^2 + a_1^2) \sin^2\theta \, d\phi^2, \quad (117)$$

i $$ds_{5,2}^{(-)2} = -c^2 dt^2 + \frac{\rho_2 dr^2}{r^2 + a_2^2} + \rho_2 d\theta^2 + (r^2 + a_2^2) \sin^2\theta \, d\phi^2, \quad (118)$$

$$ds_{5,3}^{(-)2} = -c^2 dt^2 + \frac{\rho_3 dr^2}{r^2 + a_3^2} + \rho_3 d\theta^2 + (r^2 + a_3^2) \sin^2\theta \, d\phi^2, \quad (119)$$

$$ds_{5,4}^{(-)2} = -c^2 dt^2 + \frac{\rho_4 dr^2}{r^2 + a_4^2} + \rho_4 d\theta^2 + (r^2 + a_4^2) \sin^2\theta \, d\phi^2, \quad (120)$$

where the parameters a_a_i, ρ_i, V_{zi}, $r_{3,i}$, $r_{4,}$ are defined by Exs. (102) – (107).

Unlike the "electron" and "positron" described in [7], the naked "spiral galaxy" and the naked "spiral antigalaxy" are not complete antipodes of each other, since they have different $r_{3,i}$ and $r_{4,i}$. Therefore, when merging, they do not annihilate, but complement each other.

This hypothesis of the coexistence of naked "spiral galaxies" ("SG") and naked "spiral antigalaxies" ("SAG") is supported not only by the mathematical necessity of the completeness of the Algebra of signature to maintain vacuum balance, but also by some observational facts.

For example, there is a colossal force that causes spiral galaxies to merge into one elliptical galaxy (see Figure 17).

a) b)

Fig. 17. The merger of a spiral galaxy and a spiral antigalaxy (a) leads to the fact that their spiral structure is broken up and as a result one giant elliptical galaxy is formed (b)

Purely Newtonian gravitational attraction (i.e., the gravity mechanism described in [11]) is clearly not enough to make ordinary galaxies (as huge clusters of stars) quickly approach each other. It is a different matter if it is not clusters of electrically neutral stars that are attracted, but their differently charged naked bases, i.e. a naked "galaxy" and a naked "antigalaxy". In this case, the naked geometrized bases, when approaching, drag along neutral stars, gas and dust.

For example, in order to explain the gravitational convergence of our galaxy and the galaxy M 31 (Andromeda Nebula), there is clearly not enough baryonic matter in these galaxies. Therefore, according to modern concepts, the synthetic concept of "dark matter" is used, which supposedly fills the corona (i.e., the accreted halo) of the galaxy. In this case, the mass of dark matter in the galaxy should be 80 - 85% of its total mass. In the fully geometrized hypothesis proposed in this article, the concept of "dark matter" is replaced by the concept of a charged or uncharged naked "galaxy". Perhaps this will be sufficient to explain, for example, the reason for the convergence of galaxies and many other effects on a galactic scale.

Another piece of evidence in favor of the hypothesis under consideration is the fact that the merger of a spiral galaxy and a spiral antigalaxy (see Figure 17a) leads to the destruction of their spiral structure, and as a result, one electrically neutral elliptical galaxy is formed (see Figure 17b). From the metric-dynamic model of the outer shell of a naked "elliptical galaxy" (72), it is evident that it consists of two electrically charged naked galaxies with signatures (+ – – –) and (– + + +).

A separate extensive study should be devoted to the description of naked "SGs" and "SAGs" based on the sets of metric solutions of the Einstein vacuum equation (89) – (98) and (100) – (110) using the methods proposed in GVPh&AS [1,2,3,4,5,6,7,8,9,10,11].

In this article we will only make some assumptions regarding the arms of the naked "spiral galaxy" based on the metric-dynamic model of its outer shell (89) – (98).

11 The outer shell of a "spiral galaxy"

Within the framework of the GVPh&AS developed here, the metric-dynamic model of the rotating outer shell of a naked "spiral antigalaxy" ("SG") is determined by the full set of Kerr metrics (89) – (92)

$$ds_1^{(+a1)2} = \left(1 - \frac{r_{3,1}r}{\rho_1}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(a,1)}} - \rho_1 d\theta^2 - \left(r^2 + a_1^2 + \frac{r_{3,1}ra_1^2}{\rho_1}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{3,1}ra_1}{\rho_1}\sin^2\theta\, d\phi cdt, \qquad (89')$$

$$ds_2^{(+a2)2} = \left(1 - \frac{r_{3,2}r}{\rho_2}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(a,2)}} - \rho_2 d\theta^2 - \left(r^2 + a_2^2 + \frac{r_{3,2}ra_2^2}{\rho_2}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3,2}ra_2}{\rho_2}\sin^2\theta\, d\phi cdt, \qquad (90')$$

$$ds_3^{(+b1)2} = \left(1 + \frac{r_{3,3}r}{\rho_3}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(b,3)}} - \rho_3 d\theta^2 - \left(r^2 + a_3^2 - \frac{r_{3,3}ra_3^2}{\rho_3}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_{3,3}ra_3}{\rho_3}\sin^2\theta\, d\phi cdt, \qquad (91')$$

$$ds_4^{(+b1)2} = \left(1 + \frac{r_{3,4}r}{\rho_4}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(b,4)}} - \rho_4 d\theta^2 - \left(r^2 + a_4^2 - \frac{r_{3,4}ra_4^2}{\rho_4}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_{3,4}ra_4}{\rho_4}\sin^2\theta\, d\phi cdt, \qquad (92')$$

where $a_i = \frac{r_{3,i}V_{zi}}{2c}$ is ellipticity parameter of the i-th metric layer of $\lambda_{16,20}$-vacuum in the vicinity of the core of the naked "SG";

A practically similar set of metrics was considered in the article [8] when studying the outer shell of a free valence “electron” moving rectilinearly and uniformly (see Exs. (20) – (24) in [8]):

$$ds_1^{(+a1)2} = \left(1-\frac{r_6 r}{\rho}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(a)}} - \rho d\theta^2 - \left(r^2+a^2+\frac{r_6 ra^2}{\rho}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_6 ra}{\rho}\sin^2\theta\, d\phi c dt, \qquad (21) \text{ в } [8]$$

$$ds_2^{(+a2)2} = \left(1-\frac{r_6 r}{\rho}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(a)}} - \rho d\theta^2 - \left(r^2+a^2+\frac{r_6 ra^2}{\rho}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_6 ra}{\rho}\sin^2\theta\, d\phi c dt, \qquad (22) \text{ в } [8]$$

$$ds_3^{(+b1)2} = \left(1+\frac{r_6 r}{\rho}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(b)}} - \rho d\theta^2 - \left(r^2+a^2-\frac{r_6 ra^2}{\rho}\sin^2\theta\right)\sin^2\theta\, d\phi^2 + \frac{2r_6 ra}{\rho}\sin^2\theta\, d\phi c dt, \qquad (23) \text{ в } [8]$$

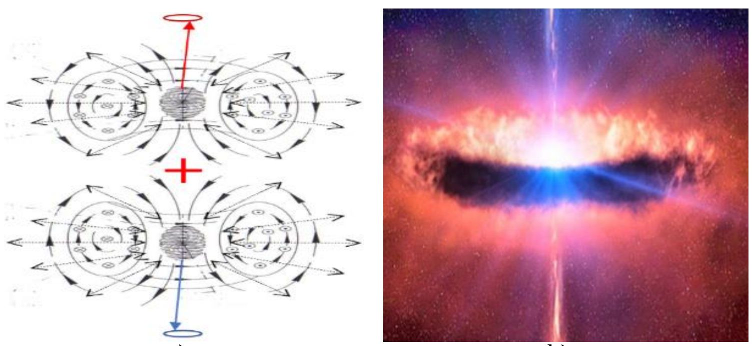
$$ds_4^{(+b1)2} = \left(1+\frac{r_6 r}{\rho}\right)c^2dt^2 - \frac{\rho dr^2}{\Delta^{(b)}} - \rho d\theta^2 - \left(r^2+a^2-\frac{r_6 ra^2}{\rho}\sin^2\theta\right)\sin^2\theta\, d\phi^2 - \frac{2r_6 ra}{\rho}\sin^2\theta\, d\phi c dt, \qquad (24) \text{ в } [8]$$

where $a_i = \frac{r_6 V_z}{2c}$ is the ellipticity parameter of the picoscopic stable $\lambda_{m,n}$-vacuum formation.

Indeed, for $r_3 \approx r_{3,1} \approx r_{3,2} \approx r_{3,3} \approx r_{3,4}$, Exs. (89) – (92) and (20) – (24) in [8] coincide up to the scale ($r_3 \gg r_6$). Therefore, we will use the results of the study in the article [8].

In this article, we will not analyze the features of the rotation of the outer shell of the naked "SG" in the case of $r_{3,1} \neq r_{3,2} \neq r_{3,3} \neq r_{3,4}$ and $V_{z1} \neq V_{z2} \neq V_{z3} \neq V_{z4}$ since this requires a separate extensive study, which may lead to a solution to the problem of the formation and features of the movement of the spiral arms of the SG.

Carrying out an analysis of the system of Kerr metrics-solutions (89) – (92) of the Einstein vacuum equation, completely analogous to the analysis of metrics-solutions (20) – (24) in [8], we find that in the outer shell of the naked “SG” (more precisely in the vicinity of its core), in addition to the laminar flowing subcont-antisubcont currents, four toroidal-helical vortices are also induced, which on average are reduced to two counter toroidal-helical vortices (see Figure 18a).



a) b)

Fig. 18. Two counter toroidal-helical subcont-antisubcont vortices (a) form one toroidal-helical vortex of □16,20-vacuum, enveloped in gas and dust (b), but throwing two jets in opposite directions

Four counter-transverse toroidal-vortex subcont-antisubcont vortices described by metrics (89) – (92) can explain not only the reason for the existence of two differently directed jets (see Figure 18), but also many other phenomena that have not yet been explained.

For example, there are spiral galaxies in which the stars rotate in two opposite directions (i.e., approximately half of the stars move along their orbits towards the other half). In addition, in many galaxies, the disk does not lie in one plane, but is curved like a figure eight (see Figure 19).

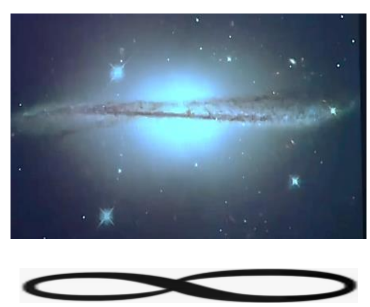


Рис. 19. Галактика, у которой диск изогнут подобно восьмерке

These and many other galactic phenomena cannot be explained by modern physical and mathematical models. Whereas the metric-dynamic model of the outer shell of a naked "SG", based on a set of metrics (89) – (92) is rich enough in parameters (102) – (107) to explain many unusual properties of spiral galaxies.

At the same time, it is obvious that the Kerr metrics (89) – (92) describe a simplified situation when the outer shell of a naked “spiral galaxy” is located in an infinite flat space. In fact, within the framework of the hierarchical cosmological model (see [6]), galaxies are located inside a closed Metagalaxy (i.e., inside the observable Universe with a radius $r_2 \sim 10^{29}$ cm). In other words, in a reference frame that very slowly rotates together with a naked “galaxy” inside an extremely slowly rotating Metagalaxy, its outer shell (more precisely, the halo of the galaxy, see Figure 9a) can be approximately described by the Kottler metrics of the form (15) – (18):

$$ds_1^{(+---)2} = \left(1 - \frac{r_{3,1}}{r} + \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_{3,1}}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$
$$ds_2^{(+---)2} = \left(1 + \frac{r_{3,2}}{r} - \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_{3,2}}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$
$$ds_3^{(+---)2} = \left(1 - \frac{r_{3,3}}{r} - \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_{3,3}}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$
$$ds_4^{(+---)2} = \left(1 + \frac{r_{3,4}}{r} + \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_{3,4}}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$

but under the condition of a large distance from the galactic core (i.e. at $r \gg r_3 \approx r_{3,1} \approx r_{3,2} \approx r_{3,3} \approx r_{3,4}$).

In other words, the Kerr metrics-solution (89) – (92) of the first Einstein vacuum equation (42) in [5] ($R_{ik} = 0$) do not describe a huge rotating spherical halo around a rotating naked "SG". For a more correct description of the galactic halo (as well as for the entire rotating galaxy as a whole, located inside the huge Metagalaxy), it is necessary to find the exact solution metrics of the second Einstein vacuum equation (46) in [5] ($R_{ik} \pm \Lambda g_{ik} = 0$).

In our opinion, a deep analysis of even a simplified set of metrics (89) − (92) with $r_{3,1} \neq r_{3,2} \neq r_{3,3} \neq r_{3,4}$, and $V_{z1} \neq V_{z2} \neq V_{z3} \neq V_{z4}$ using the mathematical apparatus of GVPh&AS [1,2,3,4,5,6,7,8,9,10,11] will lead to an understanding of many processes occurring in the outer shell of the SG and SAG, including their spiral arms and in the halo. However, this requires a separate extensive study.

CONCLUSION

This twelfth part of the "Geometrized Vacuum Physics (GVPh) based on the Algebra of Signature (AS)" (GVPh&SA) is devoted to the study of the galactic level of organization of the Universe based on the mathematical apparatus and methods described in the previous articles of this project [1,2,3,4,5,6,7,8,9,10,11].

This article proposes a hypothesis that the geometric funnel-shaped (resting or rotating) basis of all types and kinds of galaxies (spherical, elliptical, lenticular, spiral and ring) are various combinations of 16 types of galactic G_k-"quarks" and G_k-"antiquarks" with different signatures, which are presented in Table 1.
In the framework of the GVPh&AS developed in this article, galactic G_k-"quarks" and G_k-"antiquarks" are practically the same (i.e., they are described by the same metrics) as planetary P_k-quarks" and P_k-"antiquarks" (see Table 1 in [10]) and picoscopic E_k-"quarks" and E_k-"antiquarks" (see Table 1 in [6]). All these "quarks" and "antiquarks" differ only in the set of radii of spheres (i.e. core of the "corpuscles") r_{i-1}, r_i, r_{i+1} from the hierarchy of radii (3) of the hierarchical cosmological model [6].

In other words, all these "quarks" and "antiquarks" in the resting form are described by the same complete set of Kottler solution metrics of the second Einstein vacuum equation (46) in [5], and in the rotating form - by the same complete set of Kerr solution metrics of the first Einstein vacuum equation (42) in [5]. They differ mainly in scale. For example, galactic G_k-"quarks" are approximately 10 orders of magnitude larger than planetary P_k-"quarks", which in turn exceed the picoscopic E_k-"quarks" in size by 20 orders of magnitude.

The essential difference between the "corpuscles" (i.e. stable spherical $\lambda_{m,n}$-vacuum formations) of different scales consisting of these "quarks" and "antiquarks" is mainly that the larger the scale of the "corpuscles", the finer the details of their metric-dynamic structure become noticeable and should be taken into account. For example, in all Kerr metrics (20) – (24) in [8], due to the extreme smallness of the picoscopic E_k-"quarks", it can be assumed that all r_{6i} and V_{zi} are the same. Whereas in the Kerr metrics-solutions (89) – (92) of the galactic G_k-"quarks", it should be taken into account that the case is closer to reality $r_{3,1} \approx r_{3,2} \approx r_{3,3} \approx r_{3,4}$ and $V_{z1} \approx V_{z2} \approx V_{z3} \approx V_{z4}$. This leads to the fact that large-scale "corpuscles" (i.e., naked "galaxies" and "antigalaxies") have a more visible internal infrastructure (for example, such as spiral arms, jets, Fermi bubbles, satellites, etc.).

At the same time, there are no purely naked G_k-"quarks" and G_k-"antiquarks" and naked "galaxies" and "antigalaxies" consisting of them. The directed (ordered) motion of a large cluster of small "corpuscles" (such as naked "stars" and "planets", "gas") and a huge cluster (cloud) of even smaller "corpuscles" (such as "atomic" and "molecular gas") are capable of influencing the metric-dynamic state of naked G_k-"quarks" and distorting their geometric structure. On the other hand, the rotating funnel-shaped metric-dynamic structure of the additive mixture of galactic G_k-"quarks" and G_k-"antiquarks" influences the behavior of the cluster of "stars" and "atomic-molecular" clouds captured in this gravitational trap. Together they form a huge variety of star-planetary-gas-dust clusters with different configurations (morphology), which we call galaxies.

A huge stationary (or rotating) $\lambda_{16,20}$-vacuum gravitational funnel (i.e., the outer shell of a naked "galaxy") attracts billions of "stars" and enormous clouds of "gas" and "dust" in almost the same way as a local cluster of "dark matter".

Therefore, we propose to consider giant "corpuscles" (i.e., naked "galaxies" consisting of a huge cluster of G_k-"quarks" and G_k-"antiquarks") as "particles" of dark matter. This essentially means that it is proposed to supplement the Standard Model of elementary "particles", consisting of E_k-"quarks" and E_k-"antiquarks" (see Table 1 in [6]), with planetary P_k-"quarks" and P_k-"antiquarks" (Table 1 in [10]) and galactic G_k-"quarks" and G_k-"antiquarks" (Table 1 in this article).

This article is mainly of a programmatic nature. It only outlines the ways of solving a number of problems of the world of galaxies based on the hierarchical cosmological model [5,6] and the mathematical apparatus of the "Geometrized Vacuum Physics Based on the Algebra of Signature" (GVPh&AS) [1,2,3,4,5,6,7,8,9,10,11]. Each hypothesis expressed here requires detailed elaboration and experimental verification. But at the same time, the direction of search proposed here can lead to important results.

Let's recall that the entire scientific project GVPh&AS is aimed at implementing the Clifford-Einstein-Wheeler program for the complete geometrization of physics, and we hope that this article is another step in this direction.

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APPENDIX 1

What is more beautiful is more correct

Hierarchical cosmological metric-dynamic model, based on metrics-solutions of the truncated third vacuum Einstein equation (20) in [6] (or (2)) with a conditionally limited, closed hierarchical chain of ten $\pm\Lambda_k$-term

$$\begin{cases} R_{ik} + g_{ik}\sum_{m=1}^{10}\Lambda_m = 0, \\ R_{ik} - g_{ik}\sum_{m=1}^{10}\Lambda_m = 0, \end{cases} \qquad (2')$$

where $\Lambda_m = \frac{3}{r_m^2}$, m = 1,2,3, …, 10, and according to Ex. (44) in [6]:

$r_1 \sim 10^{39}$ cm is radius commensurate with the radius of the "mega-Universe" core;
$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of an "observable Universe" core;
$r_3 \sim 10^{17}$ cm is radius commensurate with the radius of a naked "galactic" core;
$r_4 \sim 10^{7}$ cm is radius commensurate with the radius of the core of a naked "planet";
$r_5 \sim 10^{-3}$ cm is radius commensurate with the radius of a naked "biological cell"; (3′)
$r_6 \sim 10^{-13}$ 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 a "proto-plankton" core;
$r_{10} \sim 10^{-55}$ cm is radius commensurate with the size of the "instanton" core.

The metric-solutions of the system of Eqs. (2´) using the methods of the Algebra of signature [1,2,3,4,5,6,7,8,9,10,11] describe a direct decreasing chain of ten stable spherical $\lambda_{m,n}$-vacuum formations nested into each other with approximate radii (3´) (see Figure A1a), and a reverse increasing chain of ten stable spherical $\lambda_{m,n}$-vacuum anti-formations nested into each other with the same approximate radii (3´) (see Figure A1b).

Sequential closed
hierarchical cosmological model 1

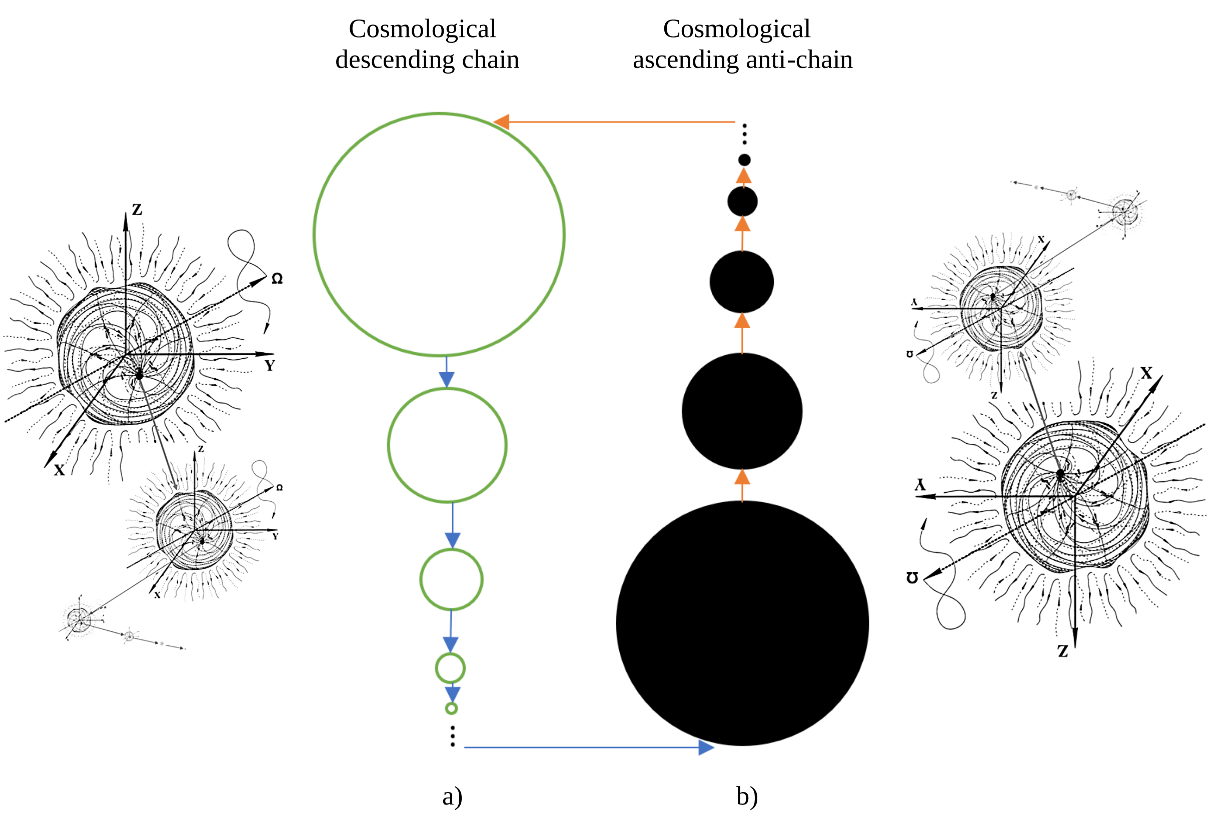


Fig. A1. Schematic representation of a sequential closed hierarchical cosmological model 1

The sequential descending chain of solution metrics (35) − (42) in [6] of equation (2´) can be represented in the following form:

Sequential closed
hierarchical cosmological model 1
(SCHCM 1)

1.1 Direct descending ten-level cosmological chain (A1)
with signature $(+ - - -)$ (see Figure A1a)

The core 1 (A2)

of the naked "mega-Universe$_{10}$" with $r_1 \sim \mathbf{10^{39}}$ cm,
interval $[r_2, r_1]$ (Figure A1a), with the signature $(+ - - -)$

I $$ds_1^{(+---)2} = \left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A3}$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A4}$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A5}$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2); \tag{A6}$$

The core 2 (A7)

of the naked "observable Universe$_{10}$" with $r_2 \sim \mathbf{10^{29}}$ cm,
interval $[r_3, r_2]$ (Figure A1a), with the signature $(+ - - -)$

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A8}$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A9}$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A10}$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2); \tag{A11}$$

The core 3 (A12)

of the naked "galactic$_{10}$" with $r_3 \sim \mathbf{10^{17}}$ cm,
interval $[r_4, r_3]$ (Figure A1a), with the signature $(+ - - -)$

I $$ds_1^{(+---)2} = \left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A13}$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A14}$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A15}$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2); \tag{A16}$$

The core 4 (A17)

of the naked "planet$_{10}$" with $r_4 \sim \mathbf{10^{7}}$ cm,
interval $[r_5, r_4]$ (Figure A1a), with the signature $(+ - - -)$

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A18}$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A19}$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2), \tag{A20}$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} - r^2(d\theta^2 + \sin^2\theta \, d\phi^2); \tag{A21}$$

The core 5 (A22)

of the naked "biological cell$_{10}$" with $r_5 \sim \mathbf{10^{-3}}$ cm,

interval $[r_6,r_5]$ (Figure A1a), with the signature $(+---)$

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A23)$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A24)$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A25)$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2); \quad (A26)$$

The core 6 (A27)

of the naked "electron$_{10}$" with $r_6 \sim \mathbf{10^{-13}}$ cm,

interval $[r_7,r_6]$ (Figure A1a), with the signature $(+---)$

I $$ds_1^{(+---)2} = \left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A28)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A29)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A30)$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2); \quad (A31)$$

The core 7 (A32)

of the naked "proto-quark$_{10}$" with $r_7 \sim \mathbf{10^{-24}}$ cm,

interval $[r_8,r_7]$ (Figure A1a), with the signature $(+---)$

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A33)$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A34)$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A35)$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2); \quad (A36)$$

The core 8 (A37)

of the naked "plankton$_{10}$" with $r_8 \sim \mathbf{10^{-34}}$ cm,

interval $[r_9,r_8]$ (Figure A1a), with the signature $(+---)$

I $$ds_1^{(+---)2} = \left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A38)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A39)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A40)$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2); \quad (A41)$$

The core 9 (A43)

of the naked " proto-plankton$_{10}$" with $r_9 \sim \mathbf{10^{-45}}$ cm,

interval $[r_{10},r_9]$ (Figure A1a), with the signature $(+---)$

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A44)$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} - r^2 (d\theta^2 + \sin^2\theta \, d\phi^2), \quad (A45)$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A46)$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (A47)$$

The core 10 (A48)

of the naked "instanton$_{10}$" with r_{10} ~ **10^{-55}** cm,

interval [r_1,r_{10}] (Figure A1a), with the signature (+ − − −)

I $$ds_1^{(+---)2} = \left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A49)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A50)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A51)$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (A52)$$

The substrate

naked closed "Universe$_{10}$"

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

i $$ds_5^{(+---)2} = c^2dt^2 - dr^2 - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2). \quad (A53)$$

1.2 Reverse ascending ten-level cosmological anti-chain (A54)

with the opposite signature (− + + +) (Figure A1b)

The core 1 (A55)

of the naked "mega-Antiuniverse$_{10}$" with r_1 ~ **10^{39}** cm,

interval [r_2,r_1] (Figure A1b), with the signature (− + + +)

I $$ds_{1,1}^{(-+++)2} = -\left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A56)$$

H $$ds_{1,2}^{(-+++)2} = -\left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A57)$$

V $$ds_{1,3}^{(-+++)2} = -\left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A58)$$

H′ $$ds_{1,4}^{(-+++)2} = -\left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (A59)$$

The core 2 (A56)

of the naked "observable Antiuniverse$_{10}$" with r_2 ~ **10^{29}** cm,

interval [r_3,r_2] (Figure A1b), with the signature (− + + +)

H′ $$ds_{2,1}^{(-+++)2} = -\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A57)$$

V $$ds_{2,2}^{(-+++)2} = -\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A58)$$

H $$ds_{2,3}^{(-+++)2} = -\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_3}{r} - \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A59)$$

I $$ds_{2,4}^{(-+++)2} = -\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_3}{r} + \frac{r^2}{r_2^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (A60)$$

The core 3 (A61)

of the naked "antigalactic$_{10}$" with r_3 ~ **10^{17}** cm,

interval [r_4,r_3] (Figure A1b), with the signature (− + + +)

I $$ds_{3,1}^{(-+++)2} = -\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A62)$$

H $$ds_{3,2}^{(-+++)2} = -\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A63)$$

V $$ds_{3,3}^{(-+++)2} = -\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_4}{r} - \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A64)

H′ $$ds_{3,4}^{(-+++)2} = -\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_4}{r} + \frac{r^2}{r_3^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2);$$ (A65)

The core 4 (A66)

of the naked "antiplanet$_{10}$" with $r_4 \sim$ **10^7** cm,

interval [r_5,r_4] (Figure A1b), with the signature $(- + + +)$

H′ $$ds_{4,1}^{(-+++)2} = -\left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A67)

V $$ds_{4,2}^{(-+++)2} = -\left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A68)

H $$ds_{4,3}^{(-+++-)2} = -\left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_5}{r} - \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A69)

I $$ds_{4,4}^{(-+++)2} = -\left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_5}{r} + \frac{r^2}{r_4^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2);$$ (A70)

The core 5 (A71)

of the naked "biological anticell$_{10}$" with $r_5 \sim$ **10^{-3}** cm,

interval [r_6,r_5] (Figure A1b), with the signature $(- + + +)$

H′ $$ds_{5,1}^{(-+++)2} = -\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A72)

V $$ds_{5,2}^{(-+++)2} = -\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A73)

H $$ds_{5,3}^{(-+++)2} = -\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_6}{r} - \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A74)

I $$ds_{5,4}^{(-+++)2} = -\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_6}{r} + \frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2);$$ (A75)

The core 6 (A76)

of the naked "positron$_{10}$" with $r_6 \sim$ **10^{-13}** cm,

interval [r_7,r_6] (Figure A1b), with the signature $(- + + +)$

I $$ds_{6,1}^{(-+++)2} = -\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A77)

H $$ds_{6,2}^{(-+++)2} = -\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A78)

V $$ds_{6,3}^{(-+++)2} = -\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A79)

H′ $$ds_{6,4}^{(-+++)2} = -\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2);$$ (A80)

The core 7 (A81)

of the naked "proto-antiquark$_{10}$" with $r_7 \sim$ **10^{-24}** cm,

interval [r_8,r_7] (Figure A1b), with the signature $(- + + +)$

H′ $$ds_{7,1}^{(-+++)2} = -\left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A82)

V $$ds_{7,2}^{(-+++)2} = -\left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A83)

H $$ds_{7,3}^{(-+++)2} = -\left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2),$$ (A84)

I $$ds_{7,4}^{(-+++)2} = -\left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right) c^2 dt^2 + \frac{dr^2}{\left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2);$$ (A85)

The core 8 (A86)

of the naked "antiplankton$_{10}$" with r_8 ~ **10^{-34}** cm,

interval [r_9,r_8] (Figure A1b), with the signature $(-+++)$

I $$ds_{8,1}^{(-+++)2} = -\left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A87)

H $$ds_{8,2}^{(-+++)2} = -\left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A88)

V $$ds_{8,3}^{(-+++)2} = -\left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A88)

H′ $$ds_{8,4}^{(-+++)2} = -\left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2);$$ (A89)

The core 9 (A90)

of the naked "proto-antiplankton$_{10}$" with r_9 ~ **10^{-45}** cm,

interval [r_{10},r_9] (Figure A1b), with the signature $(-+++)$

H′ $$ds_{9,1}^{(-+++)2} = -\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A91)

V $$ds_{9,2}^{(-+++)2} = -\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A92)

H $$ds_{9,3}^{(-+++)2} = -\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A93)

I $$ds_{9,4}^{(-+++)2} = -\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2);$$ (A94)

The core 10 (A95)

of the naked "antiinstanton$_{10}$" with r_{10} ~ **10^{-55}** cm,

interval [r_1,r_{10}] (Figure A1b), with the signature $(-+++)$

I $$ds_{10,1}^{(-+++)2} = -\left(1-\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A96)

H $$ds_{10,2}^{(-+++)2} = -\left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A97)

V $$ds_{10,3}^{(-+++)2} = -\left(1-\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_1}{r}-\frac{r^2}{r_{10}^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2),$$ (A98)

H′ $$ds_{10,4}^{(-+++)2} = -\left(1+\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_1}{r}+\frac{r^2}{r_{10}^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2);$$ (A99)

The substrate

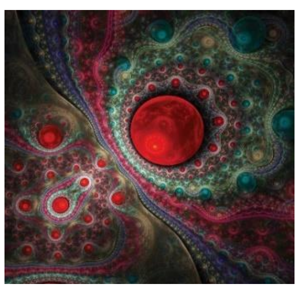
naked closed "Universe$_{10}$"

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

i $$ds_5^{(-+++)2} = -c^2dt^2+dr^2+r^2(d\theta^2+sin^2\theta\, d\phi^2).$$ (A100)

The center of this hierarchical ten-level chain is located at the center of the instanton core with an approximate radius r_{10} ~ 10^{-55} cm.

There are other possibilities for organizing a closed hierarchical cosmological model based on solutions of the third truncated Einstein equation (2). An example of such a model is given below.



Mixed closed hierarchical cosmological model 2

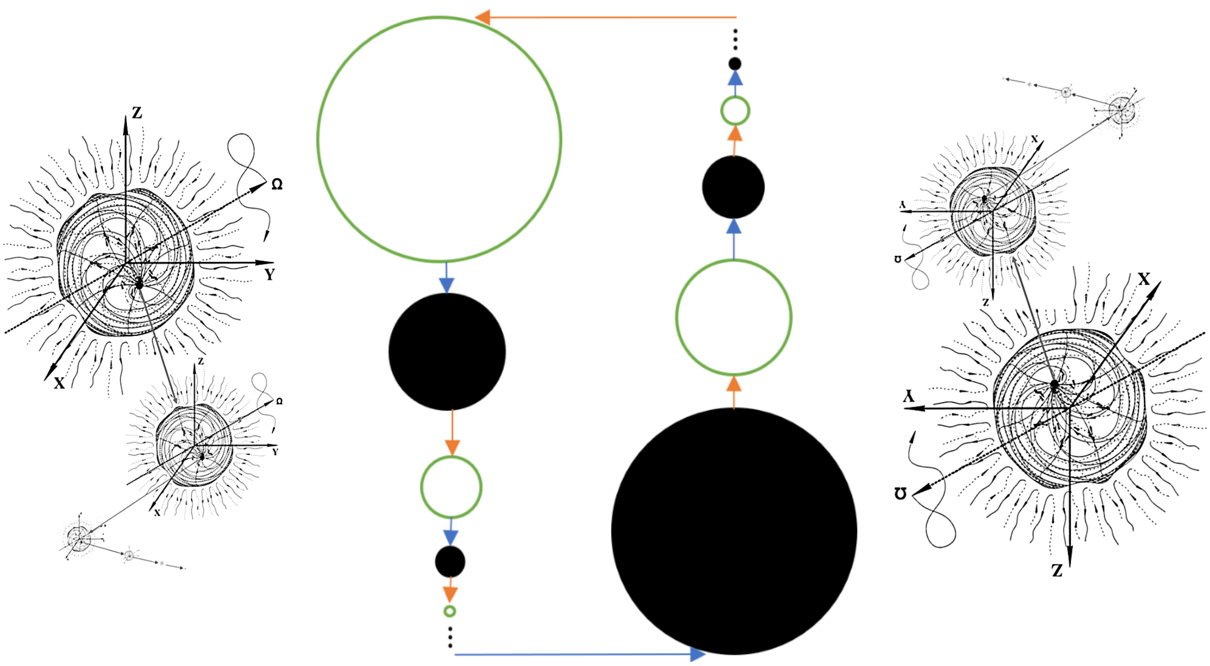


Fig. A2. Schematic representation of a mixed closed hierarchical cosmological model 2

Mixed closed hierarchical cosmological model 2

(MCHCM 2)

2.1 Direct variable ten-level cosmological chain (A101)

with variable signature (+ – – –) ↔ (– + + +) (Figure A2a):

The core 1 (A102)

of the naked "mega-Universe$_{10}$" with $r_1 \sim \mathbf{10^{39}}$ cm,

interval [r_2,r_1] (Figure A2a), with the signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2),$$ (A103)

H $$ds_2^{(+---)2} = \left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2),$$ (A104)

V $$ds_3^{(+---)2} = \left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 - \frac{r_2}{r} - \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2),$$ (A105)

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right) c^2 dt^2 - \frac{dr^2}{\left(1 + \frac{r_2}{r} + \frac{r^2}{r_1^2}\right)} - r^2(d\theta^2 + \sin^2\theta\, d\phi^2);$$ (A106)

The core 2 (A107)

of the naked "observable Antiuniverse$_{10}$" with $r_2 \sim \mathbf{10^{29}}$ cm,
interval $[r_3, r_2]$ (Figure A1a), with the signature $(-+++)$

H′ $$ds_{2,1}^{(-+++)2} = -\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A108)$$

V $$ds_{2,2}^{(-+++)2} = -\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A109)$$

H $$ds_{2,3}^{(-+++)2} = -\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A110)$$

I $$ds_{2,4}^{(-+++)2} = -\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad (A112)$$

The core 3 (A113)

of the naked "galactic$_{10}$" with $r_3 \sim \mathbf{10^{17}}$ cm,
interval $[r_4, r_3]$ (Figure A2a), with the signature $(+---)$

I $$ds_{1}^{(+---)2} = \left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A114)$$

H $$ds_{2}^{(+---)2} = \left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A115)$$

V $$ds_{3}^{(+---)2} = \left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A116)$$

H′ $$ds_{4}^{(+---)2} = \left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad (A117)$$

The core 4 (A118)

of the naked "antiplanet$_{10}$" with $r_4 \sim \mathbf{10^{7}}$ cm,
interval $[r_5, r_4]$ (Figure A2a), with the signature $(-+++)$

H′ $$ds_{4,1}^{(-+++)2} = -\left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A119)$$

V $$ds_{4,2}^{(-+++)2} = -\left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A120)$$

H $$ds_{4,3}^{(-+++-)2} = -\left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A120)$$

I $$ds_{4,4}^{(-+++)2} = -\left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad (A121)$$

The core 5 (A122)

of the naked "biological cell$_{10}$" with $r_5 \sim \mathbf{10^{-3}}$ cm,
interval $[r_6, r_5]$ (Figure A2a), with the signature $(+---)$

H′ $$ds_{1}^{(+---)2} = \left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A123)$$

V $$ds_{2}^{(+---)2} = \left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A124)$$

H $$ds_{3}^{(+---)2} = \left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A125)$$

I $$ds_{4}^{(+---)2} = \left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad (A126)$$

The core 6 (A127)

of the naked "positron$_{10}$" with $r_6 \sim \mathbf{10^{-13}}$ cm,
interval $[r_7, r_6]$ (Figure A2a), with the signature $(-+++)$

I $$ds_{6,1}^{(-+++)2} = -\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A128)$$

H $$ds_{6,2}^{(-+++)2} = -\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad (A129)$$

V $$ds_{6,3}^{(-+++)2} = -\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_7}{r} - \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A130)}$$

H′ $$ds_{6,4}^{(-+++)2} = -\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_7}{r} + \frac{r^2}{r_6^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad \text{(A131)}$$

The core 7 (A132)

of the naked "proto-quark10" with $r_7 \sim \mathbf{10^{-24}}$ cm,

interval [r_8,r_7] (Figure A2a), with the signature (+ − − −)

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A133)}$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A134)}$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_8}{r} - \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A135)}$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_8}{r} + \frac{r^2}{r_7^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad \text{(A136)}$$

The core 8 (A137)

of the naked "antiplankton10" with $r_8 \sim \mathbf{10^{-34}}$ cm,

interval [r_9,r_8] (Figure A1a), with the signature (− + + +)

I $$ds_{8,1}^{(-+++)2} = -\left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A138)}$$

H $$ds_{8,2}^{(-+++)2} = -\left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A140)}$$

V $$ds_{8,3}^{(-+++)2} = -\left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_9}{r} - \frac{r^2}{r_8^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A141)}$$

H′ $$ds_{8,4}^{(-+++)2} = -\left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_9}{r} + \frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad \text{(A142)}$$

The core 9 (A143)

of the naked " proto-plankton10" with $r_9 \sim \mathbf{10^{-45}}$ cm,

interval [r_{10},r_9] (Figure A2a), with the signature (+ − − −)

H′ $$ds_1^{(+---)2} = \left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A144)}$$

V $$ds_2^{(+---)2} = \left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A145)}$$

H $$ds_3^{(+---)2} = \left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_{10}}{r} - \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A146)}$$

I $$ds_4^{(+---)2} = \left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_{10}}{r} + \frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad \text{(A147)}$$

The core 10 (A148)

of the naked "anti-instanton10" with $r_{10} \sim \mathbf{10^{-55}}$ cm,

interval [r_1,r_{10}] (Figure A2a), with the signature (− + + +)

I $$ds_{10,1}^{(-+++)2} = -\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A149)}$$

H $$ds_{10,2}^{(-+++)2} = -\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A150)}$$

V $$ds_{10,3}^{(-+++)2} = -\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad \text{(A151)}$$

H′ $$ds_{10,4}^{(-+++)2} = -\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)c^2dt^2 + \frac{dr^2}{\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} + r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad \text{(A152)}$$

The substrate

naked closed "Universe10"

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

i $$ds_5^{(+---)2} = \pm c^2dt^2 \mp dr^2 \mp r^2(d\theta^2 \mp sin^2\,\theta\, d\phi^2). \quad \text{(A153)}$$

2.2 Direct Inverse variable ten-level cosmological anti-chain (A154)

with variable signature (+ – – –) ↔ (– + + +) (Figure A2b):

The core 1 (A155)

of the naked "mega-Antiuniverse$_{10}$" with $r_1 \sim \mathbf{10^{39}}$ cm,

interval [r_2,r_1] (Figure A2b), with the signature $(-+++)$

I $$ds_{1,1}^{(-+++)2} = -\left(1-\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A156)}$$

H $$ds_{1,2}^{(-+++)2} = -\left(1+\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A157)}$$

V $$ds_{1,3}^{(-+++)2} = -\left(1-\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_2}{r}-\frac{r^2}{r_1^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A158)}$$

H′ $$ds_{1,4}^{(-+++)2} = -\left(1+\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_2}{r}+\frac{r^2}{r_1^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad \text{(A159)}$$

The core 2 (A160)

of the naked "observable Universe$_{10}$" with $r_2 \sim \mathbf{10^{29}}$ cm,

interval [r_3,r_2] (Figure A2b), with the signature $(+---)$

H′ $$ds_{1}^{(+---)2} = \left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A161)}$$

V $$ds_{2}^{(+---)2} = \left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A162)}$$

H $$ds_{3}^{(+---)2} = \left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_3}{r}-\frac{r^2}{r_2^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A163)}$$

I $$ds_{4}^{(+---)2} = \left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_3}{r}+\frac{r^2}{r_2^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad \text{(A164)}$$

The core 3 (A165)

of the naked "antigalactic$_{10}$" with $r_3 \sim \mathbf{10^{17}}$ cm,

interval [r_4,r_3] (Figure A2b), with the signature $(-+++)$

I $$ds_{3,1}^{(-+++)2} = -\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A166)}$$

H $$ds_{3,2}^{(-+++)2} = -\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A167)}$$

V $$ds_{3,3}^{(-+++)2} = -\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_4}{r}-\frac{r^2}{r_3^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A168)}$$

H′ $$ds_{3,4}^{(-+++)2} = -\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)c^2dt^2+\frac{dr^2}{\left(1+\frac{r_4}{r}+\frac{r^2}{r_3^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad \text{(A169)}$$

The core 4 (A170)

of the naked "planet$_{10}$" with $r_4 \sim \mathbf{10^{7}}$ cm,

interval [r_5,r_4] (Figure A2b), with the signature $(+---)$

H′ $$ds_{1}^{(+---)2} = \left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A171)}$$

V $$ds_{2}^{(+---)2} = \left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A172)}$$

H $$ds_{3}^{(+---)2} = \left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)c^2dt^2-\frac{dr^2}{\left(1-\frac{r_5}{r}-\frac{r^2}{r_4^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A173)}$$

I $$ds_{4}^{(+---)2} = \left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)c^2dt^2-\frac{dr^2}{\left(1+\frac{r_5}{r}+\frac{r^2}{r_4^2}\right)}-r^2(d\theta^2+sin^2\theta\, d\phi^2); \quad \text{(A174)}$$

The core 5 (A175)

of the naked "biological anticell$_{10}$" with $r_5 \sim \mathbf{10^{-3}}$ cm,

interval [r_6,r_5] (Figure A2b), with the signature $(-+++)$

H′ $$ds_{5,1}^{(-+++)2} = -\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2+\frac{dr^2}{\left(1-\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)}+r^2(d\theta^2+sin^2\theta\, d\phi^2), \quad \text{(A176)}$$

V $$ds_{5,2}^{(-+++)2} = -\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A177)$$

H $$ds_{5,3}^{(-+++)2} = -\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_6}{r}-\frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A178)$$

I $$ds_{5,4}^{(-+++)2} = -\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_6}{r}+\frac{r^2}{r_5^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2); \quad (A179)$$

The core 6 (A180)

of the naked "electron$_{10}$" with $r_6 \sim$ **10^{-13}** cm,

interval $[r_7,r_6]$ (Figure A2b), with the signature $(+---)$

I $$ds_1^{(+---)2} = \left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A181)$$

H $$ds_2^{(+---)2} = \left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A182)$$

V $$ds_3^{(+---)2} = \left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_7}{r}-\frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A183)$$

H′ $$ds_4^{(+---)2} = \left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_7}{r}+\frac{r^2}{r_6^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2); \quad (A184)$$

The core 7 (A185)

of the naked "proto-antiquark$_{10}$" with $r_7 \sim$ **10^{-24}** cm,

interval $[r_8,r_7]$ (Figure A2b), with the signature $(-+++)$

H′ $$ds_{7,1}^{(-+++)2} = -\left(1-\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A186)$$

V $$ds_{7,2}^{(-+++)2} = -\left(1+\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A187)$$

H $$ds_{7,3}^{(-+++)2} = -\left(1-\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)c^2dt^2 + \frac{dr^2}{\left(1-\frac{r_8}{r}-\frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A188)$$

I $$ds_{7,4}^{(-+++)2} = -\left(1+\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)c^2dt^2 + \frac{dr^2}{\left(1+\frac{r_8}{r}+\frac{r^2}{r_7^2}\right)} + r^2(d\theta^2 + sin^2\theta\, d\phi^2); \quad (A189)$$

The core 8 (A190)

of the naked "plankton$_{10}$" with $r_8 \sim$ **10^{-34}** cm,

interval $[r_9,r_8]$ (Figure A2b), with the signature $(+---)$

I $$ds_1^{(+---)2} = \left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A191)$$

H $$ds_2^{(+---)2} = \left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A192)$$

V $$ds_3^{(+---)2} = \left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_9}{r}-\frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A193)$$

H′ $$ds_4^{(+---)2} = \left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_9}{r}+\frac{r^2}{r_8^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2); \quad (A194)$$

The core 9 (A195)

of the naked "proto-antiplankton$_{10}$" with $r_9 \sim$ **10^{-45}** cm,

interval $[r_{10},r_9]$ (Figure 2b), with the signature $(-+++)$

H′ $$ds_{9,1}^{(-+++)2} = -\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A196)$$

V $$ds_{9,2}^{(-+++)2} = -\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A197)$$

H $$ds_{9,3}^{(-+++)2} = -\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1-\frac{r_{10}}{r}-\frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2), \quad (A198)$$

I $$ds_{9,4}^{(-+++)2} = -\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)c^2dt^2 - \frac{dr^2}{\left(1+\frac{r_{10}}{r}+\frac{r^2}{r_9^2}\right)} - r^2(d\theta^2 + sin^2\theta\, d\phi^2); \quad (A199)$$

The core 10 (A200)

of the naked "instanton$_{10}$" with r_{10} ~ $\mathbf{10^{-55}}$ cm,

interval [r_1,r_{10}] (Figure A2b), with the signature (+ – – –)

I $$ds_1^{(+---)2} = \left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A201)$$

H $$ds_2^{(+---)2} = \left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A202)$$

V $$ds_3^{(+---)2} = \left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 - \frac{r_1}{r} - \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2), \quad (A203)$$

H′ $$ds_4^{(+---)2} = \left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right) c^2dt^2 - \frac{dr^2}{\left(1 + \frac{r_1}{r} + \frac{r^2}{r_{10}^2}\right)} - r^2(d\theta^2 + sin^2\,\theta\, d\phi^2); \quad (A204)$$

The substrate

naked closed "Universe$_{10}$"

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

i $$ds_5^{(+---)2} = \pm c^2dt^2 \mp dr^2 \mp r^2(d\theta^2 \mp sin^2\,\theta\, d\phi^2). \quad (A205)$$

The general paradox of these closed cosmological chains is that the entire mega-Universe with an approximate radius of the order of $r_1 \sim 10^{39}$ cm is located inside the core of an instanton with an approximate radius of $r_{10} \sim 10^{-55}$ cm.

In the entire project «Geometrized vacuum physics based on the Algebra of signature» [1,2,3,4,5,6,7,8,9,10,11] we used only the «Sequential closed hierarchical cosmological model 1» (SCHCM 1). This was not of great importance, since we mainly considered each "corpuscle" separately. However, it should be taken into account that other possibilities for constructing hierarchical chains are also possible.

Let's recall that, as already mentioned in [6], within the framework of the GVPh&AS it is possible to construct hierarchical chains with different numbers of "corpuscles" nested one inside another (for example, 3 "corpuscles" or 5 "corpuscles" or 7 "corpuscles" or 10 "corpuscles" etc. There is a huge number of such cosmological chains (see §6 in [6]). But the general rule is the following: – "All cosmological chains begin with one largest common "corpuscle" (for example, with the core of the "mega-Universe", with an approximate radius $r_1 \sim 10^{39}$ cm) and end with one smallest common "corpuscle" (for example, with the core of the "instanton", with an approximate radius $r_{10} \sim 10^{-55}$ cm).

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