Phenomenological justification of linear element of Schwarzschild solution of GR gravitational field equations[1]

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The possibility of getting a linear element of Schwarzschild frame of reference of spatial coordinates and time is shown, founded on the existence of Newton absolute space, which is only a container for matter. In addition to it, the presence of evolutionary changeability and spatial inhomogeneity of properties of the physical vacuum, filling all this absolutely rigid (nonexpanding) Euclidean (noncurved) infinite space, is assumed.

Introduction

Newton absolute (cosmological) time and absolute (fundamental) space, which formally doesn't depend on matter and which is only a container for matter [1], form fundamental frame of reference of time and spatial coordinates (FR) of physical vacuum (PV). It was shown in papers [2-4] that evolutionary changeability in this PVFR of propagation velocity in fundamental space of electromagnetic interaction between matter elementary particles (equal to the velocity of light in free space), as well as the effect of a physical body motion on the velocity of light [5], is unobservable in principle by the matter FR proper clock. The cause of this is mutual dependence and mutual determination of the course rate of matter proper (standard) time and of the velocity of propagation of interaction in the matter FR. Matter "adaptation" to evolutionary change of conditions of interaction of its elementary particles (consisting in persistent decrease in the PVFR of improper value of the velocity of light) leads to gauge (unobservable in principle in the matter FR) equilibrium self-contraction of physical bodies in fundamental space [2-4]. This self-contraction of physical bodies is realizing at elementary particles level and is the cause of persistent moving away of distant astronomic objects from an observer, i.e. of the effect of expansion of the Universe in matter intrinsic space. Spatial irregularity of aging of the PV leads to the physical inhomogeneity of fundamental space, which is identified here with gravitational field. This physical inhomogeneity of fundamental space becomes apparent as inequality in its different points of rates of identical physical processes (which are set by unequal average values of interaction frequencies of elementary particles of identical matters, participating in these processes), and consequently, it becomes apparent as inequality of course rate in them of proper quantum time of matter. And this is accompanied by metrical inhomogeneity (irregularity) of fundamental space for matter, which partially compensates the effect of spatial inhomogeneity in the PVFR of improper value of the velocity of light on physical inhomogeneity of space. This metrical inhomogeneity consists in unequal degree of inelastic self-contraction of matter in different points of absolute space (considering the "adaptation" of elementary particles of the matter to unequal conditions of interaction) and becomes apparent at the presence of curvature of matter intrinsic space.

1. Linear element of body, possesing rigid intrinsic FR

Let ΔL_j and Δl_j be standard average statistical values (universal means) of distance between interacting elementary particles of standard substance, which is situated in an arbitrary point j of spherically symmetric gravitational field. These standard values of the distances of interaction are being determined via standard average statistical frequency of interaction and improper value of the velocity of propagation of the wave of interaction (between exchange virtual particles and quasiparticles). Also let R_j and r_j be luminosity radiuses of the j point (distances to this point from the center of gravity of a body, possessing a gravitational field), being determined via the spherical surface area, correspondingly by a conventionally rigid in it metrical scale, common for Euclidean

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fundamental (absolute) space, and by matter intrinsic metrical scale, evolutionarily self-contracting together with the substance. Because of this, Δl_j, in contrast to ΔL_j, is the same at all the identical standards and, consequently, vary neither in space nor in time $(\Delta l = const(r,t))$. Then in fundamental space the standard normalized value of spatial frequency N_j (which is set by standard average statistical value of the interaction distance ΔL_j) and the standard normalized value of the frequency f_j of interaction of reference substance elementary particles can be determined in the following way:

$$N_j = N_{ja} / n_a = \Delta l / \Delta L_j = r_j / R_j , \tag{1}$$

$$f_j = N_{ja} \cdot V_{cj} / n_a c = N_j \cdot V_{cj} / c = V_{cj/c} r_j / R_j , \tag{2}$$

where $N_{ja} = 1/\Delta L_j$ and $n_a = 1/\Delta l$ are absolute (not normalized) values of spatial frequencies correspondingly in fundamental space and in intrinsic matter space;

$V_{cj/c} = V_{cj} / c$ is a normalized value in the j point of the velocity of propagation of interaction, which is a dimensionless quantity (as well as standard normalized values of spatial frequency (N_j) and frequency of events (f_j));

V_{cj} is the absolute (not normalized) improper value of the velocity of propagation of interaction in PVFR;

c is the light velocity constant (the eigenvalue of the velocity of light). The rate of the process of evolutionary self-contraction of matter in the space-time continuum (STC) of PV is characterized by a relative change of the value of an unobservable (hidden) parameter N. That's why in every point of physically inhomogeneous fundamental space this rate must be proportional (as well as rates of any observable physical processes) to standard normalized value in it of interaction frequency:

$$\left|(\partial N / \partial T)_R\right| / N = \left|(\partial \ln r / \partial T)_R\right| = H(r) \cdot f , \tag{3}$$

where the $H(r)$ function, independent on cosmological (absolute) time T, depends on spatial distribution in the matter of the eigenvalue of its enthalpy density. In space free from matter this function (as it will be seen from the following) is gauge-unchangeable eigenvalue of Hubble constant H_e.

It is necessary to renormalize continuously the distances in fundamental space accordingly to continuous recalibration of rigid metrical scale of fundamental space by a certain evolutionary decreasing in PVFR material scale. Using of a metrically homogeneous scale ($f_j = const(T)$, when $r_j = const$) of absolute time (MHSAT) [2], based on proportional synchronization of course rate of this time with course rates of proper quantum time of every point of all the gauge-self-contracting bodies (that is why it is a metrically homogeneous scale of cosmological time), allows avoiding continuous renormalization of absolute (cosmological) time. And, consequently, this allows considering not relative $d\tilde{T}$, but absolute value of time increment:

$$dT = \left[1 - H_e\left(\tilde{T} - \tilde{T}_k\right)\right]^{-1} d\tilde{T} . \tag{4}$$

Here metrically inhomogeneous (nonuniform) absolute time:

$$\tilde{T} = \tilde{T}_k + (1/H_e)\left[1 - \exp\{H_e(T_k - T)\}\right] \tag{5}$$

is read by an exponential (nonuniform for matter) physically homogeneous scale of absolute time (PHSAT) [2,3], which guarantees invariability in PVFR of improper value of the velocity of light $\tilde{V}_c$ in every point of gauge-self-contracting matter, but requires at this continuous renormalization of reading time. Reading of this time begins from the moment of matter hypothetical contraction in fundamental space to "zero" values of interaction distances of its elementary particles. By the MHSAT this moment of time will set in infinitely distant future and therefore is not realizing physically. In that way, using of MHSAT allows considering absolute changes (instead of relative) of standard normalized value of interaction frequency. Analogously (3), the “speed” of radial change of standard values of interaction frequency must be proportional in every point of fundamental space to the values of spatial frequencies N in them. And, besides this, it must be – inversely proportional to the square of eigenvalue (i.e. value, renormalized according to eigenvalue of material length standard) of radial distance, identically equal to luminosity radial distance in intrinsic FR of a physical body. This is caused by decrease in three-dimensional homogeneous space by this dependence of density of a flux of the source of any physical effect, which is not weakened by anything. Therefore, analogously to Poisson equation [6]:

$$(\partial f / \partial R)_T = \eta(r) N / r^2 = \eta(r) / NR^2 , \tag{6}$$

where $\eta(r)$ is a parameter, depending in general on quantity of matter, confined in a sphere with radius r, as well as on pressure in the matter. Beyond the bounds of a physical body (in a conventionally free space), this parameter is a constant value $(\eta_e = const(r, R, T))$ that determines the power of the source of gravitational induction of the PV properties spatial inhomogeneity.

The stability of values of relativistic exceedings of shrinkages of radial dimensions above the shrinkage of matter meridian dimensions is the necessary condition of energy conservation by gauge-self-contracting matter [2] as well as the condition of homogeneity of cosmological time, considered here. These exceedings of shrinkage of radial dimensions take place only in fundamental space (as well as metrical inhomogeneity of matter) and they are unobservable in principle in matter intrinsic space. The stability of the values of these exceedings is guaranteed only in the case of stability of the ratio $V_{j/c}(r)$ between improper values of velocity of radial motion V_j of points of an evolutionarily self-contracting body (and its intrinsic physical space, rigidly connected with it) and improper values of velocity of light $V_{cj} = cV_{cj/c}$ in the same points:

$$V_j = dR_j / dT = V_{j/c}(r) \cdot V_{cj} = cV_{j/c}(r) \cdot V_{cj/c} = cV_{j/c}(r) \cdot f_j R_j / r_j = -\tilde{H}_j(r) \cdot R_j , \tag{7}$$

where gauge-invariant magnitudes: $V_{j/c}(r) = V_j / V_{cj} = const(R, T)$ and $\tilde{H}_j(r) = -cV_{j/c} f_j / r_j = const(R, T)$ can be functions only of eigenvalues of radial coordinates of body points. Consequently:

$$R_j = R_{jk} \exp\left[-\tilde{H}_j (T - T_k)\right], \tag{8}$$

$$V_j = -\breve{H}_j R_{jk} \exp\left[-\tilde{H}_j (T - T_k)\right], \tag{9}$$

$$V_{cj/c} = V_{cjk/c} \exp\left[-\tilde{H}_j (T - T_k)\right]. \tag{10}$$

However, from the condition of continuity of intrinsic space of self-contracting physical body:

$$\left|(\partial R / \partial \hat{r})_T\right| = (\partial r / \partial \hat{r})\left|(\partial R / \partial r)_T\right| = \sqrt{1 - V^2 / V_c^2}\, R / r , \tag{11}$$

follows that $\tilde{H} = const(r)$ and therefore is a universal constant. And more over, from the condition of permanency of improper value of the velocity of light $\tilde{V}_c$, determined in PVFR by the PHSAT (5), the value of this constant is equal to the eigenvalue of Hubble constant $(\tilde{H} = H_e)$. This takes place because of independence on cosmological time of the value of radial coordinate of point j $R_{jk} = r_j$, determined at the moment of time T_k of calibration of the size of the length standard in the PVFR by its size in the matter FR, as well as of the value:

$$\partial R_k / \partial r = \sqrt{1 - V^2 / V_c^2}\, \partial \hat{r} / \partial r - R_k (T - T_k) \partial \tilde{H} / \partial r = const(T) \tag{12}$$

Where ∂r and $\partial \hat{r}$ are increments in physical body intrinsic space of accordingly luminosity and metrical radial intervals. Considering the stationarity of relativistic exceeding of shrinkage in fundamental space of radial dimensions above the shrinkage of meridian dimensions of the matter (gauge-evolutionarily self-contracting in fundamental space) improper value of the velocity of interaction of propagation and, consequently, improper (coordinate) value of the velocity of light are constant not only in proper quantum time of points, where they propagate. They are also permanent while taking time readings by a clock of any other points of this space and, consequently, they are permanent in astronomic (coordinate) time t, common for the whole physical body:

$$v_{cj/c} = v_{cj}/c = V_{cj}\sqrt{1-V_{j/c}^2}\,r_j/R_j = f_j\sqrt{1-V_{j/c}^2} = \sqrt{f_j^2 - r_j^2 H_e^2/c^2}\ . \quad (13)$$

Exactly this determines physical as well as metrical (due to principle metrical homogeneity of the matter intrinsic space) homogeneity of coordinate-like intrinsic time of a body, gauge-self-contracting in the fundamental space. According to (13), this also allows using of normalized improper value of the velocity of light $v_{cj/c}$ instead of standard normalized value of interaction frequency as average statistical characteristic of physical inhomogeneity of the matter intrinsic space. From the condition of unobservability in a rigid body intrinsic space of its gauge self-deformation in the PVFR $(r_j = const(T))$ and accordingly to (3):

$$\left|(\partial r/\partial R)_T\right| = \left|(1/V_j)(\partial r/\partial T)_R\right| = \left|(\partial r/\partial T)_R\right|/H_e R_j = N_j f_j H(r)/H_e. \quad (14)$$

Therefore, the ratio between the increments of luminosity and metrical radial intervals, determining the curvature of physical body intrinsic space, according to (11) and (14), in free space $(H = H_e)$ will be equal by absolute value to normalized value of the velocity of light in it:

$$\left|\partial r/\partial\hat{r}\right| = \left|(\partial r/\partial R)_T\right|\sqrt{1-V_{j/c}^2}/N_j = f_j\sqrt{1-V_{j/c}^2}\,H/H_e = v_{cj/c}H/H_e. \quad (15)$$

This means that the equality to unity of product of $a_j(r) = (\partial\hat{r}_j/\partial r_j)^2$ and $b_j(r) = v_{cj/c}^2$ functions of linear element [4,6]:

$$dS^2 = a(r)dr^2 + r^2\left(d\theta^2 + \sin^2\theta\cdot d\varphi^2\right) - b(r)c^2dt^2 \quad (16)$$

in Schwarzschild external solution is caused directly by the presence of matter evolutionary self-contraction in the fundamental space and is caused by the realization of this process accordingly to the dependence (3).

Accordingly to (6) and (14): $\partial f/\partial r = \eta(r)H_e/H(r)fr^2$. Therefore, for a conventionally free space $(\eta(r) = \eta_e = const; H(r) = H_e = const)$ we have: $f = \sqrt{2\eta_e(1/r_{ge} - 1/r)}$. The body gravitational radius $r_{ge} = r_{\min}$ (critical minimal value of luminosity radial coordinate in a intrinsic conventionally free space of the body [6]) corresponds to a hypothetical absence of interaction between elementary particles of its matter $(f_{ge} = 0)$ in the case of hypothetical concentration of all the matter on a spherical surface[2] with this radius (R_{ge} radius in the fundamental space [4]).

At the direction of parameter r_{ge} to zero (that responds to decreasing to a zero value of power of the source of gravitational induction of the spatial inhomogeneity PV properties) the average statistical interaction frequency of elementary particles, connected to this in the absolute free space lacking gravitational field, must remain finite by value. Besides, identical objects (frequency standards) must have identical frequencies in all space $(f = 1)$. And it is possible only when $\eta_e = r_{ge}/2$. Therefore:

$$f = \sqrt{1 - 2\eta_e/r} = \sqrt{1 - r_{ge}/r}\ . \quad (17)$$

Accordingly to (14) and (17), for a conventionally free space $(r_g = r_{ge})$ we have:

$$\left|\partial R\right|/R_j = \left|\partial r\right|/r_j\sqrt{1 - r_{ge}/r_j}\ .$$

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[2] This corresponds to convolution in the matter (with the help of Dirac surface δ-function) of not the three spatial dimensions, as it does at idealized punctual representation of extensive objects, but of only one spatial dimension.

Considering this, at $T = const$, we have:

$$R_j = R_e \frac{r_j\left(1+\sqrt{1-r_{ge}/r_j}H/H_e\right)^2}{r_e\left(1+\sqrt{1-r_{ge}/r_e}H/H_e\right)^2} = R_{ge} r_j \left(1+\sqrt{1-r_{ge}/r_j}H/H_e\right)^2 / r_{ge}, \qquad (18)$$

and correspondingly to this:

$$r_j = r_{ge}\left(R_j + R_{ge}\right)^2 / 4R_j R_{ge}, \qquad (19)$$

where $H = -H_e$ when $R < R_{ge}$ and $H = H_e$ when $R > R_{ge}$; R_e and

$$R_{ge} = r_{ge} \exp\left[-H_e\left(T - T_k\right)\right] \qquad (20)$$

are continuously decreasing values in the conventionally free fundamental space correspondingly of the radius of boundary (external) surface (r_e) and body gravitational radius (r_{ge}).

Considering this, in the conventionally free fundamental space we have:

$$f_j = \left(R_j - R_{ge}\right)/\left(R_j + R_{ge}\right), \qquad (21)$$

$$N_j = r_{ge}\left(R_j + R_{ge}\right)^2 / 4R_{ge}R_j^2 = \left(1+\sqrt{1-r_{ge}/r_j}H/H_e\right)^{-2} \exp\left[H_e\left(T-T_k\right)\right]. \qquad (22)$$

Radial distribution of value of improper value of the velocity of light in PVFR is set by the dependence:

$$V_{cj/c} = 4R_{ge}R_j^2\left(R_j - R_{ge}\right)/ r_{ge}\left(R_j + R_{ge}\right)^3. \qquad (23)$$

But in intrinsic conventionally free space of evolutionary gauge-self-contracting body, the radial distribution of normalized improper (coordinate) value of the velocity of light, accordingly to (13) and considering (2) and (7), will be the following:

$$v_{cj/c} = \left(\partial r / \partial \hat{r}\right) \equiv 1/\sqrt{a_j} = \sqrt{1 - r_{ge}/r_j - r_j^2 H_e^2 / c^2}. \qquad (24)$$

This fully corresponds to the distribution of value of the velocity of light in the space of Schwarzschild external solution of the GR gravitational field equations:

$$v_{cj/c} \equiv \sqrt{b_j} = \sqrt{1 - r_{ge}/r_j - r_j^2 \lambda / 3} = \sqrt{1 - r_{ge}/r_j - \left(1 - r_{ge}/r_c\right) r_j^2 / r_c^2},$$

where $\lambda = 3H_e^2/c^2 = 3\left(1 - r_{ge}/r_c\right)/r_c^2$ is the cosmological constant and r_c is the radius of observer horizon of the body intrinsic space.

According to (18), two regions of fundamental space (external $\left(R > R_{ge}, H = H_e\right)$ and internal[3] $\left(R < R_{ge}, H = -H_e\right)$) correspond to a conventionally free space of a body, possessing a linear element (world interval) of Schwarzschild external solution:

$$dS^2 = N_j^2\left[-c^2 V_{cj/c}^2 dT^2 + dR^2 + R_j^2\left(d\theta^2 + \sin^2\theta \cdot d\varphi^2\right)\right] =$$

$$= -c^2\left(1 - r_{ge}/r_j\right)dT^2 + \frac{\exp\left[2H_e\left(T - T_k\right)\right]}{\left(1+\sqrt{1-r_{ge}/r_j}H/H_e\right)^4}\left[dR^2 + R_j^2\left(d\theta^2 + \sin^2\theta \cdot d\varphi^2\right)\right] =$$

$$= -c^2 \frac{\left(R_j - R_{ge}\right)^2}{\left(R_j + R_{ge}\right)^2} dT^2 + \frac{r_{ge}^2\left(R_j + R_{ge}\right)^4}{16R_{ge}^2 R_j^4} dR^2 + \frac{r_{ge}^2\left(R_j + R_{ge}\right)^4}{16R_{ge}^2 R_j^2}\left(d\theta^2 + \sin^2\theta \cdot d\varphi^2\right) =$$

$$= -c^2\left(1 - r_{ge}/r_j - r_j^2 H_e^2/c^2\right)dt^2 + \left(1 - r_{ge}/r_j - r_j^2 H_e^2/c^2\right)^{-1} dr^2 + r_j^2\left(d\theta^2 + \sin^2\theta \cdot d\varphi^2\right). \qquad (25)$$

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[3] In the internal part of the space strength of the gravitational field is so high that it leads to turning this space inside out. Because of very sharp decrease of the size of real length standard in PVFR while the value of radius R is decreasing takes place the following. Eigenvalue of the area of enveloped (confined) spherical surface becomes not smaller but larger then eigenvalue of area of the spherical surface, which envelopes it. Therefore, concave in world space surfaces are observed in intrinsic space as convex [4].

These regions are separated by Schwarzschild sphere and practically do not differ from one another in the matter FR. Despite of physical impossibility of realization of Schwarzschild sphere, this is not accidental. In hollow astronomical bodies [4] these regions correspond to real physical spaces – external and internal. In physically homogeneous space, inertial pseudo-force only compensates but not equilibrates the force, accelerating the body motion, and can be expressed in terms of parameters of motion by the following way:

$$F_{in} = -\left(\partial P^{*} / \partial t\right)_{\tilde{m}} = -\tilde{m}\Gamma^{3}\ddot{x} = -v\left(\partial P / \partial x\right)_{\tilde{m}} = -\mathrm{H}\partial \ln \Gamma / \partial x . \qquad (26)$$

Here: $P^{*} = \tilde{m}v\left(1 - v^{2}/c^{2}\right)^{-1/2} = \tilde{m}c^{2}\sqrt{\Gamma^{2} - 1}$ and $\tilde{m}$ are correspondingly covariant linear momentum and an eigenvalue of mass of a moving body; $\Gamma = \left(1 - v^{2}/c^{2}\right)^{-1/2}$ is the parameter, determining relativistic shrinkage of dimensions of a moving body, and consequently, its velocity of motion. Hamiltonian of the body $\mathrm{H} \equiv \mathrm{U}_{\mathrm{R}}^{*} = \tilde{\mathrm{m}}\mathrm{c}^{2}\left(1 - v^{2}/c^{2}\right)^{-1/2} = \tilde{m}c^{2}\Gamma$ is equivalent to its covariant relativistic mass $m_{R}^{*} = \tilde{m}\Gamma = \mathrm{H}/\mathrm{c}^{2}$. Hamiltonian intensity of inertial pseudoforce $F_{in}/\mathrm{H} = F_{in}/m_{R}^{*}c^{2} = -d\ln\Gamma/dx = -\Gamma^{2}\ddot{x}/c^{2}$ is equivalent to the acceleration of the motion $\ddot{x} = dv/dt$ of classical physics.

During the body free fall in the gravitational field (that is not equilibrium but inertial motion of the body in physically inhomogeneous space) inertial pseudoforce $F_{in} = -\mathrm{H}\partial\ln\Gamma/\partial\mathrm{r}$ compensates (but not equllibrates) the gravitational pseudoforce [2, 3]:

$$F_{g} = -\mathrm{H}\left(\partial\ln v_{c}/\partial\hat{r}\right) = -\mathrm{H}\left(\partial\ln b/\partial r\right)/2\sqrt{a} = -\mathrm{H}\left(r_{ge} - 2r^{3}H_{e}^{2}/c^{2}\right)/2r^{2}\sqrt{1 - r_{ge}/r - r^{2}H_{e}^{2}/c^{2}} . \qquad (27)$$

Therefore, at the invariance of eigenvalue of the free falling body mass $\left(\tilde{m} = const\right)$ its Hamiltonian $\mathrm{H} \equiv U_{Rg}^{*} = \tilde{m}cv_{c}\Gamma$ (covariant component of energy-momentum tensor, to which covariant general-relativistic value of mass $m_{Rg}^{*} = \tilde{m}\Gamma v_{c}/c$ is equivalent) also stays invariable:

$$\left(\partial\ln\mathrm{H}/\partial\hat{r}\right)_{\tilde{m}} = \partial\ln v_{c}/\partial\hat{r} + \partial\ln\Gamma/\partial\hat{r} = -\left(F_{g} + F_{in}\right)/\mathrm{H} = 0 .$$

Total energy (Hamiltonian) conservability at the process of inertial motion of the body in some cases makes the usage of $\chi_{k} = \ln v_{c}$ instead $\chi_{g} = \left(-g_{44} - 1\right)c^{2}/2 = \left(v_{c}^{2} - c^{2}\right)/2$ as scalar potential of gravitational field more expedient. Potential χ_{g} determines the strength of gravitational pseudoforces relatively to contravariant general-relativistic value of mass $m_{Rg}^{*)} = \tilde{m}\Gamma c/v_{c} = \mathrm{H}/v_{c}^{2}$, nonconservating at the body free fall in the gravitational field (so at inertial motion of the body in physically inhomogeneous space). At this:

$$\partial\chi_{g}/\partial\hat{r} = v_{c}^{2}\left(\partial\chi_{k}/\partial\hat{r}\right).$$

Total energy of body is smaller than contravariant component of energy-momentum tensor $U_{Rg}^{*)} = \mathrm{H} + v_{qR}^{*}P_{q}^{*} = m_{Rg}^{*)}c^{2} = \mathrm{H}c^{2}/v_{c}^{2}$, to which gravicontravariant general-relativistic value of mass $m_{Rg}^{*)}$ is equivalent). Difference between these energies is gravitational binding energy $W_{g} = v_{qR}^{*} \cdot P_{q}^{*}$. This binding energy is an additive compensation of multiplicative transformation of energy of body in the equilibrium process of its quasistatic transfer along the direction of gradient of gravitational field. Here: $v_{qR}^{*} = \Gamma v_{q}^{*}$, $v_{q}^{*} = v_{q}v_{c}/c$ and $v_{q} = dq/dt = c\sqrt{c^{2}/v_{c}^{2} - 1}$ are covariant and contravariant values of gravitational pseudovelocity of translational body “motion” (gravitational transposition[4] of time

[4] Unlike in astronomical (coordinate) time, in proper quantum (standard [6]) time of matter gravitational transposition can be, like the interval s between world points of events, space-like (when ${}_{j}^{i}v_{c} = v_{cj}/v_{ci} < c$) as well as time-like (when ${}_{j}^{i}v_{c} > c$).

coordinates of events on it) along the orthogonal to space-time axis of conventional time-like coordinate q; $P_q^* = \tilde{m}v_q^*\left(1 - v_q^{*2}/c^2\right)^{-1/2} = \tilde{m}v_q$ - covariant value of gravitational linear pseudomomentum.

Hamiltonian strength of the gravitational field in the matter can be determined analogically:

$$k = -\partial\chi_k / \partial\tilde{r} = -b'/2b\sqrt{a} = \left(a'/2a + H'/H\right)/\sqrt{a} = -\left[r_g - \left(\kappa c^2\tilde{\mu} + 2H_e^2/c^2\right)r^3\right]\sqrt{a}/2r^2 + H'/H\sqrt{a}\,. \quad (28)$$

Here, correspondingly to (15): $ab = H_e^2/H^2$; $b' \equiv \partial b/\partial r = -b\left(2H'/H + a'/a\right)$;

$$a' \equiv \partial a/\partial r = -\frac{r_g - rr_g' - 2r^3H_e^2/c^2}{r^2\left(1 - r_g/r - r^2H_e^2/c^2\right)^2} = -\left[r_g - \left(\kappa c^2\tilde{\mu} + 2H_e^2/c^2\right)r^3\right]a^2/r^2, \quad (29)$$

and: $$r_g' \equiv \partial r_g/\partial r = \partial\left[\left(1 - 1/a\right)r - r^3H_e^2/c^2\right]/\partial r = ra'/a^2 + \left(1 - 1/a\right) - 3r^2H_e^2/c^2 = \kappa c^2\tilde{\mu}r^2 \quad (30)$$

(accordingly to (24) and to Poisson equation [6]);

$\tilde{\mu}$ is an eigenvalue of matter mass density;

$\kappa = 8\pi\gamma/c^4$ is Einstein constant; y is the gravitational constant.

Gravitational forces affecting an object are determined only by its Hamiltonian or hamiltonian strength of the gravitational field. Therefore, they do not depend directly on eigenvalue of energy density, and consistently, on eigenvalue of density of matter mass of the object. This corresponds not only to the objects situated in the free space, but also to the objects that are component parts of physical bodies (bodies possessing a gravitational field). According to (29), not only strength of gravitational field in a matter, but also the curvature of intrinsic space of the matter, which is characterized by the $a(r)$ function, does not depend directly on eigenvalue of density of the matter mass:

$$da(r)/d\tilde{\mu} = 0\,.$$

Therefore, from the condition:

$$dk/d\tilde{\mu} = \kappa c^2\sqrt{a}\,r/2 + \left(1/\sqrt{a}\right)d\left(H'/H\right)/d\tilde{\mu} = 0$$

we have: $$\left(H'/H\right) - \left(H'/H\right)_0 = -\kappa c^2 ar\left(\tilde{\mu} - \tilde{\mu}_0\right)/2\,.$$

In general case, the velocity of propagation of interaction in the matter is to depend on spatial distribution of eigenvalue of the matter enthalpy density $\tilde{\sigma} = \tilde{\mu}c^2 + \tilde{p}$. At hypothetical isobaric decreasing of eigenvalue of enthalpy density to zero (which cannot be realized only locally at $b \neq 0$, as it is shown below) enthalpy is to be determined by standard normalized value of interaction frequency of elementary particles in the PV, the same as for practically free space:

$$f(r) = \sqrt{1 - r_g(r)/r}\,.$$

Then, considering that at $\tilde{\sigma}_0(r) = 0$: $\tilde{\mu}_0 = -\tilde{p}/c^2$, and $\left(H'/H\right)_0 = 0$ $\left(H(r) = H_e = const(r)\right)$, we have:

$$ab = H_e^2/H^2 = \exp\int_{r_e}^{r}\kappa\left(\tilde{\mu}c^2 + \tilde{p}\right)ardr\,. \quad (31)$$

Here at $r = r_e$: $ab = 1$, that is in good agreement with Schwarzschild external solution. Therefore, considering (30) we see that hamiltonian strength of gravitational field:

$$k = -\left[r_g + \left(\kappa\tilde{p} - 2H_e^2/c^2\right)r^3\right]\sqrt{a}/2r^2\,, \quad (32)$$

as it was supposed to be, does not depend on eigenvalue of matter mass density also in nonvacuous space. At that:

$$rb'/ab - \left(1 - 1/a\right) + 3r^2H_e^2/c^2 = \kappa\tilde{p}r^2\,. \quad (33)$$

At the cosmological constant $\lambda = 3H_e^2 / c^2$ the expressions (30) and (33) are identical to the GR gravitational field equations for intrinsic FR of ideal liquid [6]. This shows full correspondence of physical model, considered here, to mathematical model of STC of GR.

2. Analysis of cosmological models of Universe

Improper value (determined in the astronomic time) of p_j pressure, created in the matter by gravitaty, is connected with its eigenvalue $\tilde{p}_j$ by the following dependence:

$$p_j = \tilde{p}_j \varepsilon_j / \tilde{\varepsilon}_j = \tilde{p}_j v_{cj/c} = \tilde{p}_j f_j \sqrt{1 - V_{j/c}^2} = \tilde{p}_j H_e / H_j \sqrt{a_j} .$$

Here: $\varepsilon_j = \tilde{\mu}_j \cdot c v_{cj}$ and $\tilde{\varepsilon}_j = \tilde{\mu}_j c^2$ are matter energy densities, determined in its intrinsic FR correspondingly in astronomical (coordinate) and proper quantum (standard) time of the j point. Hence:

$$\partial p / \partial \hat{r} = (v_c / c) \partial \tilde{p} / \partial \hat{r} + (\tilde{p} / c) \partial v_c / \partial \hat{r} = \varepsilon k = -c \tilde{\mu} \partial v_c / \partial \hat{r} , \quad (34)$$

$$\tilde{p}' \equiv \partial \tilde{p} / \partial r = -(\tilde{p} + \tilde{\mu} c^2) b' / 2b = -\tilde{\sigma} b' / 2b , \quad (35)$$

and:

$$\tilde{p} = -\frac{c^2}{2\sqrt{b}} \int_{b_e}^{b} \frac{\tilde{\mu}}{\sqrt{b}} db = -\frac{c^2}{v_c} \int_{v_{ce}}^{v_c} \tilde{\mu} dv_c \quad (36)$$

Considering this:

$$(ab)' = \kappa (\tilde{\mu} c^2 + \tilde{p}) r a^2 b = \kappa \left(\tilde{\mu} c^2 - \frac{c^2}{2\sqrt{b}} \int_{b_e}^{b} \frac{\tilde{\mu}}{\sqrt{b}} db \right) r a^2 b = \kappa c^2 r a^2 \sqrt{b} \int_{\tilde{\mu}_0}^{\tilde{\mu}} \sqrt{b} d\tilde{\mu} ,$$

$$\left[(ab)' / r a^2 \sqrt{b} \right]' = \kappa c^2 \sqrt{b} \tilde{\mu}' = \kappa (\partial \varepsilon / \partial r)_b ,$$

$$ab = \exp \int_{r_e}^{r} \left[\frac{\kappa c^2 r a}{\sqrt{b}} \int_{r_e}^{r} \sqrt{b} \frac{\partial \tilde{\mu}}{\partial r} dr \right] dr . \quad (37)$$

Correspondingly to (35) and according to (31) and (37) at $\tilde{\sigma} = 0$ both $\partial \tilde{p} / \partial \hat{r} = 0$ and $\partial \tilde{\mu} / \partial \hat{r} = 0$. This confirms the principal impossibility of only local fulfillment of the condition $\tilde{\sigma} = 0$ at $1/a \neq 0$, and correspondingly at $b \neq 0$ [4], at which $\partial \tilde{\sigma} / \partial \hat{r} = 0$ as well as $\partial H / \partial \hat{r} = 0$. The fulfillment of the $(\partial \tilde{p} / \partial \hat{r})_t = 0$ and $(\partial \tilde{\mu} / \partial \hat{r})_t = 0$ conditions is impossible in principle in the matter FR, which uniformly filled whole fundamental space in the far past and at this gauge-evolutionarily self-contracting in this space. It is connected with the lack of simultaneity in the PVFR of events, simultaneous in the FR of matter molecules, and is caused by presence of synchronism in whole absolute space of evolutionary change in cosmological time (read in not the matter FR, but in the PVFR [4]) of pressure in the matter and its mass density eigenvalue. Therefore, the condition $\tilde{\sigma} = 0$ $(\tilde{p} = -\tilde{\mu} c^2)$, corresponding to so-called vacuum-like state of physical environment [7] and de Sitter universe [6-8] is impracticable in principle in intrinsic FR of any protomatter. And, consequently, it can be considered only as hypothetical[5].

The initiation of gravitational macrofields in the Universe, as it was shown in [3,4], is caused by evolutionary self-contraction of the matter in the fundamental space and by the presence of electromagnetic interaction between elementary particles of neighboring atoms and molecules of the matter. Van der Waals forces of intermolecular interaction cased the breakage of the whole gas environment of the Universe into separate aggregates of gas molecules in the process of recombination of protons and electrons and made these molecules evolutionarily self-contract in

[5] So this condition is an asymptotic condition for infinitely far cosmological past. And in fact it is not physically realized.

common. If these forces did not exist, every molecule would continue contract by itself in fundamental space the way galaxies do. And consequently, physical macroinhomogeneity of this space, identifiable here with gravitational macrofields, would not take place. But in the FR of every single molecule (atom) of gas all the rest of molecules (atoms) would continue to continuously inertialy distancing from it at the Hubble velocity. Therefore, it is not possible in principle to build a globally static (without the effect of expansion) model of the Universe with metrically stable intrinsic space either at semi-uniform distribution of the matter density in the fundamental space, nor at real uniform $(r_g \approx 0)$ distribution of the density of a gaseous matter, filling uniformly all Universe in its far past. Considering metrical macrohomogeneity of the fundamental space in the far cosmological past, the linear element (25) of gauge-evolutionarily self-contracting gaseous matter fully corresponded to the linear element, found by Lemetre [6,9] and (independently on him) by Robertson [6,10] for pseudoeuclidean STC of FR, not comoving with matter. In this STC (practically corresponding to the absolute space and Newton absolute time) according to Weyl hypothesis [11, 12] galaxies rest, if their small individual velocities are not taken into account. The linear element in intrinsic spaces of evolutionarily self-contracting gas molecules in the far past only formally corresponded to the linear element of de Sitter universe [4, 7]. Considering presence of physical and metrical microinhomogeneities of intrinsic spaces of single molecules (their gravitational radiuses are equal to zero not identically), still STC metric of the molecules should be considered as singular Schwarzschild metric. In de Sitter mathematical model of the Universe, supplemented in [6] by Weyl hypothesis, the curvature of intrinsic space of the matter (uniformly distributed in fundamental space – absolute space of Newton-Weyl) can be caused by relativistic exceeding of shrinkage in the fundamental space of radial dimensions of evolutionarily self-contracting molecules of matter over the shrinkage of their meridian dimensions. But in Einstein model of the Universe curvature of intrinsic space of matter has no physical sense. The effect of the Universe expansion is not directly envisaged in this model. And consequently, the lack in molecules coordinate-like intrinsic times of simultaneity of events simultaneous in cosmological time is not envisaged in this model. And thus nonuniformity of average density of matter in the Universe in intrinsic space of any molecule of matter at the same moment of intrinsic time of this molecule is not envisaged either. This does not let consider Einstein model of the Universe as authentic even at a very rough approximation.

Conclusions

Physical model of evolutionary change of collective space-time state of the matter based on the main principles of gauge-evolutionary theory [2-4] and fully corresponding to the mathematical model of STC of GR, allows studying physical processes in matter realizing on the level of its elementary particles and therefore hidden from observation in principle. This model reveals physical entity of equations of GR gravitational field and gives an objective and internally consistent explanation to basic features of this relativistic theory of gravitation. At this, as it was shown in [4], in contrast to other well-known GR interpretations, it is devoid of paradox phenomena as well as of paradox physical objects.

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