General equations of the flat galaxy dynamic gravitational field that correspond to reality

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Abstract

The solution to the gravitational field equations of a flat galaxy has been found. It is shown that at the edge of the galaxy the excessively strong ordinary (unreduced) centrifugal pseudo-forces of inertia are compensated mainly by centripetal pseudo-forces of evolutionary self-contraction of matter in the background Euclidean space, and not by the weak gravitational pseudo-forces at the edge of the galaxy. The strength of the dynamic gravitational field of spiral and other flat (or superthin) galaxies, according to their two-dimensional topology, is inversely proportional to the radial distance, not to its square. And this is the case, despite the inverse proportionality of the strength of individual gravitational fields of all spherically symmetric astronomical objects of the galaxy exactly to the square of radial distance. The general solution of the equations of the gravitational field of the galaxy with an additional certain parameter *n* is found. At possible values of $n < 1$, the velocity of the orbital motion of stars is slightly less than the highest possible velocity even at the edge of the galaxy. According to the General Relativity (GR) equations and the Relativistic Gravithermodynamics (RGTD) equations, the configuration of the dynamic gravitational field of a galaxy in a quasi-equilibrium state is standard (canonical in RGTD). That is because it is not determined at all by the spatial distribution of the average mass density of its non-continuous matter. After all, this spatial distribution of the average mass density of the galaxy's matter is itself determined by the standard configuration of its dynamic gravitational field. The standard value of the average mass density of matter at the edge of a galaxy is determined by the cosmological constant Λ and the difference between unity and the maximum value of the parameter b_c. And it is a non-zero standard value, despite the gravitational radius at the edge of a galaxy takes the zero value. Therefore, in the RGTD, in contrast to the GR, there can be no shortage of baryonic mass.

Keywords: General Relativity, Kepler's law, galaxy, gravitational potential, non-baryonic dark matter, orbital velocity, Relativistic Gravithermodynamics.

1. Logarithmic gravitational potential

Physical laws are based only on increments of metrical distances and not on increments of coordinates. Therefore, gravitational field strength *k* is determined via its gravitational potential φ in the following way:

$$k = -grad(\varphi) = -\frac{1}{\sqrt{a}}\frac{\partial\varphi}{\partial r} = -\sqrt{1-\frac{r_g}{r}-\frac{\Lambda r^2}{3}}\frac{\partial\varphi}{\partial r},$$

where: $\Lambda=3H^2c^{-2}$ is cosmological constant, H is Hubble constant, a is square of the ratio between increment of metrical segment and increment of radial coordinate r, and r_g is gravitational radius of astronomical body, from where observation takes place.

Nowadays, the following gravitational potential is used in General Relativity (GR) and in practical calculations:

$$\varphi = cv_{cvj} = c^2\sqrt{1-r_g/r},$$

where: v_{cv} is the coordinate vacuum velocity of light.

When $\Lambda=0$ that potential forms the same spatial distribution of gravitational field strength as in classical physics:

$$k=-c^2r_g/2r^2=-GMr^{-2} \qquad (r_g=2GMc^{-2}).$$

However, it does not correspond to Einstein's opinion that free fall of bodies in gravitational field is inertial motion. According to this potential the kinetic energy of falling body is less that the difference between rest energies of the body in the starting point of the falling and in the point of its instantaneous disposition. Wrong opinion that gravitational field has own energy corresponds to that gravitational potential [1].

In contrast to this potential, the potential that is in a form of logarithm of the rest inert free energy of matter corresponds to inertial motion of freely falling body [2] with the conservation of Lagrangian **L** of its ordinary rest energy $W_{0j} = W_{00}c/v_{cvj} = m_{gr0}c^2 = m_{00}c^3/v_{cvj}$, and of Hamiltonian H of its inert free energy $E_{0j} = E_{00}v_{cvj}/c = m_{in0}c^2 = m_{00}cv_{cvj}$ [3]:

$$\varphi_j = -c^2\ln(W_{0j}/W_{00}) = c^2\ln(E_{0j}/E_{00}) = c^2\ln(v_{cvj}/c) = c^2\ln b_j/2 \qquad (1)$$

Such representation of potential is based on the possibility of proportional synchronization of all quantum clocks and on proportionality of pseudo-forces of inertia and gravitation to the Hamiltonian of matter. This is in good correspondence with the principle of mass and energy equivalence. Such representation also makes the proof of equivalence of inertial and gravitational masses redundant. Logarithmic gravitational potential forms the following spatial distribution of gravitational field strength:

$$\mathbf{k}_j = \frac{\mathbf{F}_{grj}}{m_{gr0j}} = \frac{v_{cvj}\mathbf{F}_{grj}}{m_{00j}c} = \mathbf{grad}(c^2\ln W_0) = -\mathbf{grad}(c^2\ln E_0) = -\mathbf{grad}(c^2\ln v_{cv}) =$$

$$= -\frac{{}^E G_{00}M_{gr0} - H_E^2r^3}{r^2b_j\sqrt{a_j}} = -\frac{{}^E G_{0j}M_{gr0} - H_E^2r^3/b_j}{r^2\sqrt{a_j}}.$$

The equivalent value of strength of gravitational field adjusted to the inertial mass of rest of the body that is moving in gravitational field will be as follows:

$$\mathbf{k}_{eqj} = \frac{\mathbf{F}_{grj}}{m_{inj}} = \frac{\mathrm{L}_j}{\mathrm{H}_j}\mathbf{k}_j = \frac{m_{grj}}{m_{inj}}\mathbf{k}_j = \frac{c^2}{v_{cvj}^2}\mathbf{k}_j = -\frac{c^4}{v_{cvj}^2}\mathbf{grad}(\ln v_{cv}) = -\frac{{}^E G_{0j}(r)M_{gr0} - H_E^2r^3/b_j}{r^2b_j\sqrt{a_j}}.$$

According to this the galactic intrinsic value ${}^gG_{00j}={}^EG_{jeff}$ and the observed effective value ${}^EG_{jeff}={}^EG_{0j}M_{gr0g}m_{gr}/M_{00g}m_{00}={}^EG_{0j}/b_j$ of gravitational parameter ("constant"):

$${}^gG_{00j}={}^EG_{jeff}={}^EG_{0j}c^2v_{cvj}^{-2}={}^EG_{00}b_j^{-2}={}^EG_{00}k(z,\mu_{os})\approx{}^EG_{00}(1+z_j)^4(1+2z_j)^{-2} \qquad (2)$$

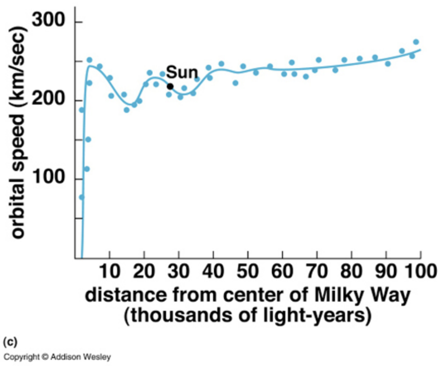
tends to infinity while approaching the event pseudo-horizon as well as the centers of the galaxies. And, of course, this should successfully prevent the false conclusions about the deficit of baryonic matter in the centers of the galaxies.

Usage of logarithmic gravitational potential does not require the adjustment of the values of mass of the Sun and the planets. If gravitational radius of Sun is 2.95 *km* then its mass should be decreased on just two millionth parts of it. It is 35 times less than the determination error of Sun mass. On the Mercury orbit the strength of Sun gravitational field should be decreased on just 20 billionth parts of it. The Earth itself has very small gravitational radius 0,887 *cm*. Due to this fact Earth mass should be decreased on just one billionth part of it. At the same time, Earth mass determination error is 100000 bigger. Unlike for the Solar System, the usage of logarithmic gravitational potential can be very essential for the far galaxies.

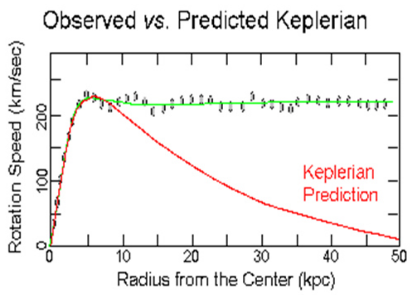
2. The inconsistency of the motion of galaxies with Kepler's laws

Laws of motion of single astronomical objects, found by Kepler, are based on gravitational influence of mainly central massive body. According to those laws, the velocity of rotation of galactic objects should decrease in inverse ratio to the square root of the distance to galaxy center. However, observations reveal the different picture: this velocity remains quasi constant on quite far distance from galaxy center for many flat (or superthin) galaxies, including ours [4].

When single objects and their aggregates form big collection (cluster) their total mass can essentially exceed the mass of central astronomical body (supermassive neutron star or quasar). The attraction of astronomical objects of the internal spherical layers of the galaxy can be much stronger than the attraction to the central body of the galaxy. Then, their collective gravitational influence can essentially distort the correspondence of the motion of peripheral astronomical objects to Kepler's laws. And, therefore, according to astronomical observations the velocities of rotation of galaxy's peripheral astronomical objects required for prevention of joint collapse of all matter of the galaxy are much higher than the velocities of rotation of the separate peripheral astronomical objects required for prevention of the independent fall of those objects onto the central astronomical body.



a)



b)

Figure: Dependencies of velocity of rotation of astronomical objects on the distance to gravity center: **a**) our Milky Way galaxy [4, 5], **b**) comparing to prognosed Keplerian velocities [6].

The quite close dependency to the observed one is the following dependence of really metrical value $\hat{v} = v/\sqrt{b} = vc/v_{cv}$ of galactic velocity of rotation v of astronomical objects on the distance to the galaxy center. It is determined by the common galactic clock when the radial distribution of the average relativistic density of corrected relativistic mass of matter in the galaxy is the following:

$$\hat{\mu}_{inc} = \frac{\hat{\mu}_{in0} + p\hat{v}^2/c^2}{1 - v^2/bc^2} = \frac{\eta + \chi_0 r}{\kappa c^2 r^2} = \frac{\hat{\mu}_{00}}{r^2}\left\{r_e^2\left[1 - \left(1 - \frac{r}{r_e}\right)\exp\left(-\frac{r}{r_e}\right)\right] + \sigma r_m^2\left[\sin\left(\frac{2\pi r}{r_m}\right) + \frac{2\pi r}{r_m}\cos\left(\frac{2\pi r}{r_m}\right)\right]\right\}, \quad (3)$$

where: $$\eta = (\kappa c^2/r)\int_0^r \hat{\mu}_{inc} r^2 dr = \kappa c^2 \hat{\mu}_{00}\left\{r_e^2\left[1 - \exp(-r/r_e)\right] + \sigma r_m^2 \sin(2\pi\ r/r_m)\right\},$$

$$\chi_0 = \kappa\hat{\mu}_{00}c^2[r_e\ \exp(-r/r_e) + 2\pi\sigma r_m \cos(2\pi\ r/r_m)],$$

$\hat{\mu}_{00}$, r_e, r_m, σ is constants.

In this case on the large distances to the central astronomical body with the radius r_e ($r >> r_e$) the parameter η is only weakly sinusoidally modulated. And, also, the square of velocity of orbital rotation of astronomical objects of the galaxy, that can be found from the condition of equality of centrifugal pseudo-force of inertia $\mathbf{F}_{in} = \mathrm{H}\hat{v}^2 c^{-2} a^{-1/2}/r$ and pseudo-force of gravity $\mathbf{F}_{gr} = \mathrm{L}c^{-2}a^{-1/2}d[\ln(v_{cv}/c)]/dr$:

$$\frac{[\hat{v}^2]_{GR}}{c^2} = \frac{\mathrm{L}\, r}{\mathrm{H}}\frac{d\ln(v_c/c)}{dr} = \frac{rb'}{2bb_s} = \frac{a}{2b_s}[1 - 1/a + (\kappa p - \Lambda)r^2] = \frac{[\eta + (\kappa p - 2\Lambda/3)r^2]}{2b_s(1 - \eta - \Lambda r^2/3)} \quad (4)$$

very slightly depends on r[1] $>> r_e$ due to the smallness of $\exp(-r/r_e)$, pressure p in the outer space of the galaxy and cosmological constant Λ. And its value can only slightly increase together with increasing of r due to the gradual increasing of the parameter η.

Here "galactic" value of coordinate velocity of light ${}^{u}v_{cvg} \equiv {}^{u}v_l = cb^{1/2}$, Lagrangian and Hamiltonian

$$\mathrm{L} = \hat{m}_{gr}c^2 = \hat{m}_{gr0}c^2(1 - \hat{v}^2c^{-2})^{1/2} = \mathrm{H}(1 - \hat{v}^2c^{-2})/b = \mathrm{H}/b_s,$$
$$\mathrm{H} = \hat{m}_{in}c^2 = \hat{m}_{in0}c^2(1 - \hat{v}^2c^{-2})^{-1/2} = \hat{m}_{00}c^2 b^{1/2}(1 - \hat{v}^2c^{-2})^{-1/2}$$

and increment of the metric radial distance $d\check{r} = a^{1/2}dr$ are determined by the parameters b, $a = 1/(1 - \eta - \Lambda r^2/3)$ and $b_s = (v_{ls}/c)^2 = b/(1 - \hat{v}^2c^{-2})$ of the equations of GR gravitational field:

$$b'/abr - r^{-2}(1 - 1/a) + \Lambda = \kappa p = \kappa\gamma\hat{\mu}_{in}c^2/b = \kappa\gamma\hat{\mu}_{00}c^2/\sqrt{b},$$
$$a'/a^2r + r^{-2}(1 - 1/a) - \Lambda = \kappa(\hat{\mu}_{in0}c^2 + p\hat{v}^2c^{-2})/(1 - \hat{v}^2c^{-2}) = \kappa\hat{\mu}_{in}c^2[1 + \gamma\hat{v}^2/b(c^2 - \hat{v}^2)],$$
$$[\ln(ba)]'/ar = \kappa\hat{\mu}_{gr}(b + \gamma)c^4/(c^2 - \hat{v}^2) = \kappa\hat{\mu}_{in}(1 + \gamma/b)c^4/(c^2 - \hat{v}^2) = \kappa\hat{\mu}_{00}(\sqrt{b} + \gamma/\sqrt{b})c^4/(c^2 - \hat{v}^2).$$

However, instead of eigenvalues of density of the mass μ_{00} and pressure p_{00} their coordinate values in FR are used in tensor of energy-momentum $\hat{\mu}_{in0} = \hat{\mu}_{00}\sqrt{b}$ and $p = p_{00}/\sqrt{b}$ ($p/\hat{\mu}_{gr0}c^2 = p_{00}/\hat{\mu}_{00}c^2 = \gamma = \mathbf{const}(r)$). This is related to temporal invariance of really metrical mechanical and thermodynamic parameters and characteristics of matter. An insufficient amount of the mass in the Universe denotes the fact that not only in RGTD but also in GR the tensor of energy-momentum should be based on the ordinary rest energy of matter that includes not only inert free energy but also bound energy of matter.

The defined by the same spatial distribution (3) average relativistic density of corrected relativistic mass of galaxy matter in GR has the following form:

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[1] Here and further, we consider the minimum radial distance r from the center of the galaxy to the point on the trajectory of rotation of the astronomical object at which equilibrium is achieved, and therefore, its radial displacement is absent (dr/dt=0).

$$\hat{\mu}_{inc} = \hat{\mu}_{00}\sqrt{b}[1+\gamma\hat{v}^2 / b(c^2 - \hat{v}^2)],$$

where: $p_{00} = \gamma\hat{\mu}_{00}c^2$, $\sqrt{b} = \dfrac{v_l}{c} = \dfrac{1}{\sqrt{a}}\left(1+\dfrac{\kappa c^2}{2}\int\limits_{r_e}^{r}\dfrac{\hat{m}_{00}a^{3/2}rdr}{V[1-\hat{v}^2c^{-2}]}\right)$, $\hat{\mu}_{00} = \hat{m}_{00} / V$;

V is volume of matter; $\hat{m}_{00} = \hat{m}_{in0}b^{-1/2} = \hat{m}_{gr0}b^{1/2}$ is intrinsic value of the mass of matter that corresponds to "critical" equilibrium value of the ordinary rest energy of matter (b=1), and $v_l \equiv v_{cv}$ is maximum possible (extreme) value of velocity of matter in the outer space of the galaxy.

As we can see, exactly the logarithmic potential of gravitational field and the spatial distribution of gravitational strength defined by it in the extremely filled by stellar substance space of the galaxy correspond to these astronomical observations. The quite significant decreasing of the average density of matter when distancing from the center of the galaxy towards the periphery also corresponds to these astronomical observations. Together with the deepening into cosmological past ($\tau_p<\tau_e$) the average density of matter in the gravithermodynamic frame of reference of spatial coordinates and time (GT-FR) of the galaxy is decreasing on its periphery proportionally to the square of radial coordinate r_p. In the picture plane of astronomical observation this radial decreasing of the density of matter is even more significant:

$$\hat{\mu}_{gr0cpobs} = \hat{\mu}_{gr0p}(r_p / r_{pobs})^3 = \hat{\mu}_{gr0cp}\exp[-3H(\tau_e - \tau_p)] = \hat{\mu}_{gr0}r_e^2 r_p^{-2}\exp\left[-\sqrt{3\Lambda}(r_p - r_e)\right],$$

since, in contrast to GT-FR of the central astronomical object of the observed galaxy, in GT-FR of terrestrial observer all other astronomical objects of this galaxy belong to the same moment of cosmological time $\tau_p = \tau_e$.

And, therefore, the quantity of baryonic matter currently present in galaxies can be quite enough for examined here justification for observed velocities of astronomical objects of galaxies. The one more contributing fact is that having the same quantity of matter ($m_{00p}=m_{00e}$) its inertial mass of rest $m_{in0}=m_{00}b^{1/2}$ on the galaxy periphery is bigger than in its center since $b_p>b_e$.

The galaxies that cooled down, and therefore were previously much larger, always had (and still have) non-rigid FRs. The variable function $u(v)$, which corresponds to a non-rigid FRs, and the value of the certain parameter $n = b_e < 1$, at which there will be no need in dark non-baryonic matter in a flat galaxy, can be matched for any flat galaxy.

The GR gravitational field equations de facto correspond to spatially inhomogeneous thermodynamic states of only utterly cooled down matter. The similar to them equations of relativistic gravithermodynamics (RGTD) [3, 7, 8] correspond to spatially inhomogeneous thermodynamic states of gradually cooling down matter. Therefore, in RGTD for matter that cools quasi-equilibrially, the four-momentum is formed not by the Hamiltonian of enthalpy, but by the Hamiltonian (GT-Hamiltonian) of the inert free energy, and Lagrangian (GT-Lagrangian) four-momentum is formed by the Lagrangian (GT-Lagrangian) of ordinary rest energy (multiplicative component of thermodynamic Gibbs free energy) of matter of astronomical object. The GR gravitational field equations de facto correspond to spatially inhomogeneous thermodynamic states of only utterly cooled down matter. In addition, in RGTD, unlike GR, bodies that move by inertia in a gravitational field, influence (by their movement) the configuration of the dynamic gravitational field surrounding them. At the same time, in equilibrial processes, along with the usage of ordinary Hamiltonians and Lagrangians, in RGTD it is also possible to use GT-Hamiltonians and GT-Lagrangians. Therefore, in RGTD for matter the Hamiltonian (GT-Hamiltonian) four-momentum must obviously be formed system not by the Hamiltonian of the enthalpy, but by the Hamiltonian (GT-Hamiltonian) of the inert free energy, and Lagrangian (GT-

Lagrangian) four-momentum must obviously be formed by the Lagrangian (GT-Lagrangian) of the ordinary rest energy (the multiplicative component of thermodynamic Gibbs free energy).

The GT-Lagrangian of the ordinary rest energy of the matter:

$$\mathrm{L}_c = m_{gr}c^2 = m_{gr0}c^2(1+v^2v_l^{-2})^{-1/2} = m_{00}c^3/v_{lc} = \mathrm{H}_c/b(1+\hat{v}^2c^{-2}) = \mathrm{H}_c/b(1+v^2v_l^{-2}) = \mathrm{H}_c/b_c$$

forms the four-momentum not with the GT-Hamiltonian momentum, but with the GT-Lagrangian momentum:

$$\mathrm{P}_{Lc} = m_{gr0}v(1+v^2v_l^{-2})^{-1/2} = m_{00}cv/v_{lc} = m_{00}vc(v_l^2+v^2)^{-1/2} = m_{00}vc/v_{lc} = m_{00}\hat{v},$$

where: $W_0^2 = \mathrm{L}_c^2 + c^4v_l^{-2}\,\mathrm{P}_{Lc}^2 = m_{00}^2c^6v_l^{-2}/(1+v^2v_l^{-2}) + m_{00}^2c^6v_l^{-4}v^2/(1+v^2v_l^{-2}) = m_{00}^2c^6v_l^{-2} = m_{gr0}^2c^4$,

$(ds_c)^2 = v_{lc}^2(dt)^2 - (d\bar{x})^2 - (d\bar{y})^2 - (d\bar{z})^2 = b_cc^2(dt)^2 - (d\hat{l})^2 = (v_l^2+v^2)(dt)^2 - (d\hat{l})^2 = bc^2(dt)^2 = \mathbf{invar}$,

$\hat{v} = vb_c^{-1/2} = vc/v_{lc} = vc/v_l\hat{\Gamma}_c$, $\hat{\Gamma}_c = (1+v^2v_l^{-2})^{1/2}$, $v_{lc}^2 = b_cc^2 = bc^2 + v^2 = v_l^2 + v^2 = \mathbf{const}(t)$,

$b_c = b\hat{\Gamma}_c^2 = (v_l^2+v^2)c^{-2} = b + v^2c^{-2} = v_{lc}^2c^{-2} = \mathbf{const}(t)$.

And therefore, the condition of quasi-equilibrium precisely in the dynamic gravitational field of the galaxy of all its objects moving by inertia leads to both the absence of relativistic dilation of their intrinsic time and the invariance of their intrinsic time with respect to relativistic transformations. The spatial homogeneity of the rate of intrinsic time in entire gravithermodynamically bound matter is consistent with the single frequency of change of its collective spatially inhomogeneous Gibbs microstates, which is not affected by either a decrease (during approaching gravity center) in the frequency of intranuclear interaction or an interactions. Moreover, this is ensured even without conformal transformations of the space-time interval s. Therefore, like the parameters v_l, v_{lc}, b and Γ_m in thermodynamics [3], the parameters a_c and b_c (or analogous to them parameters a_s and b_s) in the RGTD is a hidden internal parameters of the moving matter. And the usage of this parameter in the equations of the dynamic gravitational field of the RGTD allows us not to additionally use the velocity of matter in those equations, as well as in the equations of thermodynamics.

A similar dependence of the parameter v_{lc} on the velocity also occurs for distant galaxies that are in the state of free fall onto the event pseudo-horizon of the expanding Universe: $v_{lcg}^2 \equiv c^2 = v_{lg}^2 + v^2$. After all, according to Hubble's law and the Schwarzschild solution of the gravitational field equations with a non-zero value of the cosmological constant $\Lambda = 3H_E^2c^{-2}$ and a zero value of the gravitational radius:

$$v_{lg}^2 = c^2(1-\Lambda r^2/3) = c^2 - H_E^2r^2 = c^2 - v_g^2.$$

The use of the parameter $b_s = b\Gamma_s^2 = b/(1-v^2c^{-2}/b) = v_{ls}^2c^{-2} = \mathbf{const}(t)$ [2], built on the basis of relativistic size shrinkage $\Gamma_s = (1-v^2v_l^{-2})^{-1/2}$, in the equations of the dynamic gravitational field of the RGTD is also possible. However, in order to ensure the absence of dilation of intrinsic time of matter moving in a gravitational field by inertia, it will be necessary to use conformal Lorentz transformations (instead of the usual Lorentz transformations) of the increments of spatial coordinates and time. The solutions of the equations of dynamic gravitational field of the RGTD do not depend on the usage of the parameter b_c or the parameter b_s in them. The only parameters that will differ are the parameters of hypothetical static gravitational fields (which are reproduced on the basis of those parameters b_c and b_s).

Due to the fundamental unobservability in the intrinsic FR of matter of the evolutionary decrease of the radius r of the star´s orbit, it is the same in all FRs. The orbital velocities of galaxies and their stars that are observed on an exponential physically homogeneous scale of intrinsic time t of any observer should also be considered real in the observer´s FR. Taking

[2] Apparently, this parameter is inherent only to the equilibrial (pseudo-inertial uniform) motion of matter of bodies that are evolutionarily self-contracting in the frame of references of spatial coordinates and time which is comoving with the expanding Universe.

this into account, a dynamic gravitational field is examined here: the field in which the velocities v of the hypothetical equilibrium circular motion (r=**const**) of astronomical objects do not depend directly on the radial coordinates r, but depend only on the values of the coordinate vacuum velocity of light v_{cv} of GR or on the equivalent limit velocity of matter v_l or v_{lc} of the RGTD [3, 8]. Thus, unlike the modified Newtonian dynamics proposed by Mordechai Milgrom, both in the orthodox GR and in its modification by the RGTD, the speed of orbital motion of astronomical objects in a flat galaxy, albeit indirectly, still depends on their radial distance to the center of the galaxy.

Because of this, the Λ-reduced (evolutionarily weakened) centrifugal pseudo-force of inertia:

$$\mathbf{F}_{in} = m_{in}\hat{v}^2(1-\Lambda r^2)/r(1-\Lambda r^2/3) = \mathbf{F}_{in0} + \mathbf{F}_{inE} \approx m_{in}v^2/b_c r - 2m_{in}v^2 r/b_c v^2(r_c^2 - r^2),$$

which "balances" (compensates) the gravitational pseudo-force in a rigid FR of matter, depends on the cosmological fundamental constant $\Lambda = 3H_E^2 c^{-2} = \mathbf{const}(t)$ and, therefore, Hubble fundamental constant $H_E = \mathbf{const}(t)$. The fundamental invariance of these constants in the intrinsic time t of matter ensures the continuity of the intrinsic space of a rigid FR [3, 8].

Here: $\mathbf{F}_{in0} = m_{in}v^2/b_c r$ is ordinary (unreduced) centrifugal pseudo-force of inertia; $\mathbf{F}_{inE} = -2\Lambda m_{in}\hat{v}^2 r/(3-\Lambda r^2) = -2H_E^2 m_{in}v^2 r/b_c(c^2 - H_E^2 r^2) \approx -2m_{00}v^2 r/\sqrt{b_c}(r_c^2 - r^2)$ is centripetal evolutionary pseudo-force, which pushes matter towards the center of the galaxy, thereby compensating within the galaxy (when $r<\Lambda^{-1/2}$) the centrifugal gravitational pseudo-force, which is responsible for the evolutionary distancing of other galaxies from it according to Hubble's law; $r_c \approx c/H_E$ is the radius of the event pseudo-horizon, which covers the entire infinite fundamental space of the Universe in the FR of any matter due to the fundamentally unobservable in FR of people´s world evolutionary self-contraction (in fundamental space) of matter spiral-wave microobjects, which are the so-called elementary particles.

Therefore, astronomical objects in distant galaxies move in stationary, rather than divergent spiral orbits precisely due to the presence (in the observer's FR) of the action on them not only of gravitational, but also of evolutionary centripetal pseudo-force. And it is precisely this evolutionary centripetal pseudo-force that causes these same astronomical objects to move in convergent spiral orbits in the comoving with expanding Universe FR (CFREU) [2, 3, 8]).

The dependence of centrifugal pseudo-force of inertia exactly on the intrinsic value of the object's velocity $\hat{v} = vc/v_{lc} = v/\sqrt{b_c}$ actually compensates for the non-identity of its inertial mass $m_{in} = m_{gr}b_c$ to the much larger gravitational mass m_{gr} and thereby provides the possibility of using a single galactic value ${}^{g}G_{00}$ of the gravitational constant in the FR_g of the galaxy. But in the FR_{si} of each of the stars of this galaxy there may be their own values ${}^{S}G_{00i}={}^{g}G_{00}\,{}^{g}b_{ci}^{-2}$ of the gravitational constant [3, 8], according to which the planets and satellites rotate relative to them. Similarly, in the FR_E of the Earth, each of the distant galaxies may also have its own gravitational constant ${}^{g}G_{00i}={}^{E}G_{00}\,{}^{E}b_{ci}^{-2}$. The failure to take this into account, together with the failure to take into account the two-dimensional topology of flat galaxies, are the main reasons for the imaginary need for dark non-baryonic matter in the Universe. After all, compensation for the mutual non-identity of the inertial and gravitational masses of only the most distant galaxies does not provide compensation for the mutual non-identity of the inertial and gravitational masses of their stars.

Thus, in the own time of astronomical objects of a distant galaxy, the inertial mass of their matter is actually identical to the gravitational mass of the matter, as it should be. The fact that gravitational mass of objects of a distant galaxy in the FR of the Earth observer is greater is due to a much higher temperature of their matter in the distant past. And this is similar to the much higher temperature of matter in the bowels of the Earth. And therefore, the observed thermodynamic parameters of matter in any distant galaxy strictly correspond to the thermodynamic parameters of the Earth's matter. Therefore, the values of the parameter b_c in a distant galaxy strictly correspond to the values of the absolute temperature of its matter in the observed distant past. And therefore, the Earth's gravitational field strictly corresponds to the thermodynamic state of the matter of the Universe in any distant past.

According to this, in the tensor of energy-momentum of the RGTD not only intranuclear pressure p_N but also intranuclear temperature T_N is taken into account (where S_N is intranuclear entropy [3]):

$$b_c'/a_c b_c r - r^{-2}(1-1/a_c) + \Lambda = \kappa(T_N S_N - p_N V_N)/V = \kappa(m_{gr} - m_{in})c^2/V = \kappa m_{00}c^2(1/\sqrt{b_c} - \sqrt{b_c})/V, \quad (5)$$

$$a_c'/a_c^2 r + r^{-2}(1-1/a_c) - \Lambda = \kappa E/V = \kappa m_{in}c^2/V = \kappa m_{00}c^2\sqrt{b_c}/V,$$

$$[\ln(b_c a_c)]'/a_c r = \kappa W/V = \kappa m_{gr}c^2/V = \kappa m_{00}c^2/\sqrt{b_c}V,$$

where: b_c and a_c are the parameters of the dynamic gravitational field equations of the non-continuous matter of the galaxy; $p_V V_N = \widetilde{\beta}_{pVN} E = b_c \widetilde{\beta}_{pVN} m_{gr} c^2 = \widetilde{\beta}_{pVN} m_{in} c^2$, $\widetilde{\beta}_{pVN} \neq \mathbf{const}(r)$, $S_N = m_{gr}c^2/T_N = m_{00}c^2/T_{00} = \mathbf{const}(r)$, $T_{00N} = T_N\sqrt{b_c} = \mathbf{const}(r)$, $m_{00} = m_{gr}\sqrt{b_c} = m_{in}/\sqrt{b_c} = \mathbf{const}(r)$, $\mu_{00} = m_{00}/V \neq \mathbf{const}(r)$, $\mu_{gr} = m_{00}/\sqrt{b_c}V = \mu_{in}/b_c \neq \mathbf{const}(r)$, $\mu_{in} = m_{00}\sqrt{b_c}/V \neq \mathbf{const}(r)$, $V \neq \mathbf{const}(r)$ and $V_N \neq \mathbf{const}(r)$ are molar and intranuclear volume of matter, respectively**.**

In addition, according to the RGTD equations, the configuration of the dynamic gravitational field of a galaxy in a quasi-equilibrium state is standard (canonical in RGTD). That is so because it is not determined at all by the spatial distribution of the average mass density of its non-continuous matter. After all, this spatial distribution of the average mass density of the galaxy's matter is itself determined by the standard configuration of its dynamic gravitational field:

$$S' = \frac{d[r/a_c(1-b_c)]}{dr} = \frac{1-r_g' - \Lambda r^2}{(1-b_c)} + \frac{(r - r_g - \Lambda r^3/3)}{(1-b_c)^2}b_c' = -\frac{b_c S}{r(1-b_c)} + \frac{(1-\Lambda r^2)}{(1-b_c)^2}, \quad (6)$$

$$S = \frac{r}{a_c(1-b_c)} = \frac{r - r_g - \Lambda r^3/3}{1-b_c} = \exp\int\frac{-b_c dr}{(1-b_c)r} \times \int\left[\frac{(1-\Lambda r^2)}{(1-b_c)^2}\exp\int\frac{b_c dr}{(1-b_c)r}\right]dr,$$

where the parameter S can be conditionally considered as the distance from the event pseudo-horizon.

The trivial solution of this equation, which takes place at:

$$b_c = b_{ce}\left(\frac{3-\Lambda r^2}{3-\Lambda r_e^2}\right), \quad S_0 = \frac{r - \Lambda r^3/3}{1-b_c} = \frac{(r-\Lambda r^3/3)(3-\Lambda r_e^2)}{3-\Lambda r_e^2 - b_{ce}(3-\Lambda r^2)}, \quad r_g = \frac{(1-b_c)r_{ge}}{(1-b_{ce})}\exp\int_{r_{ge}}^{r_g}\frac{b_c dr}{r(1-b_c)} =$$

$$= \frac{(1-b_c)r_{ge}}{(1-b_{ce})}\exp\frac{2b_{ce}\ln(r/r_e) - (1-\Lambda r_e^2/3)\{\ln[r^2 + (3/\Lambda - r_e^2)/b_{ce} - 3/\Lambda] - \ln[(1/b_{ce} - 1)(3/\Lambda - r_e^2)]\}}{2(1-\Lambda r_e^2/3 - b_{ce})},$$

does not correspond to physical reality. After all, because of $b_c' = -2b_{ce}\Lambda r/(3-\Lambda r_e^2) \neq 0$ at $r \neq 0$, the solution does not imply the presence of event pseudo-horizon in the FR of matter. And the parameter b_c, unlike the parameter a_c, does not depend on the gravitational radius r_g. And therefore, gravity is absent in the FR corresponding to this trivial solution.

The gravitational potential of the dynamic gravitational field of the flat (or superthin) galaxies depend on the effective value of the gravitational constant ${}^E G_{eeff} = {}^E G_{0ge}/b_{ce} = {}^E G_{00} b_{ce}^{-2}$ in the observer's FR. Since the thing that depends on this effective value is the density of the inertial mass of matter (equivalent to its inert free energy), which previously (when $r > \Lambda^{-1/2}$, $db_c/dr < 0$) gradually increased in cosmological time (time measured in the CFREU), but now (when $r<\Lambda^{-1/2}$, $db_c/dr>0$) gradually decreases with approaching the center of gravity. And therefore, flat galaxies, which previously were cooling in quasi-equilibrium state (due to $T\sqrt{b_c} \approx \mathbf{const}$), and which are now more "hot" when approaching their centers, can have predominantly non-rigid FRs.

According to the mutual non-identity of the gravitational and inertial masses of matter we find the square of the rotation velocity of astronomical object relatively to the galaxy center according to the equations (5, 6) of dynamic gravitational field of RGTD:

$$[\hat{v}^2]_{RGTD} = \frac{c^2 r(3-\Lambda r^2) b_c'}{6 b_c^2 (1-\Lambda r^2)} = \frac{c^2 a_c (3-\Lambda r^2)}{6 b_c (1-\Lambda r^2)} \left\{ \left(1 - \frac{1}{a_c}\right) + \left[\frac{\kappa m_{00} c^2}{V} \left(\frac{1}{\sqrt{b_c}} - \sqrt{b_c} \right) - \Lambda \right] r^2 \right\} >> [\hat{v}^2]_{GR} \quad (7)$$

As we can see, at the same radial distribution of the average density of the mass $\mu_{00} = m_{00}/V$ of baryonic matter the circular velocities of rotation of astronomical objects relatively to the galaxy center are much bigger in RGTD than in GR. And this is, of course, related to the fact that:

$$(T_N S_N - p_N V_N)/V \equiv (m_{gr} - m_{in}) c^2 / V = \mu_{00} c^2 (1/\sqrt{b_c} - \sqrt{b_c}) >> p \, .$$

Thus, we can get rid of the imaginary necessity of dark non-baryonic matter in flat (superthin) galaxies (which follows from the equations of GR gravitational field) if we analyze the motion of their astronomical objects using the RGTD equations of gravitational field and if take into account the two-dimensional topology of the galaxies.

Therefore, a strength of the dynamic gravitational field of flat (or superthin) galaxies, according to their two-dimensional topology, will be inversely proportional to the radial distance, not to its square. And this will be the case, despite the inverse proportionality of the strength of individual gravitational fields of all its spherically symmetric astronomical objects exactly to the square of radial distance. In addition, at the edge of the galaxy ($r_p \approx \Lambda^{-1/2}$), the centrifugal pseudo-forces of inertia are compensated mainly by centripetal pseudo-forces (which are proportional to the cosmological constant Λ) of evolutionary self-contraction of matter in the fundamental (background) Euclidean space of comoving with expanding Universe FR.

If we do not take into account local peculiarities of distribution of average density of the mass in galaxies and examine only the general tendency of typical dependence of the orbital velocity of their objects on radial distance to the galaxy center, then the following dependencies of this velocity on the parameters $b_c = v_{lc}^2 c^{-2} = b_{ce}(b_{c0}/b_{ce0})^{n_0/n} = b_{ce}(b_{c0}/b_{ce0})^{b_{ce0}/b_{ce}}$ and $b_{ce} = v_{lce}^2 c^{-2} \approx (1+2z_e)(1+z_e)^{-2}$, and thus on radial distance r, can be matched with the graphs on Fig.:

$$\tilde{v} = \frac{v}{\sqrt{b_c}} = \sqrt{\frac{2\,\mathrm{LH}_e (b_c/b_{ce})^n}{\mathrm{HL}_e [1+(b_c/b_{ce})^{2n}]}}\tilde{v}_e = \sqrt{\frac{2 b_{ce}(b_c/b_{ce})^n}{b_c[1+(b_c/b_{ce})^{2n}]}}\tilde{v}_e = \sqrt{\frac{2}{b_c[(b_{ce}/b_c)^n + (b_c/b_{ce})^n]}} v_e = \frac{v_e}{\sqrt{b_c}} \left\{ 1 + \left[\frac{2 n_g v_e^2}{c^2} \ln\left(\frac{r}{r_e}\right) \right]^2 \right\}^{-1/4},$$

$$\hat{v} = \frac{v}{\sqrt{b_c}} = \sqrt{\frac{2\,\mathrm{LH}_e (b_c/b_{ce})^n}{\mathrm{HL}_e [1+(b_c/b_{ce})^{2n}]}}\hat{v}_e = \sqrt{\frac{2(b_c/b_{ce})^n}{b_c[1+(b_c/b_{ce})^{2n}]}} v_e = \frac{v_e}{\sqrt{b_c}} \left\{ 1 + \frac{4 n_g^2 v_e^4}{c^4} \left[\ln\left(\frac{r - \Lambda r^3/3}{r_e - \Lambda r_e^3/3} \right) - u \ln\left(\frac{1-b_c}{1-b_{ce}} \right) \right]^2 \right\}^{-1/4}, \quad (8)$$

where: b_{c0} and b_{ce0} are the parameters of the gravitational field in the galaxy's centric intrinsic $\mathrm{FR_g}$; $(dv/db_c)_e = (dv/dr)_e = 0$, $n_g = {}^E G_{eeff} M_{00g} b_{ce} c^{-2}/r_e = \varsigma M_{grg} m_{gre} {}^E G_{00} c^{-2}/m_{00e} r_e = \varsigma M_{00g} {}^E G_{00} c^{-2}/r_e b_{ce} > 1$, $n = {}^E G_{00}/{}^E G_{0ge} = b_{ce} < 1$, $n_0 = {}^g G_{00}/{}^g G_{0e} = b_{ce0} < 1$; ${}^E G_{eeff} = \varsigma {}^E G_{0ge}/b_{ce} = \varsigma {}^E G_{00} b_{ce}^{-2}$ and ${}^E G_{0ge} = {}^E G_{00}/n = {}^E G_{00}/b_{ce}$ are, respectively, the effective and real values of the gravitational constant of a galactic star e; ${}^g G_{00}$ and ${}^g G_{0e}$ are the gravitational constants in $\mathrm{FR_g}$, respectively, of the galaxy and its star e in $\mathrm{FR_E}$; $\varsigma \geq 1$ is an indicator of the level of zonal anomaly of the gravitational field caused by the location of the galaxy in a cosmosphere with an increased average density of matter or by the high speed of the galaxy's motion on a picture plane; of the galaxy in the picture plane; $u(r)$ is the indicator of the presence of non-rigidity of the FR_{0g} of a galaxy that was cooling in quasi-equilibrium state ($\mathbf{F}_{in}$<-$\mathbf{F}_{gr}$); b_{c0} and b_{ce0} are parameters of the gravitational field in the galaxy's intrinsic centric FR; r_e is the radius of the conventional galactic loose nucleus, on the surface of which the observed orbital velocity v of objects can take its maximum possible value $v_{\max} \equiv v_e = b_{ce}^{1/2}\hat{v}_e(b_e) = v_{lce}\hat{v}_e / c$; M_{00g} and $M_{grge} = M_{00g} / \sqrt{b_{ce}}$ are the ordinary and gravitational masses of the loose nucleus of the galaxy; m_{00e} and m_{gre} are the ordinary and gravitational masses of a galactic star e moving in a circular orbit at the maximum possible speed.

In the first approximate dependence [3, 8], the evolutionary self-contraction of matter in infinite fundamental space of CFREU is conditionally not taken into account. And therefore, there is no limitation of the galaxy's intrinsic space by the event pseudo-horizon (on which only the infinitely far cosmological past is always present) in it. After all, according to it, the coordinate velocity of light continuously increases along with the increase in the radial coordinate r.

Herein according to (4, 7) and similarly to diffeomorphically-conjugated forms [9]:

$$v = b_c^{1/2}\hat{v} = \{[(b_{ce}/b_c)^n + (b_c/b_{ce})^n]/2\}^{-1/2} v_{\max} = [v_e^{-4} + 4n_g^2 c^{-4} \ln^2(r/r_e)]^{-1/4},$$

$$r = r_e \exp\left[\pm (c^2/2n_g)\sqrt{v^{-4} - v_e^{-4}}\right] = r_e \exp\left\{(c^2 v_{\max}^{-2}/4n_g)\left[(b_c/b_{ce})^n - (b_{ce}/b_c)^n\right]\right\},$$

$$b_c = k_b b_{ce} = b_{ce}\left[(v_{\max}/v)^2 \pm \sqrt{(v_{\max}/v)^4 - 1}\right]^{1/n} = b_{ce}\left[\pm 2n_g v_e^2 c^{-2}\ln(r/r_e) + \sqrt{1 + [2n_g v_e^2 c^{-2}\ln(r/r_e)]^2}\right]^{1/n},$$

$$b_c' = \frac{db_c}{dr} = \frac{2n_g v_e^2 b_c}{nc^2 r\sqrt{1 + [2n_g v_e^2 c^{-2}\ln(r/r_e)]^2}} = \frac{4n_g v_e^2 b_c}{nc^2 r[(b_c/b_{ce})^n + (b_{ce}/b_c)^n]} =$$

$$= \frac{4v_e^2 b_c \varsigma M_{00g}\, {}^E G_{00} \exp\left\{\mp (c^2 v_e^{-2}/4n_g)\left[(b_c/b_{ce})^n - (b_{ce}/b_c)^n\right]\right\}}{c^4 b_{ce}^2 r_e^2 [(b_c/b_{ce})^n + (b_{ce}/b_c)^n]},$$

$$\frac{b_c'}{b_c a_c r} - \frac{1}{r^2}\left(1 - \frac{1}{a_c}\right) + \Lambda - \frac{\kappa m_{00} c^2}{V}\left(\frac{1}{\sqrt{b_c}} - \sqrt{b_c}\right) = \frac{4n_g v_e^2 [r^{-2} - r_g r^{-3} - \Lambda/3]}{nc^2[(b_c/b_{ce})^n + (b_{ce}/b_c)^n]} - \frac{r_g}{r^3} + \frac{2\Lambda}{3} - \frac{\kappa m_{00} c^2}{V}\left(\frac{1}{\sqrt{b_c}} - \sqrt{b_c}\right) = 0,$$

$$V = \frac{n\kappa m_{00} c^2 (1/\sqrt{b_c} - \sqrt{b_c})[(b_c/b_{ce})^n + (b_{ce}/b_c)^n]}{4n_g v_e^2 c^{-2}(r^{-2} - r_g r^{-3} - \Lambda/3) - n(r_g r^{-3} - 2\Lambda/3)[(b_c/b_{ce})^n + (b_{ce}/b_c)^n]} =$$

$$= \frac{n\kappa m_{00} c^2 \left\{(1/\sqrt{b_{ce}})\left[\sqrt{1+A^2} \mp A\right]^{\frac{1}{2n}} - \sqrt{b_{ce}}\left[\sqrt{1+A^2} \pm A\right]^{\frac{1}{2n}}\right\}\sqrt{1+A^2}}{2n_g v_e^2 c^{-2}(r^{-2} - r_g r^{-3} - \Lambda/3) - n(r_g r^{-3} - 2\Lambda/3)\sqrt{1+A^2}},$$

$$A = 2n_g v_e^2 c^{-2}\ln(r/r_e), \qquad 1/a_c = 1 - r_g/r - \Lambda r^2/3, \qquad r_g = \int_{r_{\min}}^{r} r_g' dr, \quad r_g^* = r_{ge} + \int_{r_e}^{r} r_g' dr,$$

and: r_g and r_{ge} [3] are the gravitational radii of any layer of the galaxy and its loose nucleus, respectively.

Thus, the gravitational radius r_{ge} of the loose nucleus of the galaxy together with r_e, b_{ce} and M_{00g} is an indicator of the power of galactic gravitational field. Theoretically finding the values of all these indicators is problematic. And it is even impossible in the case of the formation of the loose nucleus of the galaxy by antimatter (i.e. when, due to the mirror symmetry of the antimatter-matter intrinsic space, $r > r_e$ not only outside, but also inside the loose nucleus [10]).

Moreover, even for distant objects in the galaxy $r_g > 2\Lambda r^3/3$, and $b_c < 1 - \Lambda r^2 = 1 - 3H_e^2 c^{-2} r^2$. And therefore, these objects are "affected" by pseudo-forces of repulsion that are three times greater than the Hubble pseudo-forces.

Therefore:

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[3] The gravitational radius r_{ge}^* corresponds to a loose nucleus, which at $(dr/dR)_e = 0$ contains only antimatter.

$$V > \frac{n\kappa m_{00}c^4(1/\sqrt{b_c}-\sqrt{b_c})[(b_c/b_{ce})^n+(b_{ce}/b_c)^n]}{4n_g v_e^2(r^{-2}-\Lambda)},$$

$$\mu_{gr}=\frac{m_{00}}{\sqrt{b_c}V}<\frac{4n_g v_e^2(r^{-2}-\Lambda)}{n\kappa c^4(1-b_c)[(b_c/b_{ce})^n+(b_{ce}/b_c)^n]}.$$

Apparently, all this is connected with the simplification of the considered FR of the galaxy. Because in this FR, unlike the FR of galaxies′ individual astronomical objects, there is no event pseudo-horizon on which b_c=0. After all, the value of b_c can only grow continuously with the growth of the radial coordinate r ($db_c/b_c dr\neq 0$ at all points of its infinite space).

The second dependence, on the contrary, ensures the presence of a pseudo-event horizon. But according to it, more complex mutual dependencies of the gravitational parameters of the galaxy take place and analytical integration of these dependencies is impossible:

$$r-\frac{\Lambda r^3}{3}=\frac{(r_e-\Lambda r_e^3/3)(1-b_c)^u}{(1-b_{ce})^u}\exp\left[\pm\frac{c^2}{2n_g}\sqrt{v^{-4}-v_e^{-4}}\right]=\frac{(r_e-\Lambda r_e^3/3)(1-b_c)^u}{(1-b_{ce})^u}\exp\left\{\frac{c^2 v_{\max}^{-2}}{4n_g}\left[\left(\frac{b_c}{b_{ce}}\right)^n-\left(\frac{b_{ce}}{b_c}\right)^n\right]\right\},$$

$$v=b_c^{1/2}\hat{v}=\left\{\frac{1}{2}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right]\right\}^{-1/2} v_{\max}=\left\{v_e^{-4}+\frac{4n_g^2}{c^4}\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_c)\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\right]^2\right\}^{-1/4},$$

$$b_c=k_b b_{ce}=b_{ce}\left[\left(\frac{v_{\max}}{v}\right)^2\pm\sqrt{\left(\frac{v_{\max}}{v}\right)^4-1}\right]^{1/n}=$$

$$=b_{ce}\left\{\sqrt{1+\frac{4n_g^2v_e^4}{c^4}\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_c)\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\right]^2}\pm\frac{2n_g v_e^2}{c^2}\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_c)\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\right]\right\}^{1/n},$$

$$b_c'=\frac{db_c}{dr}=\frac{n_g(1-\Lambda r^2)}{n\left(r-\frac{\Lambda r^3}{3}\right)\left\{\frac{c^2}{2v_e^2b_c}\sqrt{1+\frac{4n_g^2v_e^4}{c^4}\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-r_e^3/3}\right)-u(b_c)\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\right]^2}-\frac{u(b_c)}{1-b_c}+\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\frac{du}{db_c}\right\}}=$$

$$=\frac{{}^EG_{00}M_{00g}\varsigma(1-\Lambda r^2)}{c^2r_eb_{ce}^2\left(r-\frac{\Lambda r^3}{3}\right)\left\{\frac{c^2}{4v_e^2b_c}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right]-\frac{u(b_c)}{1-b_c}+\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\frac{du}{db_c}\right\}},$$

$$\frac{b_c'}{b_ca_cr}-\frac{1}{r^2}\left(1-\frac{1}{a_c}\right)+\Lambda-\frac{\kappa m_{00}c^2}{V}\left(\frac{1}{\sqrt{b_c}}-\sqrt{b_c}\right)=$$

$$=\frac{{}^EG_{00}M_{00g}\varsigma(1-\Lambda r^2)(r^{-2}-r_gr^{-3}-\Lambda/3)}{c^2r_eb_{ce}^2\left(1-\frac{\Lambda r^2}{3}\right)\left\{\frac{c^2}{4v_e^2}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right]-b_c\left[\frac{u(b_c)}{1-b_c}-\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\frac{du}{db_c}\right]\right\}}-\frac{r_g}{r^3}+\frac{2\Lambda}{3}-\frac{\kappa m_{00}c^2}{V}\left(\frac{1}{\sqrt{b_c}}-\sqrt{b_c}\right)=0,$$

$$V=\frac{n\kappa m_{00}c^2(1-\Lambda r^2/3)\left\{(1/\sqrt{b_{ce}})\left[\sqrt{1+A^2}\mp A\right]^{\frac{1}{2n}}-\sqrt{b_{ce}}\left[\sqrt{1+A^2}\pm A\right]^{\frac{1}{2n}}\right\}\left(\sqrt{1+A^2}-B\right)}{2n_gv_e^2c^{-2}(1-\Lambda r^2)(r^{-2}-r_gr^{-3}-\Lambda/3)-n(1-\Lambda r^2/3)(r_gr^{-3}-2\Lambda/3)\left(\sqrt{1+A^2}-B\right)},$$

$$\mu_{grst}=\frac{m_{00}}{\sqrt{b_c}V}=\frac{2M_{00g}\,{}^EG_{00}v_e^2\varsigma(1-\Lambda r^2)(r^{-2}-r_gr^{-3}-\Lambda/3)}{\kappa c^6r_eb_{ce}^2(1-b_c)(1-\Lambda r^2/3)\left(\sqrt{1+A^2}-B\right)}+\frac{2\Lambda/3-r_gr^{-3}}{\kappa c^2(1-b_c)},\ \mu_{grpst}=\frac{2\Lambda/3}{\kappa c^2(1-b_{c\max})}=\frac{H_E^2}{4\pi\,{}^EG_{00}(1-b_{c\max})},$$

where: $A=\frac{2n_gv_e^2}{c^2}\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_c)\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\right]$, $B=\frac{2b_cv_e^2}{c^2}\left[\frac{u(b_c)}{1-b_c}-\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\frac{du}{db_c}\right]$,

μ_{grst} is standard value of the gravitational mass density of the galaxy matter, μ_{grpst}=4,8596 $10^{-27}/(1-b_{c\max})$ is non-zero standard value at the edge of the galaxy ($r_p=\Lambda^{-1/2}$=1,1664 10^{26} [m]=3,78 [Gpc] [3, 8, 12]) of the gravitational mass density of the galaxy matter still held by the galaxy in quasi-equilibrium, despite the zero value of the gravitational radius at its boundary (r_{gp}=0, $b'_{cp}=0$).

Thus, the variation of the gravitational constant does indeed occur not only in time (a possibility suggested by Dirac [11]), but also in space. It varies similarly to the coordinate velocity of light, and therefore a function of it can be used as a gravitational potential. Moreover, the spatial distribution of the potentials of gravitational field of a flat galaxy does not actually depend on the values of local gravitational radii of this galaxy. The values of these local gravitational radii themselves depend on the gravitational field parameter b_c and determine both the curvature of the galaxy's intrinsic space and the spatial distribution of the allowed average mass density of matter. Consequently, new massive astronomical objects captured by the gravitational field of the galaxy will only have to fall onto its loose nucleus. And if the loose nucleus of the galaxy contains antimatter, those objects will be annihilated by it.

The dependence of the local values of the gravitational radii of a galaxy on the radial coordinate is determined from the following differential equation:

$$r'_g=\kappa\mu_{in}c^2r^2=\frac{\dfrac{2n_g v_e^2(1-\Lambda r^2)}{nc^2(1-\Lambda r^2/3)\left(\sqrt{1+A^2}-B\right)}\left(1-\dfrac{r_g}{r}-\dfrac{\Lambda r^2}{3}\right)+\left(\dfrac{2\Lambda r^2}{3}-\dfrac{r_g}{r}\right)}{\dfrac{1}{b_{ce}}\left\{\sqrt{1+\dfrac{4n_g^2v_e^2}{c^2}\left[\ln\left(\dfrac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_c)\ln\left(\dfrac{1-b_c}{1-b_{ce}}\right)\right]^2}\mp\dfrac{2n_gv_e^2}{c^2}\left[\ln\left(\dfrac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_c)\ln\left(\dfrac{1-b_c}{1-b_{ce}}\right)\right]\right\}^{\frac{1}{n}}-1},$$

or using dependent on it parameter S:

$$dS=d\left(\frac{r-r_g-\Lambda r^3/3}{1-b_c}\right)=-\frac{n}{n_g}\left\{\frac{c^2}{4v_e^2b_c}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right]-\frac{u(b_c)}{1-b_c}+\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\frac{du}{db_c}\right\}\left(1-\frac{\Lambda r^2}{3}\right)\left[\frac{b_cS}{(1-\Lambda r^2)(1-b_c)}-\frac{r}{(1-b_c)^2}\right]db_c,$$

$$r_g=r-\frac{\Lambda r^3}{3}-(1-b_c)\exp\left[-\int\frac{b_cdr}{(1-b_c)r}\right]\times\int\left\{\frac{1-\Lambda r^2}{(1-b_c)^2}\exp\left[\int\frac{b_cdr}{(1-b_c)r}\right]\right\}dr=r-\frac{\Lambda r^3}{3}-$$

$$-\frac{nc^2(r_e-\Lambda r_e^3/3)(1-b_c)}{4n_gv_e^2}\exp\left[-\int\frac{b_cdr}{(1-b_c)r}\right]\times\int_{b_{ce}}^{b_c}\left\{\frac{[(b_c/b_{ce})^n+(b_{ce}/b_c)^n]}{b_c(1-b_c)^2}-\frac{4v_e^2c^{-2}u}{(1-b_c)^3}\right\}\exp\left\{\frac{c^2}{4n_gv_e^2}\left[\left(\frac{b_c}{b_{ce}}\right)^n-\left(\frac{b_{ce}}{b_c}\right)^n\right]+\int\frac{b_cdr}{(1-b_c)r}\right\}db_c=$$

$$=\frac{nc^2(r_e-\Lambda r_e^3/3)(1-b_c)}{4n_gv_e^2}\exp\left[-\int\frac{b_cdr}{(1-b_c)r}\right]\times\int_{b_{ce}}^{b_c}\left\{\left[1-\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\left(\frac{b_c(1-\Lambda r^2/3)}{1-\Lambda r^2}-1\right)\frac{du}{db_c}\right]\frac{1}{(1-b_c)^2}-\right.$$

$$\left.-\frac{u}{(1-b_c)^3}\left[\frac{b_c(1-\Lambda r^2/3)}{1-\Lambda r^2}-1\right]+\frac{\Lambda c^2[(b_c/b_{ce})^n+(b_{ce}/b_c)^n]}{6v_e^2(r^{-2}-\Lambda)(1-b_c)^2}\right\}\exp\left\{\frac{c^2}{4n_gv_e^2}\left[\left(\frac{b_c}{b_{ce}}\right)^n-\left(\frac{b_{ce}}{b_c}\right)^n\right]+\int\frac{b_cdr}{(1-b_c)r}\right\}db_c,$$

where: $\displaystyle\int\frac{b_cdr}{(1-b_c)r}=\frac{n}{n_g}\int\frac{1-\Lambda r^2/3}{(1-\Lambda r^2)(1-b_c)}\left\{\frac{c^2}{4v_e^2}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right]-\frac{b_cu}{1-b_c}+b_c\ln\left(\frac{1-b_c}{1-b_{ce}}\right)\frac{du}{db_c}\right\}db_c$.

At u=-1 ($v_e=c/\sqrt{2}$, $\mathbf{F}_{in}<<-\mathbf{F}_{gr}$) this solution of the standard equation of the dynamic gravitational field of a flat galaxy allegedly degenerates. After all, in this case the value of the gravitational radius of the galaxy becomes proportional to the cosmological constant Λ, and therefore to the Hubble constant:

$$r_g=\frac{2n\Lambda(3r_e-\Lambda r_e^3)(1-b_c)}{9n_g}\exp\left[-\int\frac{b_cdr}{(1-b_c)r}\right]\times\int_{b_{ce}}^{b_c}\frac{r^2\{b_c+c^2v_e^{-2}(1-b_c)[(b_c/b_{ce})^n+(b_{ce}/b_c)^n]/4\}}{(1-\Lambda r^2)(1-b_c)^3}\exp\left\{\frac{c^2}{4n_gv_e^2}\left[\left(\frac{b_c}{b_{ce}}\right)^n-\left(\frac{b_{ce}}{b_c}\right)^n\right]+\int\frac{b_cdr}{(1-b_c)r}\right\}db_c.$$

But in fact the cosmological constant Λ, like the parameter b_c, is a hidden parameter of almost all physical characteristics of matter. And it is thanks to it that at $b_{ce}>(1-\Lambda r_e^2)/(1-\Lambda r_e^2/3)$ in the non-rigid FR of a cooling flat galaxy in a state of observant self-contraction ($u=-c^2v^{-2}/2$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$), the radial values of the gravitational radii $r_g(r)$ of a flat galaxy become larger than in the hypothetical rigid FR of a flat galaxy (u=0, $\mathbf{F}_{in} = -\mathbf{F}_{gr}$).

Thus the trivial solution of the equation takes place both at u=0 ($\mathbf{F}_{in} = -\mathbf{F}_{gr}$) and at a negative value of the parameter $u=-\varepsilon(z_e)c^2v^{-2}/2$ ($\mathbf{F}_{in} < -\mathbf{F}_{gr}$), where: $\varepsilon(z_e)\le 1$ is the galactic constant, which determines the rate of contraction of a galaxy and is apparently dependent on the redshift z of the wavelengths of its emission radiation.

And therefore, when $b_{ce} > (1-\Lambda r_e^2)/(1-\Lambda r_e^2/3)$, the smaller the maximum orbital velocity $v_e < c/\sqrt{2}$ of astronomical objects in a flat galaxy, the greater in the latter case the value of the gravitational radius on the surface of its loose nucleus will be.

Also what is important is that even in an incredibly weak gravitational field (when $\varepsilon(z_e)=1$, $u=-c^2v^{-2}/2$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$) and even at large radial distances, astronomical objects will rotate around the center of a galaxy with orbital velocities very close to the maximum possible speed [4 – 6]. After all, regardless of the value of the variable function u, the orbital velocities of astronomical objects in a flat galaxy at n=b_{ce}=0 can theoretically be equal to the maximum velocity $v_{\max}\equiv v_e$ at all radial distances.

Moreover, it is precisely thanks to $b_{ce} > (1-\Lambda r_e^2)/(1-\Lambda r_e^2/3)$ that this takes place at $u=-c^2v^{-2}/2$ ($\varepsilon(z_e)=1$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$) at very large distances from the center of the galaxy. After all, when $u=-c^2v^{-2}/2$ ($\varepsilon(z_e)=1$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$), the radial distances from the center to the objects of the cooling galaxy at the same value of the parameter b_c were much greater in the past than the hypothetical radial distances that could be much smaller at u=0 ($\mathbf{F}_{in} = -\mathbf{F}_{gr}$):

$$r-\frac{\Lambda r^3}{3}=\left(r_e-\frac{\Lambda r_e^3}{3}\right)\left(\frac{1-b_{ce}}{1-b_c}\right)^{\frac{c^2}{2v^2}}\exp\left[\pm\frac{c^2}{2n_g}\sqrt{v^{-4}-v_e^{-4}}\right]=\left(r_e-\frac{\Lambda r_e^3}{3}\right)\left(\frac{1-b_{ce}}{1-b_c}\right)^{\frac{c^2}{2v^2}}\exp\left\{\frac{c^2}{4n_g v_e^2}\left[\left(\frac{b_c}{b_{ce}}\right)^n-\left(\frac{b_{ce}}{b_c}\right)^n\right]\right\}>>$$

$$>>\left(r_e-\frac{\Lambda r_e^3}{3}\right)\exp\left[\pm\frac{c^2}{2n_g}\sqrt{v^{-4}-v_e^{-4}}\right]=\left(r_e-\frac{\Lambda r_e^3}{3}\right)\exp\left\{\frac{c^2}{4n_g v_e^2}\left[\left(\frac{b_c}{b_{ce}}\right)^n-\left(\frac{b_{ce}}{b_c}\right)^n\right]\right\},$$

$$\frac{dr}{db_c}=\frac{nc^2(r-\Lambda r^3/3)}{4n_g v_e^2 b_c(1-\Lambda r^2)}\left\{\frac{1}{1-b_c}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right]-n_g\ln(1-b_c)\left[\left(\frac{b_c}{b_{ce}}\right)^n-\left(\frac{b_{ce}}{b_c}\right)^n\right]\right\}>>\frac{c^2(r-\Lambda r^3/3)}{4v_e^2 b_c(1-\Lambda r^2)}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right].$$

The transition from the dynamic to the hypothetical static gravitational field of a flat galaxy when u=0 ($\mathbf{F}_{in} = -\mathbf{F}_{gr}$) is carried out as follows:

$${}^s b=\frac{b_s}{2}\left(1+\sqrt{1-\frac{4v^2}{b_s c^2}}\right)=\frac{b_s}{2}\left(1+\sqrt{1-\frac{8v_e^2}{b_s c^2[(b_{se}/b_s)^n+(b_s/b_{se})^n]}}\right),\quad {}^s b_e=\frac{b_{se}}{2}\left(1+\sqrt{1-\frac{4v_e^2}{b_{se}c^2}}\right)\quad \text{(in GR and RGTD);}$$

$$b=b_c(1-\hat{v}^2c^{-2})=b_c-v^2c^{-2}=b_c-\frac{2v_{\max}^2(b_c/b_{ce})^n}{c^2[1+(b_c/b_{ce})^{2n}]}=b_c-\frac{v_e^2}{c^2\sqrt{1+\{2n_g v_e^2c^{-2}\ln[(r-\Lambda r^3/3)/(r_e-\Lambda r_e^3/3)]\}^2}},$$

$$b_e=b_{ce}(1-\hat{v}_e^2c^{-2})=b_{ce}-v_e^2c^{-2},\qquad b'=b'_c+\frac{4n_g^2v^6(1-\Lambda r^2)}{c^6(r-\Lambda r^3/3)}\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)>b'_c\qquad \text{(in RGTD).}$$

The gravitational force acting in a static gravitational field on a conditionally motionless body is greater than the gravitational force acting in a dynamic gravitational field on the same body that is moving. And this is not only due to the decrease in the gravitational mass of the body due to its movement. After all, in a space full of rapidly moving bodies, the intensity of the dynamic gravitational field also decreases. That is why it is necessary to use precisely the dynamic gravitational field instead of a static one in calculations of the rotational motion of galactic objects.

Thus, in the equations of the dynamic gravitational field of RGTD, as in the equations of thermodynamics, not only gravitational, but also relativistic indicators are internal hidden parameters of the RGTD-state of matter in motion. And that is why in RGTD, unlike orthodox

GR, the use of an external relativistic description of the state of matter in motion is not always required.

The FR practically equivalent the FR of an observed galaxy is galaxy's intrinsic GT-FRg_0, the transition to which can be reached by transforming the parameters. The invariants of such a transformation are not only the radii of the circular orbits of astronomical objects in the galaxy, but also the following relations:

$v_0 / v_{e0} = v / v_e = \mathbf{invar}$, $\quad n_0 \ln k_{b0} = n \ln k_b = \mathbf{invar}$ $\quad [b_{ce0} \ln(b_{c0} / b_{ce0}) = b_{ce} \ln(b_c / b_{ce}) = \mathbf{invar}$].

The following dependence of the orbital velocity of objects of galaxies on parameter b_{c0} and, thus on radial distance r, can be applied to these objects in intrinsic GT-FR_{g0} of galaxy [3]:

$$v_0 = v_{e0} \sqrt{\frac{2}{(b_{c0} / b_{ce0})^{b_{ce0}} + (b_{ce0} / b_{c0})^{b_{ce0}}}} = v_{e0} \left\{ 1 + \frac{4 n_{g0}^2 v_{e0}^4}{c^4} \left[\ln\left(\frac{r - \Lambda r^3 / 3}{r_e - \Lambda r_e^3 / 3} \right) - u(b_{c0}) \ln\left(\frac{1 - b_{c0}}{1 - b_{ce0}} \right) \right]^2 \right\}^{-\frac{1}{4}},$$

where: $n_{g0} = n_g b_e / b_{e0}$, $v_{e0}^2 = v_e^2 b_{e0} / b_e$, $b_{c0} = b_{ce0} (b_c / b_{ce})^{\frac{b_{ce}}{b_{ce0}}} = b_{ce0} \left[(v_{e0}^2 v_0^{-2} \pm \sqrt{v_{e0}^4 v_0^{-4} - 1} \right]^{\frac{1}{b_{ce0}}} =$

$$= b_{ce0} \left\{ \sqrt{1 + \frac{4 n_{g0}^2 v_{e0}^4}{c^4} \left[\ln\left(\frac{r - \Lambda r^3 / 3}{r_e - \Lambda r_e^3 / 3} \right) - u(b_{c0}) \ln\left(\frac{1 - b_{c0}}{1 - b_{ce0}} \right) \right]^2} \pm \frac{2 n_{g0} v_{e0}^2}{c^2} \left[\ln\left(\frac{r - \Lambda r^3 / 3}{r_e - \Lambda r_e^3 / 3} \right) - u(b_{c0}) \ln\left(\frac{1 - b_{c0}}{1 - b_{ce0}} \right) \right] \right\}^{\frac{1}{b_{ce0}}},$$

$$r - \frac{\Lambda r^3}{3} = \frac{(r_e - \Lambda r_e^3 / 3)(1 - b_{c0})^u}{(1 - b_{ce0})^u} \exp\left[\pm \frac{c^2}{2 n_{g0}} \sqrt{v_0^{-4} - v_{e0}^{-4}} \right] = \frac{(r_e - \Lambda r_e^3 / 3)(1 - b_{c0})^u}{(1 - b_{ce0})^u} \exp\left\{ \frac{c^2 v_{e0}^{-2}}{4 n_{g0}} \left[\left(\frac{b_{c0}}{b_{ce0}} \right)^{b_{ce0}} - \left(\frac{b_{ce0}}{b_{c0}} \right)^{b_{ce0}} \right] \right\}.$$

In the Schwarzschild solution of the GR equations with a non-zero value of the cosmological constant Λ, in addition to the Schwarzschild singular sphere, on which only the infinitely distant cosmological future always lies, there is also a singular sphere of the event pseudo-horizon, on which only the infinitely distant cosmological past always lies. Relativistic non-simultaneity in cosmological time τ of events that take place in different locations but simultaneous in the intrinsic time t of matter turns out to be a mutual agreement of the Schwarzschild solutions of the gravitational field equations in CFREU and FR of matter. And this is due to the use of the physically homogeneous scale of its intrinsic time instead of the metrically and spatially homogeneous scale of intrinsic time of the matter. Otherwise, the values of almost all physical parameters and characteristics of the matter would have to be continuously renormalized. It is because of this that on the singular surface (b_c=0) of the event pseudo-horizon, the gravitational "constant" according to the Dirac hypothesis takes an infinitely large value.

And this corresponds to a very slow rate of physical processes ($b_c \approx 0$) in the distant cosmological past near the event pseudo-horizon. Moreover, it actually refutes the incredibly rapid initial rate of physical processes according to the false theory of the Big Bang of the Universe, which localizes the Universe in the distant past at a "point" instead of localizing its distant cosmological past in the observer's FR on a sphere with the maximum possible radius $R_c = (\Lambda/3)^{-1/2}$.

Thanks to: $m_{gre} (d \ln b_c / dr)_e = m_{gre0} (d \ln b_{c0} / dr)_e (n_0 / n)^{3/2}$ $[\ln(v_{lc} / v_{lce}) = v_{lce}^{-2} v_{lce0}^2 \ln(v_{lc0} / v_{lce0})$, $m_{gre} = m_{gre0} v_{lce0} / v_{lce}$, when: $G_{00} = \mathbf{const}(v_{lce})$, $M_{00} = \mathbf{const}(v_{lce})$, $m_{00} = \mathbf{const}(v_{lce})$, $r_e = \mathbf{const}(v_{lce})$], $a_c = a_{c0}$ and $v_e / v_{lce} = v_{e0} / v_{lce0}$, we have the following relations for the centrifugal pseudo-forces of inertia and for the gravitational pseudo-forces in the intrinsic ${}^{ec}FR_g$ of a distant galaxy and in the ${}^{E}FR$ of the observer of this galaxy:

$${}^{g}\mathbf{F}_{ine0} = \frac{m_{ine0} c^2 v_{e0}^2}{r_e v_{lce0}^2} = {}^{E}\mathbf{F}_{ine} \frac{m_{ine0}}{m_{ine}} = {}^{E}\mathbf{F}_{ine} \frac{v_{lce0}}{v_{lce}} = {}^{E}\mathbf{F}_{ine} \sqrt{\frac{n_0}{n}},$$

$$ {}^{g}\mathbf{F}_{gre0} = \frac{m_{gre0}}{2\sqrt{a_{ce0}}}\left(\frac{d\ln b_{c0}}{dr}\right)_e = {}^{E}\mathbf{F}_{gre}\sqrt{\frac{n_0}{n}} = \frac{m_{gre}}{2\sqrt{a_{ce}}}\left(\frac{d\ln b_c}{dr}\right)_e\sqrt{\frac{n_0}{n}} = \frac{m_{gre0}}{2\sqrt{a_{ce0}}}\left(\frac{d\ln b_{c0}}{dr}\right)_e\frac{n_0^2}{n^2} = {}^{E}\mathbf{F}_{gre0}\frac{{}^{ge}G_{00}}{{}^{E}G_{00}}, $$

where: ${}^{g}\mathbf{F}_{gre0} = -{}^{g}\mathbf{F}_{ine0} = -{}^{E}\mathbf{F}_{ine}v_{lce0}/v_{lce} = {}^{E}\mathbf{F}_{gre}\sqrt{n_0/n}$ and ${}^{g}\mathbf{F}_{ine0}$ are the galactic internal values of the gravitational pseudo-force and the centrifugal pseudo-force of inertia acting on star e, respectively; ${}^{E}\mathbf{F}_{gre} = -{}^{E}\mathbf{F}_{ine} = -{}^{E}\mathbf{F}_{ine}v_{lce0}/v_{lce} = {}^{E}\mathbf{F}_{gre}\sqrt{n_0/n}$ and ${}^{E}\mathbf{F}_{ine}$ are the observed external of gravitational pseudo-force and the centrifugal pseudo-force of inertia acting on the star e in the observer's ^{E}FR respectively; ${}^{E}\mathbf{F}_{gre0}$ is the gravitational pseudo-force acting on a similar star in a similar hypothetical galaxy at a distance from the observer $\Lambda^{-1/2}$ ($b_{ce0}\approx 1$).

In the case of using the gravithermodynamic (astronomical) intrinsic time (b_{c0}=1) of a distant galaxy, we obtain the galactic value of the gravitational constant ${}^{g}G_{00} = {}^{E}G_{00}b_{ce}^{-2}$.

Thus, the lack of temporal invariance of the gravitational "constant" refutes not only the Big Bang of the Universe, but also the need for dark non-baryonic matter.

In centric intrinsic FR$_{g0}$ of the galaxy when $u = -c^2v^{-2}/2$ the following typical (standard) radial distribution of the average density of gravitational mass of the matter in the galaxy takes place:

$$ \mu_{grst0} = \frac{m_{00}}{\sqrt{b_{c0}}V} = \frac{2n_{g0}v_{e0}^2(1-\Lambda r^2)(r^{-2} - r_{g0}r^{-3} - \Lambda/3)}{n_0\kappa c^4(1-b_{c0})(1-\Lambda r^2/3)\left(\sqrt{1+A^2} - B\right)} + \frac{2\Lambda/3 - r_{g0}r^{-3}}{\kappa c^2(1-b_{c0})}, $$

$$ A = \frac{2n_{g0}v_{e0}^2}{c^2}\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e - \Lambda r_e^3/3}\right) + \frac{c^2}{2v_0^2}\ln\left(\frac{1-b_{c0}}{1-b_{ce0}}\right)\right], \quad B = \frac{1}{2}\left\{n_{g0}\ln\left(\frac{1-b_{c0}}{1-b_{ce0}}\right)\left[\left(\frac{b_{c0}}{b_{ce0}}\right)^{n_0} - \left(\frac{b_{ce0}}{b_{c0}}\right)^{n_0}\right] - \frac{b_{c0}}{1-b_{c0}}\left[\left(\frac{b_{c0}}{b_{ce0}}\right)^{n_0} + \left(\frac{b_{ce0}}{b_{c0}}\right)^{n_0}\right]\right\}. $$

According to this distribution, when at the edge of the galaxy ($r_p=\Lambda^{-1/2}$=1,1664 10^{26} [m]=3,78 [Gpc] [3, 8, 12]) the gravitational mass density of matter still held by the galaxy in quasi-equilibrium, despite the zero value of the gravitational radius at its boundary (r_{g0p}=0, $b'_{c0p} = 0$, $b_{c0p} = b_{c0\max}$, $r_{g0p}r_p^{-3} = \Lambda^{3/2}r_{g0p} = 0$), becomes non-zero standard:

$$ \mu_{grpst0} = 2\Lambda/3\kappa c^2(1-b_{c0\max}) = H_E^2/4\pi\,{}^{E}G_{00}(1-b_{c0\max}). $$

3. Conclusions

If all stars of the galaxy move in stationary or quasi-stationary orbits, then it can be considered that the galaxy is in a quasi-equilibrium state. According to the RGTD equations, the configuration of the dynamic gravitational field of a galaxy in a quasi-equilibrium state is standard (canonical in RGTD). That is because it is not determined at all by the spatial distribution of the average density of mass of its non-continuous matter. After all, this spatial distribution of the average mass density of the galaxy's matter is itself determined by the standard configuration of its dynamic gravitational field. In the equations of the dynamic gravitational field of RGTD, as in the equations of thermodynamics, not only gravitational, but also relativistic indicators are internal hidden parameters of the RGTD-state of matter in motion. And that is why in RGTD, unlike orthodox GR, the use of an external relativistic description of the state of matter in motion is not always required. The general solution of the equations of the gravitational field of the galaxy with an additional variable parameter n is found. The additional variable parameter n determines in GR and RGTD the distribution of the average mass density mainly in the friable galactic nucleus. The velocity of the orbital motion of stars is close to the Keplerian one only for $n > 2^{34}$. At $n < 2^{34}$, it is slightly less than the highest possible velocity even at the edge of the galaxy. The standard value of the average mass density of matter at the edge of a galaxy is determined by the cosmological constant Λ and the difference between unity and the maximum value of the parameter b_c. And it is a non-zero standard value, despite the gravitational radius at the edge of a galaxy takes the zero value. Therefore, in relativistic gravithermodynamics, in contrast to GR, there can be no shortage of baryonic mass in principle. And, therefore, the presence of non-baryonic dark matter in the Universe is not necessary. The most significant fact is the absence of relativistic dilatation of intrinsic time of galaxies according to received transformations. And this confirms the correspondence of the orbital motion of galactic astronomical objects to GT-Lagrangians and GT-Hamiltonians or to Lorentz-conformal transformation of increments of metrical intervals and metrical time for the galaxies [3, 8]. Besides:

1. At the edge of the galaxy ($r_p \approx \Lambda^{-1/2}$), the excessively strong ordinary (non-reduced) centrifugal pseudo-forces of inertia are compensated mainly by centripetal pseudo-forces of evolutionary self-contraction of matter in the fundamental (background) Euclidean space [2, 3, 8, 13] of comoving with expanding Universe FR, and not by the weak gravitational pseudo-forces at the edge of the galaxy.

2. The strength of the dynamic gravitational field of spiral and other flat (or superthin) galaxies, according to their two-dimensional topology, is inversely proportional to the radial distance, not to its square. And this is the case, despite the inverse proportionality of the strength of individual gravitational fields of all its spherically symmetric astronomical objects exactly to the square of radial distance.

3. The gravitational constant decreases evolutionarily in cosmological time along with the decrease in the average density of matter in the Universe.

4. In the Universe there may be anomalous zones with an increased average density of matter, and therefore with an increased effective value ${}^{E}G_{eeff}$ of the gravitational constant ($\varsigma>1$).

5. Galaxies moving in the picture plane with large meridional or sagittal velocities should also be considered “anomalous”. After all, the proposed dynamic gravitational field assumes only the evolutionary radial distancing of galaxies from the observer and directly (without using the gravitational field anomaly index ς) takes into account only the presence of the orbital motion of the stars of the galaxy.

6. The gravitational potentials of the dynamic gravitational field of flat galaxies do depend on the effective value of the gravitational constant ${}^{E}G_{eeff} = {}^{E}G_{0g}\varsigma / b_{ce} = {}^{E}G_{00}\varsigma b_{ce}^{-2} \approx {}^{E}G_{00}\varsigma (1+z_e)^4 (1+2z_e)^{-2}$.

7. All flat (or superthin) galaxies have only the dynamic gravitational fields in which the velocities v of the hypothetical equilibrium circular motion ($r=\mathbf{const}$) of objects in equilibrium state are already taken into account in the parameter b_c and, moreover, do not depend directly on the radial coordinates r, but depend only on the values of the limit values of the motion velocity of matter $v_{lc} = c\sqrt{b_c}$, and theses galaxies have mainly non-rigid FRs.

8. Along with the decrease in the value of the coordinate vacuum velocity of light v_{cv}, the effective value of the gravitational constant increases. And this is manifested precisely in the non-identity of the gravitational mass, which is equivalent to the Lagrangian of ordinary rest energy, and the inertial mass, which is on the contrary equivalent to the Hamiltonian of only the inert free energy of matter.

9. Dynamic gravitational field corresponds well to flat (or superthin) galaxies in which, at the possible values of parameter $n < 1$, the velocity of the orbital motion of stars is only slightly less than the highest possible velocity even at the edge of the galaxy.

10. There is no relativistic dilation of intrinsic time during the orbital motion of galactic objects.

11. The centrifugal pseudoforces of inertia depend also on the cosmological fundamental constant $\Lambda = 3H_E^2 c^{-2} = \mathbf{const}(t)$ and Hubble fundamental constant $H_E = \mathbf{const}(t)$, exactly the invariance of which in the intrinsic time t of matter ensures in principle the continuity of the spatial continuum of a rigid FR [3, 12].

12. The variable function $u(v)$, the value of the parameter $n=b_{ce}$, the value of the indicator ς of the level of the gravitational field zonal anomaly and the value of mass of the galaxy

loose nucleus, at which there will be no need in dark non-baryonic matter in the galaxy, can be applied to any flat galaxy.

13. Therefore, dark non-baryonic matter may turn out to be the same theoretical misconception and imaginary entity [12] as dark energy, the Big Bang of the Universe and black holes (which are actually neutron stars that have a hollow-body topology and mirror symmetry of their own space [3, 12]).

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