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Hierarchy Cosmological Model based on the Algebra of Signatures

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Abstract

This report is devoted to the main additions (i.e., modifications) to Einstein's general theory of relativity, which led to the creation of the "Hierarchical Cosmological Model" based on a fully geometrized vacuum physics from the standpoint of the Algebra of signature. This project is aimed at implementing the Clifford-Einstein-Wheeler program for the complete geometrization of physics.

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Introduction

Einstein's General Theory of Relativity (GTR) has received reliable confirmation in practice for weak stellar-planetary gravitational fields and for minor local deviations of the spacetime continuum from pseudo-Euclidean geometry.

However, for solving a number of problems related to cosmology, strong gravitational fields, and, especially, the attempt to create a fully geometrized physics, the initial assumptions of Einstein's GTR are clearly insufficient.

Therefore, numerous attempts have been made to modernize GTR, both by Einstein himself and by his associates and followers. For example, the following have been developed: Riemann-Cartan-Schowten torsion geometry, Einstein-Weyl geometry, Weitzenbeck-Vitali-Shipov absolute parallelism geometry, Newman-

Penrose isotropic tetrad method, Rosen bimetric geometry, complex Riemannian geometry, Finsler geometry, Horns-Desky teleparallel gravity models, RS gravity models (Randall-Sundrum models), loop quantum gravity model, Brans-Dicke gravity model, Gauss-Bone gravity model, conformal gravity, multidimensional superstring theories and M-theory, etc. However, to date, all these attempts have not achieved the desired result [1, 2].

The purpose of this article is to report on the main additions to Einstein's General Theory of Relativity (GTR), which led to the creation of the "Hierarchical Cosmological Model" based on a fully geometrized vacuum physics from the perspective of the Algebra of signature [3-17].

The proposed hierarchical cosmological model potentially eliminates many problems that cannot, in principle, be resolved within the framework of modern natural science. In particular, it is possible to outline solutions to the following problems:

- To obtain metric-dynamical models of virtually all elementary "particles" included in the Standard Model ("bosons," "leptons," "baryons," and "mesons") as stable deformations of the vacuum [8];
- To substantiate the advantages of metric-dynamical models of naked planets and stars, naked galaxies, and the Universe as a whole [14].
- To reveal the metric-dynamic causes of inertia §7.2 in [5] and [10], gravity [14], electro-magnetism §6 in [6] and electric charge §2.2.2 in [9]
- Substantiate the absence of baryon asymmetry in the Universe [8];
- Derive the Schrödinger equation based on the principle of "extremum of averaged efficien-cy" of a stochastic system (i.e., a chaotically wandering nucleus of a "particle"), which includes the principle of "least action" and the principle of "maximum entropy" [15,16].
- Propose an alternative to the multidimensional Calabi-Yau manifold based on the Algebra of signatures [4,17];
- Explain the reason for the confinement of "quarks" in "hadrons" (§4.7 in [8]);
- Eliminate the fundamental differences between modernized general relativity and quantum mechanics [15];
- Dispel the fog regarding dark matter [14] and dark energy.
- To propose ways of developing advanced zero (i.e. vacuum) technologies, such as: "vacuum energy" §9 in [10], "alternative inertialess methods of movement in space" §10 in [10] and §11,12 in [13], "communication channels with superluminal information transfer speeds" §7 in [5], "stellar-planetary gravitational spectroscopy" [13], "volumetric spectral-signature analysis" §6 in [3], "unlimited compaction of biocybernetic power" [3] and many others.

Major Upgrades to Einstein's General Theory of Relativity

The project "Geometrized Vacuum Physics Based on the Algebra of Signature" (abbreviated GVPh&AS) [3,4,5,6,7,8,9,10,11,12,13,14,15,16,17] aims to implement the Clifford-Einstein-Wheeler program for the complete geometrization of physics. This project proposes the following upgrades to Einstein's general relativity (GR):

All theories and textbooks of Einstein's GR use 4-dimensional metric spaces with one and/or two signatures (+− − −) and/or (− +++). GVPh&AS, on the other hand, takes into account all 16 possible types of 4-dimensional spaces with the following signatures (i.e., topologies) [3,4]:

$$\mathrm{sign}\left(ds^{(a,b)2}\right) = \begin{pmatrix} (++++) & (+++-) & (-++-) & (++-+) \\ (---+) & (-+++) & (--++) & (-+-+) \\ (+--+) & (++--) & (+---) & (+-++) \\ (--+-) & (+-+-) & (-+--) & (----) \end{pmatrix} \quad (01)$$

2) Einstein's vacuum equations (with a zero right-hand side), for example,

$$R_{ik}=0, \tag{2}$$

or

$$R_{ik}+\Lambda g_{ik}=0 \tag{3}$$

are used in GVPh&AS as conservation laws, since the covariant derivative of zero is equal to its ordinary derivative, which is zero (see Introduction and §1 in [7])

$$\nabla_j 0 = \frac{\partial 0}{\partial x^j} - \Gamma^l_{ij} 0 - \Gamma^l_{kj} 0 = \frac{\partial 0}{\partial x^j} = 0. \tag{4}$$

Therefore, in this case also

$$\nabla_j R_{ik} = \frac{\partial R_{ik}}{\partial x^j} = 0, \tag{5}$$

or

$$\nabla_j (R_{ik} + \Lambda g_{ik}) = \frac{\partial (R_{ik}+\Lambda g_{ik})}{\partial x^j} = 0. \tag{6}$$

Therefore, within the framework of the GVPh&AS, the Einstein vacuum equations (2) and/or (3) are considered as initial conditions for searching for stable vacuum deformations of the corpuscular (i.e., spherically symmetric) type [7,8].

3) In general relativity, the Einstein vacuum equations without the Λ-term (2) or with only one Λ-term (3) are mainly used. While in GVPh&AS it is proposed to also use the vacuum equation with an infinite number of $\pm\Lambda_i$-terms (see §6 in [7] and [8])

$$R_{ik} + ½\, g_{ik}\left(\sum_{m=1}^{\infty} \Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right) = 0, \tag{7}$$

since, similarly to (5) and (6), the covariant and ordinary derivatives of the left-hand side of this equation are independent of each other and equal to zero (see Introduction and §1 in [7])

$$\nabla_j\left(R_{ik} + ½\, g_{ik}\left(\sum_{m=1}^{\infty} \Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right)\right) = \frac{\partial (R_{ik} + ½\, g_{ik}(\sum_{m=1}^{\infty} \Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n)=)}{\partial x^j} = 0. \tag{8}$$

where $\Lambda_m = \frac{3}{r_m^2}$, $\Lambda_n = \frac{3}{r_n^2}$, where r_m is the radius of the core of the m-th corpuscle (or "particle"), and r_n is the radius of the core of the n-th anticorpuscle (or "antiparticle").

Within the framework of the GVPh&AS, the second term in Eq. (7) is subject to the condition of being equal to zero when averaged everywhere.

$$\overline{½\left(\sum_{m=1}^{\infty} \Lambda_m + \sum_{n=1}^{\infty} - \Lambda_n\right)} = 0. \tag{9}$$

Ex. (9) is a mathematical formulation of the vacuum (zero) balance condition, which states, among other things, that in a mega-Universe, the number of "particles" of various types must be equal to the number of similar "antiparticles" (see Introduction in [3]).

In other words, within the framework of the GVPh&AS, with total averaging over the entire mega-Universe, we return to Einstein's original vacuum equation (2) (see [8]).

$$R_{ik}=0,$$

which has two trivial solutions for a flat spacetime continuum in spherical coordinates:

- a metric-solution with the signature of Minkowski space (+ – – –)

$$ds_o^{(+)2} = c^2dt^2 - dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2; \tag{10}$$

- and a metric-solution with the signature of the Minkowski antispace (– + + +)

$$ds_o^{(-)2} = -c^2dt^2 + dr^2 + r^2d\theta^2 + r^2\sin^2\theta\, d\phi^2. \tag{11}$$

4) Before the total (i.e., complete) averaging (9), a 10-level hierarchical cosmological model was proposed in GVPh&AS, within the framework of which a closed mega-Universe is filled with an infinite number of corpuscles (i.e., "particles") with different core radii [8]

$$r_m = \sqrt{\frac{3}{\Lambda_m}}, \quad \text{where } m = 1,2,3,4,5,6,7,8,9,10, \tag{12}$$

and anticorpuscles (i.e., "antiparticles") with the radii of core

$$r_n = \sqrt{\frac{3}{\Lambda_n}}, \quad \text{where } n = 1,2,3,4,5,6,7,8,9,10. \tag{13}$$

For a heuristic distribution of corpuscles and anticorpuscles across 10 types of varieties (i.e., characteristic sizes), equation (7) takes the form [8]

$$R_{ik} + ½\, g_{ik}\left(\sum_{k=1}^{10}\sum_{m=1}^{\infty} \Lambda_{km} + \sum_{k=1}^{10}\sum_{m=1}^{\infty} -\Lambda_{km}\right) = 0, \tag{14}$$

where $\pm\Lambda_{km} = \frac{3}{r_{km}^2}$, with a discrete hierarchy of characteristic radii [8]:

$r_1 \sim 10^{39}$ cm is radius commensurate with the radius of the mega-Universe core; (15)
$r_2 \sim 10^{29}$ cm is radius commensurate with the radius of the observable Universe core;
$r_3 \sim 10^{19}$ cm is radius commensurate with the radius of the galactic core;
$r_4 \sim 10^{7}$ cm is radius commensurate with the radius of the core of a planet or star;
$r_5 \sim 10^{-3}$ cm is radius commensurate with the radius of a biological cell;
$r_6 \sim 10^{-13}$ cm is radius commensurate with the radius of an elementary particle core;
$r_7 \sim 10^{-24}$ cm is radius commensurate with the radius of a proto-quark core;
$r_8 \sim 10^{-34}$ cm is radius commensurate with the radius of a plankton core;
$r_9 \sim 10^{-45}$ cm is radius commensurate with the radius of the proto-plankton core;
$r_{10} \sim 10^{-55}$ cm is radius commensurate with the size of the instanton core.

As a result of this heuristic "copying" of the surrounding reality, a "Hierarchical cosmological model" is obtained, consisting of an infinite number of corpuscles and anticorpuscles of various sizes (see Figure 1). This results in the formation of numerous chains of corpuscles and anti-corpuscles nested within one another like Russian dolls (Figures 1 and 2) [8].

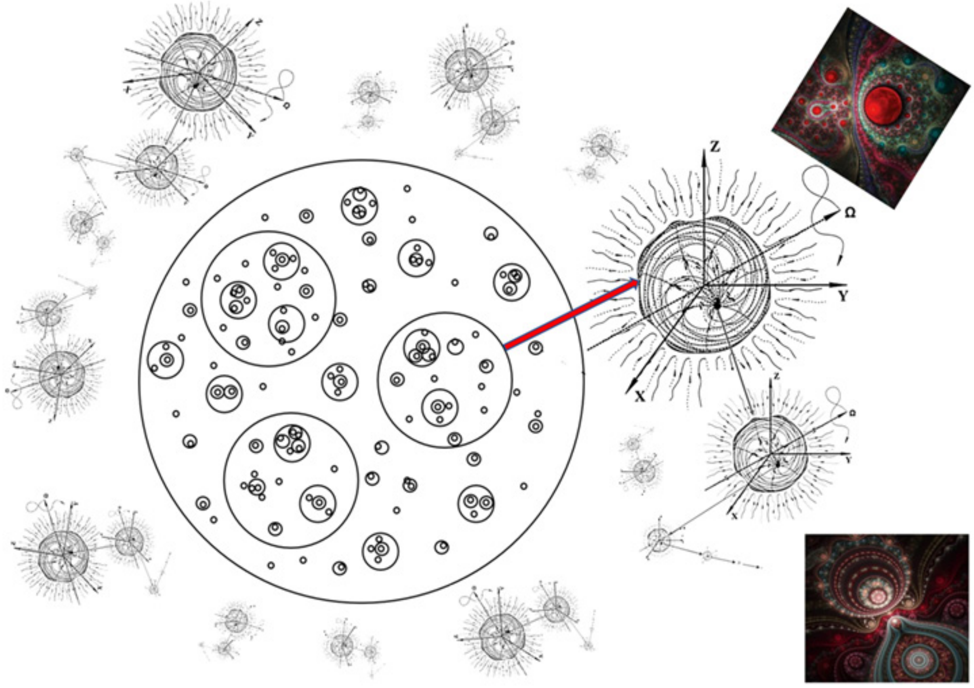

Figure 1: Schematic representation of the “Hierarchical cosmological model”, consisting of an infinite number of hierarchical chains of corpuscles and inticorpuscles of various sizes (15), nested inside each other like Russian dolls

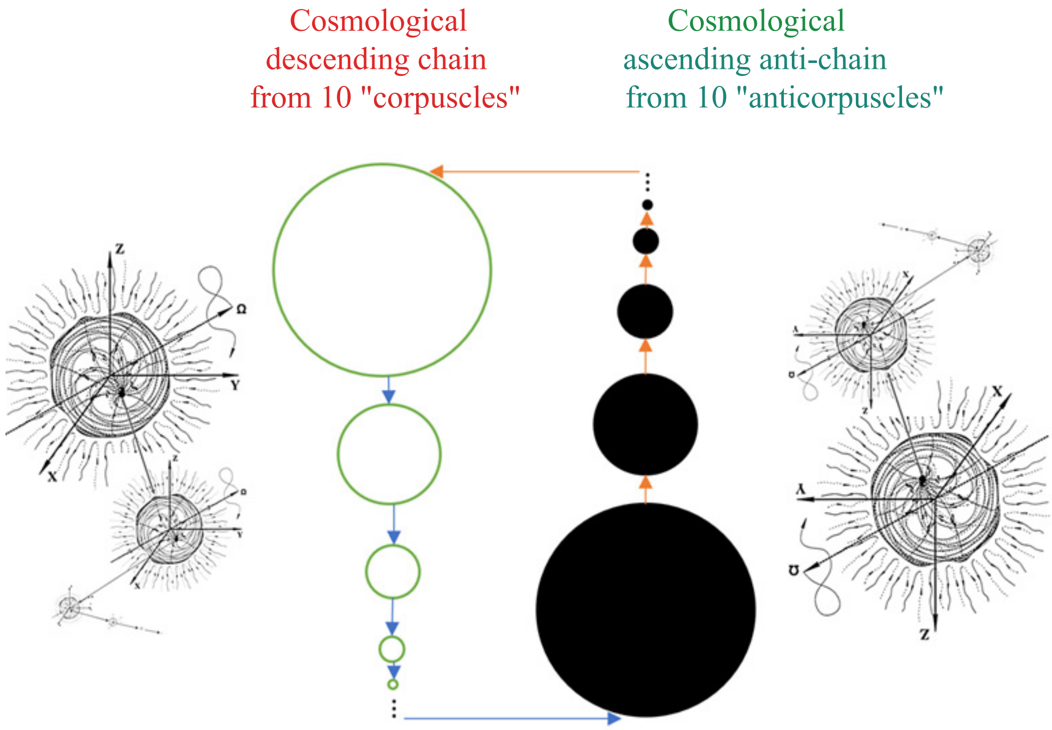

Figure. 2: Schematic representation of one of the closed h (ierarchical chains of corpuscles and anticorpuscles of various sizes (15), nested into one another like Russian dolls

Within the framework of this “Hierarchical cosmological model”, all hierarchical chains begin with one common core of the largest “corpuscle” (in particular, with the core of the “mega-Universe” with a radius $r_{1m} \sim 10^{39}$ cm) and end at the core of one common smallest “corpuscle” (in particular, at the core of the “instanton” with a radius $r_{10m} \sim 10^{-55}$ cm).

The closed nature of this “Hierarchical cosmological model” is that the largest anticore (for example, the core of the anti-"mega-Universe" with radius r1m) is located inside the smallest core (for example, in the core of the "instanton" with radius r_{10m}) and, conversely, the largest core (for example, the core of the "mega-Universe" with radius r_{1m}) is located inside the smallest anti-nucleus (for example, in the nucleus of the anti-"instanton" with radius r_{10m}) (see Figures 2 and 3). To some extent, the universal topology of the hierarchical cosmological model resembles a double Klein bottle (Figure 3a) or a Baby (Boy) and Anti-Baby (Girl) in the Womb of the Father-Mother (Figure 3b), since the Father-Mother are both outside the Embryos and inside them in the form of DNA molecules.

a. b.

Figure 3: a) Klein bottles; b) Baby (Boy) and anti-Baby (Girl) in the Womb of the Father-Mother, with the Father-Mother inside these Embryos in the form of DNA molecules

Let the reduced Ex. (9) be non-zero in some local region of the mega-Universe.

$$\overline{½(\sum_{m=1}^{M}\Lambda_m - \sum_{n=1}^{N}\Lambda_n)} = \pm½B, \quad (16)$$

where M is the total number of "particles" of various sizes in the studied region of the mega-Universe; N is the total number of "antiparticles" of various sizes in the same region of the mega-Universe.

Ex. (16) within the framework of a 10-level hierarchical cosmological model can be represented as

$$\overline{½(\sum_{m=1}^{M}\Lambda_m - \sum_{n=1}^{N}\Lambda_n)} = ½\left(\sum_{k=1}^{10}\sum_{m=1}^{L_k}\Lambda_{km} - \sum_{k=1}^{10}\sum_{m=1}^{J_k}\Lambda_{km}\right) = \pm½B, \quad (17)$$

where L_k is the total number of "particles" of the k-th size (type) from hierarchy (15); J_k is the total number of "antiparticles" of the k-th size (type) from hierarchy (15) filling the studied region of the mega-Universe.

That is, if in this region, on average, the total number of "particles" is not equal to the number of "antiparticles" (the region is electrically charged), then for this section of the mega-Universe, one can write the local vacuum equation

$$R_{ik} \pm ½g_{ik}B = 0, \quad (18)$$

Moreover, if $B=R+2D$ (where $R=g^{ik}R_{ik}$ is the scalar curvature this section of the mega-Universe), then Ex. (18) takes the form of the Einstein-Hilbert equation

$$R_{ik} \pm ½g_{ik}R = \mp g_{ik}D \quad (19)$$

with the source of local curvature $\mp g_{ik}D$.

But when averaging over the entire mega-Universe as a whole: “Every valley will be filled and every mountain and hill will be made-low. And the crooked paths will become straight, and the rough will become smooth paths” (Gospel, Luke 3:5).

Within the framework of the GVPh&AS, it is proposed to use all possible solutions of Einstein's vacuum equations. For example, equation (2) $R_{ik}=0$ has not one, but six Schwarzschild solution metrics:

- three solution metrics with the signature (+ – – –)

$$ds_1^{(+)2} = \left(1-\frac{r_0}{r}\right)c^2dt^2 - \frac{1}{\left(1-\frac{r_0}{r}\right)}dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (20)$$

$$ds_2^{(+)2} = \left(1+\frac{r_0}{r}\right)c^2dt^2 - \frac{1}{\left(1+\frac{r_0}{r}\right)}dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \quad (21)$$

$$ds_3^{(+)2} = c^2dt^2 - dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2; \quad (22)$$

- three solution metrics with the signature (– + + +)

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

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

$$ds_3^{(-)2} = -c^2dt^2 + dr^2 + r^2d\theta^2 + r^2\sin^2\theta\, d\phi^2. \qquad (25)$$

in theories based on general relativity (GR), as a rule, only the Schwarzschild metric (20) is used, which greatly limits the capabilities of such model representations.

5) Within the framework of the GVPh&AS, the metric-dynamic state of a stable vacuum formation is determined by averaging possible metric solutions to the Einstein vacuum equation. For example, the result of averaging metrics (20) and (21) is the metric

$$ds_{12}^{(+)2} = \frac{1}{2}\left(ds_1^{(+)2} + ds_2^{(+)2}\right) = c^2dt^2 - \frac{r^2}{r^2-r_0^2}dr^2 - r^2d\theta^2 - r^2\sin^2\theta\, d\phi^2, \qquad (26)$$

which has many interesting properties (see [9,10,11,12,15]).

6) The sum (or averaging) of quadratic forms, for example, corresponds to the Pythagorean theorem ($c^2 = a^2 + b^2$). This means that elements of length $s_1^{(+)}$ and $s_2^{(+)}$ are always perpendicular to each other ($s_1^{(+)} \perp s_2^{(+)}$). This is possible if the averaged space, for example, with the averaged metric (26) is a "fabric" woven from the "threads" $s_1^{(+)}$ and $s_2^{(+)}$ (see Figure 4).

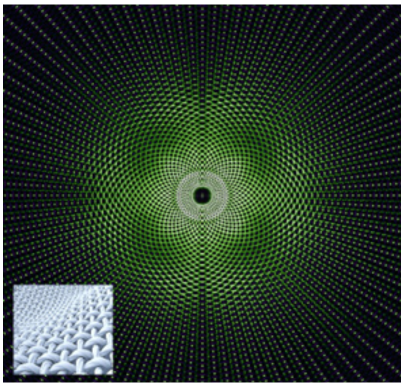

Figure 4: A two-dimensional illustration of a three-dimensional space-time "fabric" woven from mutually perpendicular "threads" $s_1^{(+)}$ and $s_2^{(+)}$

In general relativity, the zeroth component of the metric tensor g_{00} in a metric of the form

$$ds^2 = g_{00}\, c^2\, dt^2 \qquad (27)$$

is associated with the change in the flow of local time τ. Under the condition of constancy of the speed of light in a vacuum (c = const), it follows from metric (27)

$$\tau = \sqrt{g_{00}}\, c\, dt. \qquad (28)$$

At the same time, it is possible to postulate the existence of a global (Newtonian) time t = T, associated with the Absolute Observer, which flows everywhere in a rectilinear and uniform manner. In this case, it follows from metric (27) that the component of the metric tensor g_{00} is associated with the change in the speed of light in a local curved region of the vacuum.

$$c' = \sqrt{g_{00}}c. \quad (29)$$

However, a third case is possible (used in GVPh&AS), when both the constancy of the speed of light (c = const) and the existence of global (Newtonian) time t = T are postulated. Then it remains to assume that the component of the metric tensor g_{00} is associated with the motion of a local region of vacuum. For example, let us compare the kinematic metric (describing the motion of a local region of vacuum, see (96) in §6.2 in [5]).

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

with the metric (20)

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

As a result, we discover the identical equality of the zero components

$$1 - \frac{r_0}{r} \equiv 1 - \frac{v^2}{c^2} \quad (31)$$

which implies

$$v(r) \equiv \sqrt{\frac{c^2r_0}{r}}, \quad (32)$$

where v(r) is the dependence of the vacuum layer flow velocity on the parameter r in a curved vacuum region, the curvature of which is described by metric (20).

For the stationary case

$$ds^2 = c^2g_{00}dt^2 + 2g_{0\alpha}dx^\alpha cdt + g_{\alpha\beta}dx^\alpha dx^\beta, \quad \text{where } g_{ij} = \text{const}, \quad (33)$$

The components of the vacuum layer acceleration vector are determined by the expression [1, p. 341]

$$a_\alpha = \frac{c^2}{\sqrt{1-\frac{v^2}{c^2}}}\left\{-\frac{\partial \ln\sqrt{g_{00}}}{\partial x^a} + \sqrt{g_{00}}\left(\frac{\partial g_\beta}{\partial x^a} - \frac{\partial g_\alpha}{\partial x^\beta}\right)\frac{v^\beta}{c}\right\}, \quad \text{where} \quad g_\alpha = -\frac{g_{0\alpha}}{g_{00}}. \quad (34)$$

Thus, within the framework of the GVPh&AS, any deformation of a localized region or layer of vacuum is accompanied by the emergence of accelerated intra-vacuum flows.

Conclusion

All of the above-mentioned major modernizations of GTR adopted within the framework of the project "Geometrized Vacuum Physics Based on the Algebra of Signature " (GVPh&AS) [3-17] make it possible to construct a "Hierarchical cosmological model" (see Figure 1) and outline ways to solve the following problems: develop the light-geometry of vacuum, construct metric-dynamic models of virtually all elementary particles included in the Standard Model, reveal the nature of gravity, make assumptions regarding dark matter and dark energy, completely seal the right-hand side of the Einstein-Hilbert equation, derive the Schrödinger equation, and reveal the origins of the genetic coding of nature. Within the framework of this hypothesis, the baryon asymmetry of the Universe is absent, the fundamental differences between the modernized General Relativity and Quantum Mechanics are erased, the discretized infinity is closed, etc.

The GVPh&AS [3-17] can be considered as a theoretical basis for the development of zero (i.e. vacuum) technologies, such as: vacuum energy, alternative inertialess methods of movement in space, superluminal communication channels, unlimited multiplexing of information transmission channels, etc.

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