Ignoring the Compensation of Gravitational Time Dilation by Inertial Motion and Other Theoretical Misconceptions and Imaginary Entities in Physics, Astronomy, and Cosmology

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Abstract

The majority of theoretical misconceptions and the most significant misunderstandings in modern astronomy, cosmology and physics are caused by a purely mathematical approach and ignoring philosophical comprehension of physical reality and, as a result, by not deep enough understanding of the essence of certain physical phenomena and objects. Foremost, it's all about phenomena and objects that are under consideration by Special Relativity (SR) and General Relativity (GR). The author has analyzed historical roots of discussed here misconceptions and misunderstandings and has shown the possible ways to overcome them. Such constructive approach gives us the hope for getting rid of the majority of revealed here misconceptions and misunderstandings. Unfortunately, this is the problem of not only the astronomy and cosmology, but also of physics in general. The unreality of black holes, Big Bang, non-baryonic dark matter, dark energy, photons and neutrinos is justified in details. The possibility of existence of antimatter inside the neutron stars and quasars that have the hollow body topology and mirror symmetry of their intrinsic space is justified. The big redshift and long lasting high luminosity of quasars are explained. The spatio-temporal noninvariance of the gravitational constant and the fictiveness of Etherington's identity are proved. The fact that spatial distribution of gravitational field strength, defined by logarithmic gravitational potential, perfectly corresponds to astronomical observations is shown. It is shown that according to the GR and the Relativistic Gravithermodynamics (RGTD) equations, the configuration of the dynamic gravitational field of a galaxy in a quasi-equilibrium state corresponds to reality. The fact that Hubble's redshift is linearly dependent on comoving distance instead of luminosity distance is justified. It is shown that mentioned above fact corresponds to astronomical observations. It is concluded that such concepts as corpuscle and elementary particle are purely macroscopic. The inadmissibility of the presence of "thing-in-itself" in physics is shown.

Keywords: Black hole, Quasar, Big Bang, Dark matter, Dark energy, Neutrino.

Preamble (from the author)

Recently besides the epochal misunderstandings such as dilation of proper time of matter by the inertial motion of bodies, "Big Bang" of the Universe and "black holes" the two more not less significant misunderstandings appeared: "non-baryonic dark matter" and "dark energy". This clearly testifies the presence of protracted crisis in theoretical physics. It gradually becomes the simple handicraft industry instead of creative reflection of reality. The non-correspondence to physical reality, delusions and gaps that were found in very harmonic constructs of special (SR) and general (GR) relativities are started to be hushed up by "Turanians", who are dominant now in scientific circles, or become “patched” by them via the introduction of new material entities (Kantian “things-in-themselves”) instead of reconsidering the physical entities of those theories themselves.

Exactly such primitive approach (as it is brilliantly substantiated by Nikolai Trubetskoy [1]) is characteristic for Turanian simplified-perfunctory and purely holistic worldview and also for the inherited dogmatic-paradigmatic and not very deep comprehension of physical reality.

This crisis started right after the discovery of possibility to construct the relativistic theory of thermodynamics alternative to the theory of Planck-Hasenöhrl by Heinrich Ott [2] and independently of him by Heinrich Arsels [3]. Due to heavy debates on this question H. Arsels told about the “modern crisis of thermodynamics” (and not at all of the dogmatized itself SR). However the majority of physicists came to the conclusion about relativistic invariance of thermodynamics, but still do not understand the fact that it is possible only in case of absence of relativistic dilation of intrinsic time of matter that moves in gravitational field only by inertia. Despite the principal possibility of gravity-relativistic dilation of the intrinsic time of matter, the matter that only moves by inertia in the gravitational field is not affected in principle by this dilation of intrinsic time [4, 5]. And it is guaranteed by more complex Lorentz-conformal relativistic transformations of increments of spatial coordinates and time, which guarantee gravity-relativistic invariance and the conservation (during the process of inertial motion) of not only ordinary rest energy and internal energy of matter, but also of all its other thermodynamic and gravithermodynamical potentials and parameters [5–7]. Exactly those Lorentz-conformal relativistic transformations guarantee the absence of essential difference in the age of twins, and this makes the twins paradox (paralogism) a minor phenomenon. The primitive ordinary Lorentz relativistic transformations correspond not to inertial but to uniform (pseudo-inertial) motion of matter. That is why the tensor of energy-momentum being based on the thermodynamic parameters and characteristics of matter can be formed in general case only in frames of references of coordinates and time (FR) that is comoving only with continuous matter. And, therefore, for non-rigid (for example, naturally cooling down) matter this tensor should be formed not in the metrical space, but in inseparable from matter itself its intrinsic physical space using non-metrical coordinate grid. For the transition to metrical space, in which the single metrical length standard is used, using renormalization of spatial parameters it is necessary to know not only the radial distribution of the magnitude of molar volume of matter, but also the radial distribution of parameters of Lorentz-conformal transformation. And this is, of course, not considered by anyone now. Unfortunately, the folk wisdom “the simplicity is worse than a theft” has been replaced in modern physics with the Turanian statement "everything genius can be only simple".

As it will be shown in this article the fictive necessity of dark energy in the Universe is caused by the wrong usage of non-corrected luminosity (photometric) distance in Hubble relation, as well as by ignoring the absence of relativistic dilation of intrinsic time for far galaxies that only freely (by inertia) fall onto the event pseudo-horizon. The identification of uniform (pseudo-inertial) motion with inertial motion in SR also contributes to this.

Of course, in simplest cases, for example, in case of uniform (pseudo-inertial) radial motion and, possibly, also in case of pseudo-equally-slowed-down (according to Möller) radial motion of naturally cooling down matter, the solutions of equations of gravitational field of GR can be obtained also in non-comoving with matter spaces and in particular in comoving with expanding Universe FR. And, at least, standard Lorentz transformations of increments of spatial coordinates and times are applicable for uniform (pseudo-inertial) radial motion of objects of rigid body that is evolutionary self-contracting in comoving with expanding Universe FR. But for the motion of matter by inertia in a gravitational field, the Lorentz transformations of increments of spatial coordinates and time are unsuitable at all. After all, the motion of matter by inertia does not cause dilation of its proper time, but on the contrary compensates for the gravitational dilation of its proper time. And this is confirmed not only by the gravitational-relativistic invariance of thermodynamic parameters and potentials of matter, but also by the equations of motion of the planets of the Solar System.

The legitimacy of usage in the tensor of energy-momentum of continuous matter of extranuclear (thus thermodynamic) parameters and characteristics instead of intranuclear was substantiated by Richard Tolman [8], who de facto proved the mutual consistency (correlation) of extranuclear and intranuclear parameters and characteristics of continuous matter. In the quasi-equilibrium state of matter the product of absolute temperature, that characterizes the intensity of extranuclear thermodynamic processes, and coordinate vacuum velocity of light v_{cv}, that characterizes the intranuclear state of matter, is the spatially homogenous magnitude. However, such correlation is absent for the non-continuous matter of the galaxies and that is why the tensor of energy-momentum of non-continuous matter of the galaxy should be formed only based on relativistically non-invariant intranuclear parameters and characteristics of matter. It was for a reason that Albert Einstein himself had doubts that universal structure of tensor of energy-momentum is possible and compared it with the low quality timber in comparison to metrical tensor, which he compared with elegant marble.

All these misunderstandings are caused by a distorted physical interpretation of the theory of relativity itself and by the not deep enough understanding of physical essence of different forms of such main physical concepts as space and time and also by the not having knowledge about physical processes hidden behind the mathematical model of space-time continuum (STC). Both the revealed by Henri Poincaré physical nature of the curvature of intrinsic space of matter and the revealed by Hermann Weyl possibility of non-observable in principle in people's world gauge deformation of matter on the level of its microobjects and, consequently, of corresponding to it STC are de facto ignored. Moreover, not all people understand the united nature of thermodynamic and gravitational properties of matter, according to which the equations of gravitational field of GR are the equations of spatially inhomogeneous gravithermodynamic state of gauge evolving matter. The neglecting of the principal unrealizability of singularities in GR (taking into account the correspondence of zero value of velocity of light v_{cv} only to infinitely large values of absolute temperature and pressure), as well as the neglecting of possibility of self-organization by matter and antimatter of mirror symmetric configuration of intrinsic space, are responsible not only for the replacement of ultra massive hollow neutron stars by "black holes", but also for the non-understanding of the nature of ultra high luminosity of quasars and supernovas. Non-perception of the fact that the Universe cannot be homogeneous in principle in intrinsic STCs of astronomical objects and the false identity (paralogism) of Etherington (that is based on the imaginary dilation of intrinsic time of inertially moving far galaxies) are responsible for the fictive necessity of phantom "dark energy" in the Universe. Non-understanding of the fact that tensor of energy-momentum should be formed not being based on the external thermodynamic characteristics, but namely being based on the intranuclear gravithermodynamic characteristics of non-continuous matter, is responsible for the fictive necessity of phantom "non-baryonic dark matter" in the Universe.

The ignoring of spiralwave nature of matter [9] and the fact that Universe eternally existed [10], and not making the difference between infinite coordinate-like cosmological time and finite in the past path-like cosmological time is the reason why scientific community accepted the naive theory of "Big Bang" of the Universe.

The scientific research made by author, results of which are described in the proposed for consideration work, is dedicated to the justification of everything mentioned above.

Introduction

Tensor equation of gravitational field of GR can be represented using either curvature of Riman's space-time continuum (STC) or metric inhomogeneity and metric instability of pseudo-Euclidean space [11, 12]. The solution of this equation in metrically homogeneous Riman's STC corresponds to the solution in the background pseudo-Euclidean space [13]. This background Euclidean space is metrically inhomogeneous. Either metrically homogeneous time scales or exponential time scales can be used in such space [11, 12]. Such metrically inhomogeneous scales allow performing conformal transformations of time. Either infinitely far past or infinitely far future can become finite due to such time transformations.

General covariance of formulation of physical laws regarding the transformations of spatial coordinates and time in GR takes place during the transition from any stable and metrically homogeneous frame of reference of spatial coordinates and time (FR) to another stable and metrically homogeneous FR. In metrically instable and inhomogeneous spaces the dimensions of length standard are different at different moments of time in the same point and also at one moment of time in different points. Therefore, not only metrical and physical characteristics of distant in time or space objects and events, but also fundamental physical constants should be renormalized in FR of such spaces [14]. Such renormalization should be done even when there was no transition to another point of observation in space.

The concept of Universe homogeneity may be applied only to comoving with expanding Universe FR (CFREU). In CFREU (Weyl's FR) the radial distancing of galaxies from the observer is absent. Mutually proportional evolutional shrinkage of length standard and of all macro and micro objects of matter takes place in CFREU instead. All infinite fundamental space of CFREU is covered by the event horizon (pseudo-horizon of the past) in the gravithermodynamic FR (GT-FR) [4, 15, 16] of evolutionally self-contracting matter. Relativistic failure to comply with simultaneity of simultaneous in CFREU events takes place in GT-FR. As a result, only infinitely far cosmological past is simultaneous with any event in people's world (in GT-FR) on this pseudo-horizon [11, 12]. Metrical distance to the event horizon, thereby, tends to infinity while approaching event horizon. And this takes pace regardless of the finite value of the Schwarzschild radial coordinate r_c of this pseudo-horizon. Thus, concentration of astronomical objects in GT-FR inevitably increases while approaching this pseudo-horizon of the past and, consequently, while deepening into cosmological past. Therefore, the Universe can not be homogeneous in GT-FR's intrinsic space in principle.

Thermodynamical interpretation of General Relativity [5, 16], consideration of the Universe as a single spiral-wave formation [9], and consideration of the so-called elementary particles and quarks as finite local flows of these spiral waves [11, 17] actually allowed the creation of a "theory of everything" [18, 19], which would explain, in fact, everything in the world within the framework of a single model.

In an extremely rarefied substance, one micro-object may correspond to a very large volume of outer space, filled with a very large number of pairs of terminal local sinks and sources of turns of spiral waves (that are now conditionally considered respectively as virtual “particles” and virtual “antiparticles”). Nearby virtual “antiparticles” can annihilate the particles of this micro-object with the de Broglie frequency, and instead of it, a new micro-object similar to it can be actualized at a large distance with a probability that is less, the greater its distance from the original annihilated micro-object is. And this agrees well with quantum mechanics, which states that a micro-object can be detected with a certain probability at any point in space. And besides, this does not at all contradict either classical physics, SR and GR, or the relativistic gravithermodynamics (RGTD) [5, 16], since such a seemingly instantaneous transposition of a micro-object is not associated with the transfer of energy faster than the velocity of light v_{cv}. It is simply replaced by a new micro-object in a new location. Although at any moment in time a new micro-object can theoretically take, with a certain probability, any of a large number of microstates, this does not mean that it is simultaneously in several microstates. There is simply a change (with the de Broglie frequency) of microstates of micro-objects (which are similar to and replace the annihilated micro-object), depending on many random factors. All this indicates the advisability of considering not the individual behavior of any object, but the changes (with de Broglie frequencies) in the collective spatiotemporal microstates of all gravitermodynamically interconnected micro-objects of both the object under study and the measuring instruments used in the research process. The change of these microstates is carried out by the influx of the next turn of spiral waves of space-time modulation of the dielectric and magnetic permeability of the physical vacuum onto all microobjects.

Although the simultaneous spontaneous inversion of wave fronts of all microobjects of matter (and thus mutual transformation of matter into antimatter and of antimatter into matter when the Universe expansion in FR of people’s world is changed to Universe self-contraction) is as it were fundamentally possible, the Universe self-contraction itself in FR of people’s world is impossible. After all, this could have led to replacing evolution with degradation of all macroobjects of the Universe and eventually to the predominance of antihydrogen in it.

Relativistic invariance of thermodynamics [5, 6, 16] indicates the fundamental impossibility of slowing down of the rate of intrinsic time of the matter that moves by inertia in surrounding gravitational field at any speed. So, the simple Lorentz transformations (and not the more general conform-Lorentz transformations) of the increments of spatial coordinates and time are not inherent in the motion of matter by inertia in the gravitational field. They are inherent only in the uniform motion of matter and, first of all, in the process of evolutionary self-contraction of its microobjects in CFREU.

Imaginary Black Holes

Relativistic non-simultaneity in cosmological time τ of differently locative events that are 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 GT-FR [5, 12]. For the reasons[2] mentioned above, only the infinitely far cosmological future is always present on Schwarzschild's singular sphere [11, 12, 20]. Finite value of its radius r_s in GT-FR corresponds to zero value of its radius $R_S = 0$[3] in the background Euclidean space of CFREU. This fact corresponds to hypothetic self-contraction (into "point") of any object (in CFREU) in infinitely far cosmological future. That is the reflection of conformality of both infinity and zero [21]. That's why the very suggestion about possible collapse of the matter from outside to the inside of the fictive Schwarzschild sphere and into infinitely far cosmological future is frankly absurd. The same conclusions can be made based on the solutions of GR equations for spatially inhomogeneous thermodynamic state of matter. Tending of coordinate velocity of light to zero while approaching real singular surface always corresponds only to the tending of temperature and pressure of matter to infinity [10, 11, 15, 22–24].

Therefore, real singular sphere can be only median sphere [11, 12, 25]. It can separate external matter from internal antimatter in hollow astronomical bodies. Thus, catastrophic annihilation of matter and antimatter is prevented. Therefore, extraordinary neutron stars can be considered by mistake as compact or supermassive "black holes". Those extraordinary neutron stars have the hollow body topology in the background Euclidean space and mirror symmetry of intrinsic Riman's space (see Fig. 1).

[2] Exactly due to relativistic non-simultaneity in CFREU of events that are simultaneous in GT-FR.

[3] Thus, due to the evolutionary self-contraction of matter, it takes zero size in the infinite background Euclidean space not in the distant past. Zero size could hypothetically be taken by all "island" galaxies, but only individually and in the infinitely distant future. In fact, it will never happen.

Herewith the internal space inside the singular sphere is “turned inside out” like the shirt that is worn inside out [11, 12, 25]. That is, in internal empty space of antimatter its concave spherical surface is perceived as being convex. Due to strong gravitational field in intrinsic space the eigenvalues of the area of covering spheres is not more but less than eigenvalues of the area of covered by them spheres.

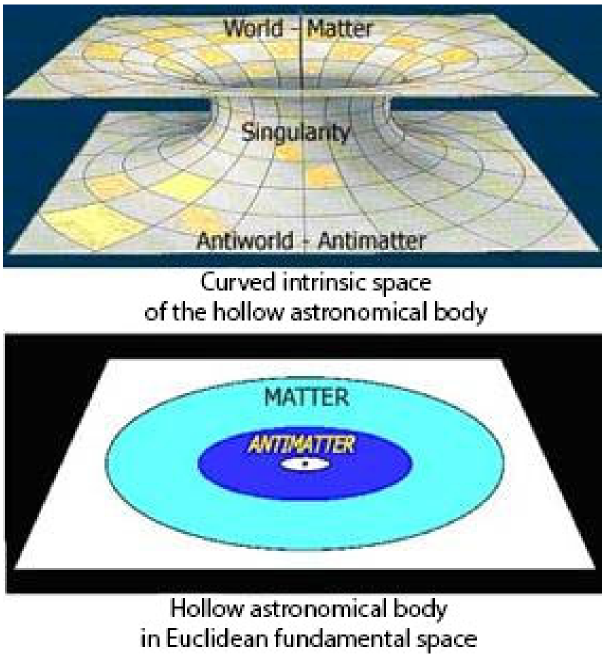

Fig.1. Curved intrinsic space of the hollow astronomical body and this body in Euclidean fundamental space of CFREU.

The possibility of existence of such unusual bilayered topology of astronomical bodies is confirmed by the solutions of equations of GR gravitational field. This is confirmed not only in GT-FR, but also in CFREU. Internal surface of hollow astronomical body is convex in its STC. At the same time the phenomenon of contraction of “internal Universe” takes place in internal intrinsic “empty” space covered by that internal surface. The "lost" Fuller-Wheeler antiworld is located in the inner half-space of the hollow body. After all, unlike the outer half-space, it contains antimatter, not matter. Only such phenomenon is acceptable for the long-lived existence of antimatter (diverging spiral wave formations) [9–12, 16, 23, 24]. Universe expansion phenomenon is acceptable only for the long-lived existence of matter (converging spiral wave formations).

Quasars

Bilayered shell-like quasars also have mentioned above topology. The thickness of both external layer of all matter and internal layer of all antimatter of such quasars are much less that the radius r_S of median singular sphere. Therefore, the photosphere of bilayered shell-like quasars is very close to the singular sphere. As a result, such quasars have very big gravitational shift to the red area of spectrum of radiation frequency v. The observed gravitationally-Dopler-like redshifts of wavelength $\lambda = c/v$ of the quasars radiation spectra are much bigger than mostly the Dopler redshifts $z = \Delta\lambda_D/\lambda_0$ of the radiation spectra of the stars from galaxies that surround that quasars. Continuous gradual annihilation of matter and antimatter, apparently, guarantees extra long-lived ultrahigh luminosity of quasars [11, 12, 25].

The mass of bilayered shell-like quasar and the radius of its median singular sphere can be determined based on excess of redshift of quasar radiation spectrum (compared to the Doppler redshift of surrounding stars in the galaxy) and imaginary deficit of baryonic matter.

It is possible, of course, that the majority of quasars are the loose nuclei of the galaxies that have the topology of hollow body in background Euclidean space and the mirror symmetry of intrinsic space. Then, namely near the sphere with minimum possible value of Schwarzschild radius, there is a maximum of velocity of rotation of external stars that consist from matter as well as of internal stars that consist of antimatter. The catastrophic annihilation of these stars does not happen due to the high velocity of their orbital motion.

If the value of radius $r_e = R_{t/e}$ of the surface of "loose nucleus" of the galaxy is the minimum possible in mirror symmetric configuration of intrinsic space of the galaxy (when in CFREU $(dr/dR)_e = 0$ and $(dv_{cv}/dR)_e = 0$, then its "loose nucleus" will de facto be the antiquasar. Where:

$$r = r_e(1+\tilde{R}/R_e)(1+R_e/\tilde{R})/4 = [r_e + \tilde{R}_t(\tau)][1+r_e/\tilde{R}_t(\tau)]/4,$$

$$\tilde{R}_{t/inside}(\tau) = \psi R(t) + r_c(1-\sqrt{1-r_e/r_c})^2 = r\left(1-\sqrt{1-r_e/r}\right)^2, \qquad r_c = c/H_E,$$

$$r_e^2/\tilde{R}_{t/outside}(\tau) = \psi r_e^2/R(t) + r_c(1-\sqrt{1-r_e/r_c})^2 = r\left(1-\sqrt{1-r_e/r}\right)^2 = \tilde{R}_{t/inside}(\tau), \quad \psi = 1-\left(1-\sqrt{1-r_e/r_c}\right)^2 r_c/r_e,$$

$$R_{inside}(t) = r\left(1-\sqrt{1-r_e/r}\right)^2/\psi - r_c\left(1-\sqrt{1-r_e/r_c}\right)^2/\psi, \qquad R_{inside}(t,r)R_{outside}(t,r) = r_e^2,$$

$$\frac{1}{R_{outside}(t)} = \left[\left(1+\sqrt{1-r_e/r}\right)^{-2}/r - \left(1+\sqrt{1-r_e/r_c}\right)^{-2}/r_c\right]\frac{1}{\psi} = r_e^{-2}\left[r\left(1-\sqrt{1-r_e/r}\right)^2 - r_c\left(1-\sqrt{1-r_e/r_c}\right)^2\right]\frac{1}{\psi} = R_{inside}(t)r_e^{-2},,$$

$\tilde{R} = \tilde{R}_t(\tau)R_e/r_e$ and $\tilde{R}_t(\tau)$ are the values of the radial coordinate R in CFREU; τ is the cosmological time measured in CFREU.

And, consequently, all stars of loose nucleus of galaxy will consist of only antimatter. The solution of equations of gravitational field of GR in background Euclidean space [11, 16, 25] confirms the principal possibility of existence of such "loose" structure of galaxies.

Imaginary Big Bang

In FR of people's world the Sun that "rotates" around the Earth has large kinetic energy of rotation. However, we ignore the fact that the Sun has this energy because we know well that the Earth rotates around its axis. Already Hermann Weyl [26, 27] proved that there exists such FR where only peculiar motion of distant galaxies takes place (where their radial motion is absent). Why then we grant "dark energy" to the whole Universe and not to the separate island galaxies within it. After all the Earth, together with its whole galaxy and all standards of length, is the collective spiral-wave formation that is gauge-self-contracting in the outer space [9]. And all of them together evolutionary decrease in infinite fundamental space of the Universe. The same applies to all other island galaxies.

Only two known solutions of equations of GR gravitational field can be juxtaposed to expanding Universe. Those are: Schwarzschild solution [28] when the value of cosmological constant is $\Lambda = 3H_E^2 c^{-2}$ [12], which corresponds to the local representation of the process of Universe expansion, and Friedman solution when $\Lambda = 0$ [29] ($\Lambda \neq 0$ in ΛCDM model [30]), which corresponds to the global representation of the process of Universe expansion.

According to Schwarzschild solution and Einstein hypothesis distant galaxies are falling free on the "event horizon" constantly moving along the geodesic lines of space-time continuum (STC) of their observer. They fundamentally cannot reach that pseudo-horizon of the past because it belongs (at any moment of observer's time) to infinitely far cosmological past (in coordinate cosmological time) as well as to infinitely distant objects of the Universe in its background Euclidean space [13] of the CFREU. And this is, of course, related to the conformality [21] of these two infinities that are mutually compensated in the gravithermodynamic FR (GT-FR) [4, 5, 16] of Schwarzschild solution. Exactly in this the background Euclidean space of the Universe, where physical vacuum rests [11, 12], according to Weyl hypothesis [26, 27] galaxies perform only small peculiar moves. And standards of length are evolutionally decreasing together with all objects of matter in this space.

So any proto-micro-object of the Universe that has negligibly small mass ($r_g \approx 0$), according to Schwarzschild solution in background Euclidean space $r = r_c R/(r_c + R) = cR/(c + H_E R)$ in infinitely far cosmological past had its own space that was limited by the sphere of maximal radius $r_{\max} = r_c \approx 4812.4$ $[Mpc]$ and that covered all infinite space of the Universe ($R_{\max} = \infty$). Of course, in infinitely far past it could be only some “bouillon” of proto-micro-objects (spiralwave self-formation in the Universe). However, according to Schwarzschild solution we can not say about any creation of matter and space from some point object. So, the Universe protomatter (spiralwave self-formation in the Universe) existed eternally and took certain volume in intrinsic space covering by itself the whole infinite space of the Universe.

Friedman solution due to negligibly small values of average density of mass in the Universe (comparing to $3H_E^2/4\pi G$) and pressure in the outer space (comparing to $3H_E^2c^2/4\pi G$) is the special case of the Schwarzschild solution in the background Euclidean space of the Universe: namely in the FR of physical vacuum [11, 12] of identical CFREU when the value of gravitational radius of astronomical object, from which the observation of Universe expansion is performed, is negligibly small. In contrast to Schwarzschild solution that includes the events pseudo-horizon in the equations of Friedman solutions (as well as in the equations of Schwarzschild solution in background Euclidean space) the event pseudo-horizon (on which the speed of light is equal to zero) is absent. This denotes the absence of the Hubble radial motion of galaxies and, thus, the absence of relativistic effects in the space of Friedman solution. Galaxies in this space perform only small peculiar moves while distances between them are increasing in this space due to mutually proportional decreasing of the dimensions of both length standards and all material objects in this space. This, of course, requires the constant renormalization of non-normalized spatial parameters to align them with the new values of the size of length standard.

Thus, there fundamentally cannot be any radial motion of objects in Friedman solution because of the absence of singular surface of event horizon in this solution. Therefore, Doppler Effect and other relativistic effects related to motion are not applicable for this solution.

Gravitational dilation of time, counted by quantum clock, takes place in GT-FR. Therefore, it makes sense to call this dilated time as gravity-quantum time, and to call all correspondent to that time values of physical characteristics as gravity-quantum values. The gravity-quantum time of any certain observer can be proportionally synchronized with the unified astronomical coordinate time (gravithermodynamic time [10, 16]) t_E owing to the possibility of proportional synchronization of all gravity-quantum clocks in GT-FR of Earth. Thus, that gravity-quantum time will also be proportionally synchronized with the cosmological time τ, counted in the point of observer’s disposition according to metrically homogeneous scale of cosmological time (CTMHS).

Comparison of the solutions of equations of GR gravitational field with cosmological Λ-part in GT-FR and in CFREU shows that precisely Λ-part is responsible for Hubble's expansion of the Universe [11, 12]. The value of Hubble constant is also determined by this Λ-part: $H_E = c\sqrt{\Lambda/3}$. Λ-part also limits the maximal value of Schwarzschild radius $r_c \approx c/H_E = (3/\Lambda)^{1/2}$ in the space of GT-FR. However it does not form the horizon of past events in GT-FR and CFREU [11, 12]. World points of the pseudo-horizon, formed by Λ-part in GT-FR, correspond to infinity in space and time in CFREU. Mentioned above fact guarantees the possibility of existence of infinitely far cosmological past in CFREU when use CTMHS [10, 31, 32].

According to the Friedman's solution of equations of GR gravitational field for the flat space, the Universe expands strictly exponentially. Therefore, its size should asymptotically tend to zero while deepening into infinitely far past.

And the theory of Big Bang of the Universe (that is based on its origination from a point) is false. After all the spherical surface that corresponds to infinitely far past of cosmological time has not zero, but, quite the contrary, maximum possible value of photometric radius in FR of people's world $r_c \approx c/H_E = (3/\Lambda)^{1/2}$.

However, the time that corresponds to any event of the past is finite in principle. That's why instead of infinite coordinate cosmological time finite path-like cosmological time is set in the Universe based on the imaginary primacy of any specific event. Of course, that time is based on assumed finiteness of the far past in the Universe. Big Bang of the Universe has been proclaimed as such fictive primary event.

Therefore, infinite cosmological coordinate time [33] and finite cosmological intrinsic time should be distinguished. The former is based on the infinitely long evolution of the Universe both in the future and in the past. The latter defines only the nominal age of the Universe approximately from the moment of spontaneous transformation of its protomatter into continuous hydrogen medium. Not very long in time but turbulent course of events until the creation of continuous hydrogen environment of the Universe indicates the usage of exponential scale of path-like (age) cosmological time instead of metrically homogeneous scale in cosmology.

Of course, the Friedman solution of equations of gravitational field of GR with zero value of gravitational constant is applied to the globally non-bonded matter of the Universe. The Universe has island structure [34 – 36]. Within the limits of each “island” (galaxy or the group of gravitationally bonded galaxies – small island “universe”) cosmological constant is not equal to zero and its value $\Lambda = 3H_E^2 c^{-2}$ is strictly determined by the value of Hubble constant. The absence of the “center of masses” of unified gigantic stellar formation in the Universe makes the applicability of equations of gravitational field of GR to the description of the properties of the entire set of "islands" of the Universe (the entire island Universe) questionable. All these islands in the Universe perform only small peculiar movements in fundamental space of CFREU, while their radial movements in GT-FR of observer are caused by evolutionary self-contraction of the sizes (in CFREU) of spiral-wave self-formations that correspond to all microobjects and macroobjects of matter. The Hubble constant, as well as intrinsic value of velocity of light, is fundamentally invariable magnitude since it ensures the continuity of the spatial continuum in rigid FRs [37] and, thus, also in FR of people´s world. And that is why it can gradually change only in non-rigid FRs [38]. After all, the invariance (in time) of the Hubble constant is the main sign of the rigidity of intrinsic FR of the observer. That is why the introduction of non-zero value of cosmological constant into Friedman solution does not have physical sense (as, obviously, there is no sense in the application of this solution for gravitationally non-bonded island objects of the Universe).

The one more thing is that we should not exclude is the possibility that GR can be inapplicable to the description of the universe evolution in far cosmological past – before the breaking (disruption) of its uniform gas continuum. Gravitational fields originate in Universe only after that discontinuity.

On the inapplicability of GR for describing the evolution of matter and the Universe as a whole up to the moment of the breakdown of its gas continuum

Firstly, on the very early stages of matter evolution many notions used in GR were inapplicable to that matter. Even nowadays, macroscopic metrics is not very applicable to the description of the microworld. That is because of physical inhomogeneity and instability of intrinsic spaces of matter microobjects.

Secondly, even after primary hydrogen was formed there were no forces of gravitational attraction between its atoms. In contrast, positively charged nuclei of hydrogen repelled one another [12]. Thirdly, the gravitational gradients of coordinate velocity of light were absent in Universe gas continuum before its breaking. Therefore, no gravitational field yet existed [12].

That’s why it should be admitted that gravity is the purely macroscopic thermodynamic phenomenon [5, 10, 15, 16, 23, 24]. It is based on the presence of gradients of coordinate velocity of light in the space and on tending of the whole gravithermodynamically bonded matter to the collective state with the minimums of integral values of its inert free energy [4, 5] and thermodynamic Gibbs free energy. Such state could self-organize only after the discontinuity of entire gas substance of the Universe. Spatial gradients of coordinate velocity of light spontaneously originated as a result of that discontinuity. This finally caused the nonconservation of the momentum of matter microobjects. And, thus, this caused the gradual mutual attraction of those microobjects in the process of electromagnetic and other interactions.

Therefore, tensor equations of GR gravitational field is, in fact, the equation of self-organized spatially inhomogeneous gravithermodynamic state of matter [5, 15, 16, 23, 24]. Such state of matter corresponds to the minimums of integral values of its inert free energy and thermodynamic Gibbs free energy. This equation connects the energy-momentum tensor with the tensor of curvature of space-time via only the gravitational constant. Therefore it is based on the laws of classic thermodynamics as well as on the ability of matter to self-deformate in the background Euclidean space on the level of its microobjects. Thus, the curvature and physical macroinhomogeneity of the space of gravithermodynamically bonded matter and the gravitational field that corresponds to that macroinhomogeneity are formed. And only the cosmic rays can be considered as the gravitational radiation (gravitational waves). Other types of gravitational waves that transfer the energy cannot exist. And therefore, hypothetical gravitons, which would be responsible for both the gravitational (inhomogeneous spatial) and the evolutionary self-compression of micro-objects in the CFREU, are not needed by the Universe at all.

Therefore, usage of GR tensor equation to describe the Universe evolution before the breaking of its uniform gas continuum is, for sure, the nonsense. There was no spatial inhomogeneity of thermodynamic state of matter and, therefore, no gravitational fields and gravitational waves at that time.

Evolutional self-contraction of terminal spiral wave formations in CFREU that correspond to hydrogen nuclei (protons), for sure, took place not only after but also before the breaking of Universe gas continuum [5, 9, 11, 12, 16, 23, 24]. However it did not have any relation to the gravity (gradients of coordinate velocity of light) that originated later. That self-contraction should be determined by equations and dependences of the synergetics and not the GR.

Spatio-temporal noninvariance of the gravitational constant

There are two types of time in GR: intrinsic gravity-quantum metrical time and unified astronomical coordinate time. The dilemma of the usage of one of those times (metrical or coordinate) in the formulation of certain physical laws is quite up to date.

Coordinate pseudo-vacuum velocity of light $v_{cvj}(r) = cb_j^{1/2}$ is determined in GR for certain point *j* in unified (for all gravithermodynamically bonded matter of the Earth) coordinate astronomical time t_E. It is equivalent (but not identical) to the limit velocity v_{lj} of matter individual (separate) motion in RGTD [4, 5, 16, 23] and its value depends on Schwarzschild radial coordinate *r* of that point. It decreases in GT-FR while approaching the pseudo-horizon or the gravity center. The spatial distribution of the gravithermodynamic values of the limit velocity of matter motion in the intrinsic pseudo-centric ^{ic}FR of point *i* is not identical to it in other pseudo-centric ^{ic}FRs or even in truly centric FR_0:

$$^{i}v_{lj} = c(v_{lj} / v_{li}) \neq {}^{i}v_{l0j} = c(v_{l0j} / v_{l0i}) .$$

The thing identical in different pseudo-centric ^{ic}FRs is the spatial distribution of only the gravity-quantum values $^{ic}v_l$ of the limit velocity of matter motion, which also depends on the limit velocity of matter motion v_{li} at point *i* of the disposition of the real or supposed observer:

$$^{ic}\vec{v}_{lj} = c(\vec{v}_{lj} / \vec{v}_{li})^{(v_{li}/c)^2} = c(v_{l0j} / v_{l0i})^{(v_{l0i}/c)^2} = \mathbf{invar} \quad \left[{}^{ic}b_j = (b_j / b_i)^{b_i/2} = {}^{ic}b_{0j} = (b_{0j} / b_{0i})^{b_{0i}/2} = \mathbf{invar}\right].$$

Here: v_{l0j} and v_{l0i} are the values of limit velocity of matter motion in intrinsic centric $^{ic}FR_0$ of prospective observe in a far away galaxy.

Metric eigenvalue of the limit velocity of matter motion, like the pseudo-vacuum velocity of light is the spatio-temporal invariant (gauge-invariant and Lorentz-invariant constant) by intrinsic clock. This eigenvalue (proper value in Special Relativity) is equal to the constant of velocity of light in any point of space: $^{i}v_{li} = {}^{j}v_{lj} = c$. Obviously, Newton's momentum $\mathbf{P}_{\mathrm{N}j} = m_{00}c(v_j / v_{lj}) = \mathbf{invar}(t_i)$, like Kepler's momentum $\mathbf{P}_{\mathrm{K}\,j} = m_{00}cv_j(v_{lj}^2 + v_j^2)^{-1/2} = m_{00}c(v_j / v_{lcj}) = m_{00}\hat{v}_j$ of matter does not depend on the rate of gravity-quantum time, which is not equal in the points with different gravitational potential. Therefore, the values in FR of inertial and gravitational mass will be expressed via proper rest mass (eigenvalue of mass) m_{00} in the following way

$m_{in0j} = m_{00} v_{lj} / c = m_{00} b_j^{1/2}$ and $m_{gr0j} = m_{00} v_{lj} / c b_j = m_{in0j} / b_j = m_{00} c / v_{lj}$. And their gravity-quantum values will be as follows:

$$^{ic}m_{in0j} = m_{00}\, {}^{ic}v_{lj} / c = m_{00} (v_{lj} / v_{li})^{c^{-2} v_{li}^2} = m_{00} (b_j / b_i)^{b_i / 2},$$

$$^{ic}m_{gr0j} = m_{00} c / {}^{ic}v_{lj} = m_{00} (v_{li} / v_{lj})^{c^{-2} v_{li}^2} = m_{00} (b_i / b_j)^{b_i / 2}.$$

Obviously, proper rest mass m_{00} can be equal for homogeneous matter in gravitational field only in case of presence of its thermodynamic quasi-equilibrium.

As it was shown by Tolman [8] and as it follows from the Schwarzschild internal solution for incompressible ideal liquid [41], the gravitational forces in it are proportional to enthalpy $H_{T0} = U_0 + pV = H_{T00} c / v_{lj}$, (where: H_{T00}=$\mathbf{const}(r)$), which is not decreasing in contrast to inert free energy E, but, quite the contrary, is increasing while approaching the gravitational attraction center. And since for quasi-equilibrium cooling down matter $(pV - ST)/W_0 = \mathbf{const}(r)$, then the ordinary rest energy of matter $^{i}W_{0j} = W_{0j} / {}^{i}v_{lj} \equiv G_{0j} / {}^{i}v_{lj} = (G_j - U_{ad}) / {}^{i}v_{lj}$ (which is the identical multiplicative component G_{0j} of the Gibbs free energy G_j) is also inversely proportional to coordinate velocity of light. Where p is the pressure, V is the molar volume, $U_{ad} = \mathbf{const}(r)$ is the additive compensation of multiplicative transformation of multiplicative component $G_{0j} \equiv W_{0j} = m_{gr0j} c^2 = m_{00} c^3 / v_{lj}$ [4, 5] of Gibbs free energy G_j of matter. And, consequently, the equivalence of gravitational mass of rest to the inertial mass of rest $^{i}m_{in0j} = m_{00}\, {}^{i}v_{lj} / c$ (that is used in Hamiltonian) takes place only by the intrinsic gravity-quantum clocks of point j ($^{j}m_{gr0j} \equiv {}^{j}m_{in0j}$).

Thus: $^{E}v_{lj} = (1 - 2\, {}^{E}G_{00}\, {}^{S}M_{gr0E}\, c^{-2} / r_j)^{1/2} = (1 - 2\, {}^{E}G_{00}\, {}^{S}M_{in0E}\, {}^{S}v_{lrE}^{-2} / r_j)^{1/2} = (1 - 2\, {}^{E}G_{eq} M_{in0E}\, c^{-2} / r_j)^{1/2}$ in gravitational field of the Earth and similarly:

$$^{S}v_{lE} = (1 - 2\, {}^{S}G_{00} M_{gr0S} c^{-2} / r_E)^{1/2} = (1 - 2\, {}^{S}G_{eq} M_{in0S} c^{-2} / r_E)^{1/2}$$

in gravitational field of the Sun, where: $M_{gr0E} = M_{00E} c / {}^{S}v_{lrE} = M_{in0E} c^2 / {}^{S}v_{lrE}^2$ and $M_{gr0S} = M_{00S} c / {}^{g}v_{lrS} = M_{in0S} c^2 / {}^{g}v_{lrS}^2$ are gravitational masses of rest of the Earth and the Sun correspondingly in FR of the Sun and in FR of the galaxy; $M_{in0E} = M_{00E}\, {}^{S}v_{lrE} / c$ and $M_{in0S} = M_{00S}\, {}^{g}v_{lrS} / c$ are the inertial masses of rest of the Earth and the Sun correspondingly in the FR of the Sun and in FR of the galaxy; M_{00E} and M_{00S} are their masses in intrinsic FRs;

${}^{S}v_{lrE}={}^{S}v_{lE}(1-{}^{S}v_{E}^{2}\ {}^{S}v_{lE}^{-2})^{-1/2}$ and ${}^{g}v_{lrS}={}^{g}v_{lS}(1-{}^{g}v_{S}^{2}\ {}^{g}v_{lS}^{-2})^{-1/2}$ are coordinate pseudo-vacuum velocities of light that correspond to the Earth in FR of the Sun and to the Sun in FR of the galaxy in hypothetic state of their rest in these FRs; ${}^{S}v_{E}$ and ${}^{g}v_{S}$ are velocities of motion of the Earth in FR of the Sun and of the Sun in FR of the galaxy; ${}^{E}G_{eq}={}^{E}G_{00}c^{2}/{}^{S}v_{lrE}^{2}$ and ${}^{S}G_{eq}={}^{S}G_{00}c^{2}/{}^{g}v_{lrS}^{2}$ are the equivalent real values of Terrestrial and Solar gravitational constants relatively to inertial masses of the Earth and the Sun correspondingly.

Moreover, in contrast to the constant of velocity of light, gravitational constant G is not spatio-temporaly invariant constant. Its gravity-quantum values on Earth ${}^{iE}G_{00}={}^{E}G_{00}v_{li}^{2}c^{-2}$ and ${}^{iE}G_{eq}={}^{E}G_{00}\,{}^{S}v_{lrE}^{-2}v_{li}^{2}$ depends on Schwarzschild radial coordinate of the point i of observer disposition. And, consequently, gravitational constant is non-invariant in relation to the transformation of time rate when switch to the time count by another quantum clock. Therefore, gravity-quantum value of gravitational constant ${}^{iE}G_{00}$ cannot be equal to solar gravitational constant ${}^{S}G_{00}$. This gravitational constant ${}^{S}G_{00}$ is determined in the coordinate astronomical time t_S unified for the whole gravitationally-bonded matter of Solar system. All the more so, ${}^{iE}G_{00}$ is not equal to Universe gravitational constant ${}^{U}G_{00}$, that is determined in coordinate cosmological time τ. Solar value ${}^{S}G_{00}$ that is used nowadays in astronomy slightly exceeds both Universal value ${}^{U}G_{00}$, and galactic values ${}^{g}G_{00}$.

But, of course, galactic values of gravitational constant: ${}^{g}G_{00}={}^{U}G_{00}\,{}^{U}v_{lg}^{-2}c^{2}$ could significantly exceed not only its current value, but also the current value of Solar gravitational constant in far cosmological past. Gravitational influence of galaxies one on another during their mutual distancing constantly decreases. Therefore, not only the coordinate velocity of light in the outer space ${}^{U}v_{los}$, but also its galactic values ${}^{U}v_{lg}$ steadily tend to the value of the constant of velocity of light.

Thus, gradual decreasing of galactic values of gravitational constant takes place contrary to the Dirac hypothesis [39] not directly in time but indirectly due to gradual increasing of coordinate pseudo-vacuum velocity of light in the outer space (external gravitational potential that is formed by all other galaxies of the Universe) and, therefore, due to evolutional decreasing of the average density of matter in the Universe.

Masses of the Sun and the planets of Solar system are determined based on Earth gravitational constant ${}^{E}G_{00}$. Possibly, value of gravitational constants of the planets and the Moon can differ from the values predicted for them based on ${}^{E}G_{00}$. Therefore, it would be advisable to perform space experiments for determination of the values of gravitational constant at least on the nearest planets and the Moon.

Possibly, if use logarithmical gravitational potential $\varphi_j = c^2 \ln(v_{lj}/c) = c^2 \ln b_j /2$ all examined here gravitational parameter ("constant") can be expressed via general galactic gravitational constant ${}^{g}G_{00E}$ as: ${}^{j}G = {}^{g}G_{00E} c^2 v_{lj}^{-2} = {}^{j}G_{00E} / b_j$.

Non-identity of inertial and gravitational masses

In classical mechanics and in SR the inert free energy of rest $E = m_{in0}c^2 = m_{00}cv_l$[4], which tends to the minimum and transforms into kinetic energy in the process of the fall of body in gravitational field, is the equivalent to the thermodynamic internal energy, which tend to the minimum in the process of cooling of matter. The conservation of the Newtonian [GT-Hamiltonian] of the inert free energy of rest of matter $\mathrm{N} \equiv m_{in}c^2 = E\hat{\Gamma} = m_{in0}c^2\hat{\Gamma} = m_{00}c(v_l^2 + v^2)^{1/2} = \mathbf{const}(r)$ ($v_l\hat{\Gamma} = \sqrt{v_l^2 + v^2} = \mathbf{const}(r)$) is guaranteed due to the decreasing of inertial mass of rest $m_{in0} = m_{00}v_l / c$ of matter in the process of its free fall. The Kepler's momentum $\mathbf{P}_{\mathrm{K}} = (\partial \mathrm{N}_{in} / \partial v)_{v_l} = m_{00}c(v/v_l)(1 + v^2 v_l^{-2})^{-1/2} = m_{gr0}v/\hat{\Gamma}$, which is proportional to gravitational mass $m_{gr0} = m_{00}c / v_l$, is derived from the Newtonian of namely inert free energy of matter. The magnitude of matter momentum, according to Noether's theorem [40] and Heisenberg uncertainty principle, is invariant (in relation to the transformation of time) characteristic of moving matter and, consequently, is invariant for all observers despite the different rates of time of their gravity-quantum clocks.

And, consequently, it is quite obvious that inertial mass $m_{in} \equiv c^{-2}\mathrm{N} = c^{-2}E\hat{\Gamma} = m_{00}(v_l^2 + v^2)^{1/2}/c$ of moving matter is equivalent to its gravitational mass $m_{gr} \equiv c^{-2}\mathrm{K} = c^{-2}W_0 / \hat{\Gamma} = m_{00}c(v_l^2 + v^2)^{-1/2}$ only by the intrinsic clock of the point, from which matter started its inertial motion, in case of the correction of the value of gravitational constant, which guarantees the conventional absence of

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[4] Here, only the cooled down matter is considered ($\Gamma_m = 1$).

bound energy of matter in centric or pseudo-centric intrinsic FR of matter. And this is related with the equivalence of inertial mass of matter to the Newtonian of its inert free energy, while the gravitational mass of matter is equivalent to the Keplerian $\mathrm{K} = W_0 / \hat{\Gamma} = m_{00} c^3 (v_l^2 + v^2)^{-1/2}$ of its ordinary rest energy[5]. And the ratio of these masses is invariant due to the conservation in time of Newtonians of inert free energy and of Keplerians of ordinary rest energy according to the proportionally synchronized gravithermodynamic clocks (of observed matter and of observer) which moves by inertia:

$$m_{gr0} = m_{in0} \frac{\mathrm{N}_i \mathrm{K}_j}{\mathrm{K}_i \mathrm{N}_j} = m_{in0} \frac{v_{lri}^2}{v_{lrj}^2} \equiv m_{in0} \, {}^i v_{lrj}^{-2} c^2 = \mathbf{const}(t) \, ,$$

where: ${}^i v_{lrj} = c v_{lrj} / v_{lri} = c (v_{lj}^2 + v_j^2)^{1/2} (v_{li}^2 + v_i^2)^{-1/2}$ is the value of limit velocity of matter individual (separate) motion in the points r of its hypothetic rest relatively to hypothetic observer of the motion.

However, in case of the need to analyze the motion of stars in distant galaxies, such proportional synchronization of gravithermodynamic clocks is not possible in principle. And due to the spatiotemporal non-invariance of the gravitational constant, it is necessary to use observations using gravity-quantum clocks [4].

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:

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

where: $a = (\partial \hat{r} / \partial r)^2$ 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 GR and in practical calculations:

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

[5] The absence of inert bound energy in matter in its own gravity-quantum time takes place even in the state of rest of the matter. After all, according to the own gravity-quantum clock of the molecules of a homogeneous matter, the bound energy of its other molecules is positive in its lower layers and negative in its upper layers. In the common astronomical time of the entire matter, the inert bound energy of all its molecules is fundamentally only positive.

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

$$k = -c^2 r_g r^{-2}/2 = -GM_{gr0} r^{-2} \qquad (r_g = 2Gc^{-2} M_{gr0}).$$

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 inert free 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 [42].

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 with the conservation of Keplerian K of its ordinary rest energy $W_{0j} = W_{00}c/v_{lj} = m_{gr0}c^2 = m_{00}c^3/v_{lj}$ [4, 5], and of Newtonian N of its inert free energy $E_{0j} = E_{00}v_{lj}/c = m_{in0}c^2 = m_{00}cv_{lj}$ [11, 12]:

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

Such representation of potential is based on the possibility of proportional synchronization of all quantum clocks and on proportionality of pseudo-force of inertia to the Newtonian of inert free energy and on proportionality of pseudo-force of gravitation to the Keplerian of ordinary rest energy of matter. This corresponds to the principle of equivalence of mass and energy. Such representation also makes the proof of equivalence of inertial and gravitational masses of body (by its intrinsic gravity-quantum clocks) redundant. Logarithmic gravitational potential forms the following spatial distribution of gravitational field strength:

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

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

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:

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

According to this the galactic intrinsic value ${}^g G_{00j} = {}^E G_{jeff}$ and the observed effective value ${}^E G_{jeff} = {}^E G_{0j} M_{gr0g} m_{gr} / M_{00g} m_{00} = {}^E G_{0j}/b_j$ of gravitational parameter ("constant")[6]:

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[6] Exactly this reflects the presence of $1/b_j(z, \mu_{os})$ times larger gravitational mass for the source of gravity and for the object that is moving by inertia in gravitational field (but compared to its inertial mass, that, quite the contrary,

$$ {}^{g}G_{00j} = {}^{E}G_{jeff} = {}^{E}G_{0j}c^2v_{lj}^{-2} = {}^{E}G_{00}b_j^{-2} = {}^{E}G_{00}k(z,\mu_{os}) \approx {}^{E}G_{00}(1+z_j)^4(1+2z_j)^{-2} \quad (2) $$

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.

Using both the logarithmic gravitational potential and the effective value of the gravitational parameter will not even require correction of the values of mass of both the Sun and its planets. Given the Sun's gravitational radius of 2.96 km and its diameter of 1,400,000 km, the Sun's gravitational mass should be reduced by no more than nine parts per million from its used value. But this is seven times less than the error of its definition. In the orbit of Mercury, the strength of the gravitational field of the Sun will have to be reduced by only eighty billionths of its used value. And the Earth itself has a rather small gravitational radius of 0.887 cm. And this would require reducing its gravitational mass by only four billionths of a part from its used value. While the error in determining the mass of the Earth is twenty-five thousand times greater.

Unlike the Solar System, for distant galaxies, the use of not only the logarithmic gravitational potential, but also the effective value of the gravitational "constant" can be quite essential. And it can eliminate the need to use fictitious dark matter.

Imaginary Etherington's Paradigm

Luminosity of fast moving galaxies is isotropic only in their intrinsic FRs. However, this luminosity is also considered as isotropic in the GT-FR of any far observer during the astronomical photometric calculations. Therefore, relativistic transformations of angular coordinates are ignored in those calculations [14, 43]. Thereby, distances to galaxies are not determined by those calculations in the GT-FRs of observer. They are, in fact, determined in CFREU. Only in CFREU the luminosity of all galaxies is isotropic and the Universe itself is uniform. However, the imaginary Etherington's identity [44] for uncorrected luminosity distance D_L and for imaginary value of angular diameter distance ${}^{i}D_A$, that corresponds to it, in the calculations is also taken into account:

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decreases $b_j^{-1/2}$ times in distant outer space). The galactic intrinsic and the observed effective values of the gravitational "constant" can be considered as dependent only on the evolutionary redshift z of the radiation wavelength only in the case of admissibility of neglecting both the dependence of the parameter b_j on gravitational fields and its gradual increase due to the evolutionary decrease in the average density of matter μ_{os} in the Universe. Based on the redshift of the relict radiation $z = 1089$, the relict value of the gravitational "constant" could not exceed Newton's gravitational constant by more than 297300 times.

$$D_L = {}^iD_A(1+z)^2.$$

Etherington's identity is based on the imaginary relativistic dilation of intrinsic time of the galaxy by (1+z) times [45]. That time dilation (inherent to GT-FR) is actually absent in CFREU when using the CTMHS. The primary frequency of radiation of the galaxy is the same as the frequency of identic to it radiation in nearby vicinity of observer in CFREU by CTMHS. That frequency is only progressively decreasing in "ontogenesis" (in the process of propagation of that radiation) together with decreasing of velocity of light in CFREU in accordance with CTMHS [11, 12].

Such imaginary time dilation by $(1+z)$ times takes place in CFREU by physically homogeneous scale of cosmological time (CTFHS). The velocity of light does not change during its propagation when using the CTFHS, in contrast to CTMHS. The frequency of radiation that is lesser by $(1+z)$ times corresponds to "phylogenesis" (to the process of the emission of that radiation). The infinitely far future becomes finite when using the exponential CTFHS. As we go deeper into the cosmological future, the rate of physical processes increases according to CTMHS. That is, for sure, similar to the imaginary increasing of the rate of physical processes while deepening into cosmological past, caused by the use of the exponential scale of the cosmological time (CTES). This CTES is currently used in cosmology. Infinitely far cosmological past imaginarily becomes finite by that CTES.

Thus, we are dealing with the Etherington's paralogism. This paralogism is caused by the mixing of observations in two different FRs – in CFREU and in GT-FR. The Universe is observed in CFREU as uniform (monotonous), with the single for all its objects cosmological time and without the presence of global relativistic effects. Consequently, the relativistic time dilation on the astronomical objects moving away from each other in the expanding Universe, which is allegedly mutually observed in the GT-FR of each of the objects, is imaginary (fictive) for CFREU (and, therefore, for the global perception) [5, 10, 46]. The Universe is non-uniform (not monotonous) in GT-FR. And not only relativistic time dilation on far astronomical objects, but also relativistic anisotropy of their luminosity is observed (according to SR and GR) in the GT-FR. That relativistic anisotropy of luminosity was ignored by Etherington in contrast to fictive relativistic time dilation. Of course, Etherington could consider these relativistic effects (inherent to Schwarzschild solution only) as applicable for Friedman solution without understanding that the Hubble radial motion of objects of matter is absent in this solution.

Moreover in any observer's FR the coordinate sizes of these objects (in the moment when they emit the radiation) are conformally reduced in their cross-section more than it is required for the absence of dilation of their intrinsic time. According to GR their transverse scale factor N_Λ formally exceeds its limit value, beyond which there should be not a deceleration but acceleration of the rate of intrinsic time of moving body [14]:

$$N_\Lambda = \frac{D_M}{D_A} = 1 + z = \frac{1}{1 - v_g / v_l} > N_0 = \left(\frac{c}{v_l}\right)\frac{1}{\sqrt{1 - v_g^2 v_l^{-2}}} = \frac{1}{1 - v_g^2 v_l^{-2}},$$

where: $v_l = c\sqrt{1 - v_g^2 v_l^{-2}}$; v_g is the velocity of radial motion of distant galaxy; D_M is the transverse comoving distance to the galaxy in CFREU.

According to the increment of the interval [46]:

$$(ds)^2 = c^2(dt')^2 - (dx'_m)^2 - (dy'_m)^2 - (dz'_m)^2 = N_\Lambda^2[c^2(dt)^2 - (dx_m)^2 - (dy_m)^2 - (dz_m)^2],$$

when: $dx'_m = 0$, $dy'_m = 0$ and $dz'_m = 0$ the $dx_m = v_g d\hat{t} = (v_g / v_l)cdt$, $dy_m = 0$, $dz_m = 0$, will take place, and:

$$c^2(d\,t')^2 = N_\Lambda^2(1 - v_g^2 v_l^{-2})c^2(dt)^2 = N_\Lambda^2(1 - v_g^2 v_l^{-2})v_l^2(d\,\hat{t})^2 = c^2(1 + v_g / v_l)^2(d\,\hat{t})^2 = c^2[(v_l + v_g)/(v_l - v_g)](dt)^2.$$

And, consequently, the dilation of intrinsic time of astronomical objects of far galaxies that are distancing from observer is absent in conformally transformed time *t* of the observer FR and all the more so by its real clock that counts universal astronomical time $\hat{t}$. So, according to GR formalism not the time dilation but vice versa the acceleration of the rate of intrinsic time of distant galaxies takes place by the observer's clock: $d\,t' = (1 + v_g / v_l)d\,\hat{t} > d\,\hat{t}$. However, if just the time gravitational dilation of time of distant galaxies is completely compensated by the free fall of distant galaxies on the events pseudo-horizon, then indeed there fundamentally cannot be any contraction or dilation of the unified gravithermodynamic (not coordinate) time of matter of these galaxies. And this could take place due to the conformal gravitationally-Lorentz transformations of increments of space coordinates and time, which guarantee the relativistic invariance of Hamiltonian of inertially moving body as well as of all thermodynamic potentials and parameters of its matter. But in fact it takes place due to the relativistic invariance of the Newtonian [GT-Hamiltonian]: $\mathrm{N} = E_0 v_{lcg} / c = m_{in} c^2 = m_{in0} c^2 (1 + v_g^2 v_{lg}^{-2})^{1/2} = m_{00} c v_{lcg} = m_{00} c^2 = \mathbf{const}\ (r,t)$ (which is alternative to Hamiltonian) and the relativistic invariance of the Keplerian [GT-Lagrangian]:

$$\mathrm{K} = W_0 c / v_{lcg} = m_{gr} c^2 = m_{gr0} c^2 (1 + v_g^2 v_{lg}^{-2})^{-1/2} = m_{00} c^3 / v_{lcg} = \mathrm{N}/b_g (1 + v_g^2 v_{lg}^{-2}) = \mathrm{N}/b_{cg} = \mathrm{N} = \mathbf{const}\ (r,t)$$

(which is alternative to Lagrangian) of galaxies moving only by inertia in the FR of the terrestrial observer, since: $v_{lcg}^2 = v_{lg}^2 + v_g^2 = c^2(1 - \Lambda r^2 / 3) + H_E^2 r^2 = c^2 = \mathbf{const}(r,t)$, $m_{grg} = m_{ing} = m_{00g}$, $b_{cg} = b_g + v_g^2 c^{-2} = 1$, $b_{g\min} = 2/3$, $v_{g\max}^2 c^{-2} = H_E^2 r_{\max}^2 c^{-2} = 1/3$ and $r_{\max} = \Lambda^{-1/2} = 8.5734 \cdot 10^{25}$[m] ≈ 2.778 [Gpc].

And therefore, thanks to Newtonian and Keplerian, the relativistic invariance of the flow of proper time of distant galaxies is guaranteed by the invariance of the relativistic interval s_{cg} for all observers moving at different speeds:

$$(ds_{cg})^2 = v_{lcg}^2 (dt)^2 - (d\hat{x})^2 - (d\hat{y})^2 - (d\hat{z})^2 = b_{cg} c^2 (dt)^2 - (d\hat{l})^2 = (v_{lg}^2 + v_g^2)(dt)^2 - (d\hat{l})^2 = b_g c^2 (dt)^2 = \mathbf{invar} .$$

Thus, avoiding not only the relativistic non-invariance of the parameters and potentials of thermodynamics, but also the false presence of relativistic dilation of proper time in distant galaxies is entirely possible only if modern physics uses the relativistic Newtonian and the relativistic Keplerian instead of the classical Hamiltonian and Lagrangian, respectively.

The similar imaginary effect of mutually observed time dilation in two inertial FRs (IFRs) takes place in the clocks paradox in Special Relativity (SR). This is due to the fact that events at different points are not simultaneous events in the observer's IFR, although they are simultaneous events in the IFR of the observed moving body. And such resultant time dilation becomes true only for the observer that transits from one IFR to another IFR that moves in opposite direction in order to make re-meeting possible. In the case of mutual observation of time dilation for two distant galaxies that are mutually distancing only in GT-FR and resting in CFREU such difference between these galaxies is absent. That is why time dilation is fictive (seeming) for both distant galaxies.

It is worth to mention, that Lorentz transformations in SR are only the transformations of increments of the coordinates and not of the increments of metrical intervals (segments) [4, 5, 23, 24]. That is, apparently, why relativistic dilation of only coordinate time, and not metric time, takes place in distancing galaxies when observations are performed in GT-FR of that galaxies. According to Lorentz-conformal transformations of increments of spatial coordinates and time (that guarantees the invariance of thermodynamic potentials and parameters of matter to them) the relativistic dilation of intrinsic time is absent at all for inertially moving bodies [4, 5]. The distancing from observer far galaxies are namely inertially fall onto the events pseudo-horizon and, therefore, there, of course, should not be any relativistic dilation of intrinsic time for them.

Intrinsic time dilation in distancing galaxies, which is defined based on the redshift of radiation spectrum, is just the imaginary phenomenon. That time dilation is the similar to such imaginary phenomenon as the movement of the Sun across the earthly sky. And, of course, it is the similar to the phenomenon of Universe expansion in people's world "from nothing" and "into nowhere". That is why relativistic decreasing of the quantity of radiation quanta, which are registered by observer, is determined in its GT-FR by the (z+1) factor, and not by $(1+z)^2$ factor, which is declared by unreliable Etherington's identity.

So, nowadays Etherington's identity is only the imaginary Paradigm. The real astronomic identity should, of course, be taken instead of it:

$$D_L = D_A(1+z)^{3/2}.$$

This identity, in fact, connects the luminosity distance D_L with corrected photometric distance в GT-FR $r = D_A$. This photometric distance is used in Schwarzschild solution of GR gravitational field equations.

Gravity-temporal invariance of really metrical values of mechanical and thermodynamic parameters of matter

In contrast to the momentum the forces that act on the matter, as all types of its energies, formally depend on the rate of time gravity-quantum clock. During the transition from unified gravithermodynamic (astronomical) time to gravity-quantum intrinsic times of matter the magnitudes of these forces, as well as magnitudes of non-centric values of all energies, are increasing c/v_l times. In intrinsic FR of r point, from which the matter started its fall:

$$^{r}\mathbf{F}_{in}=\mathbf{F}_{in}c/v_{lr}={}^{r}m_{in0r}\,{}^{r}\widehat{a}_r=m_{00}a_r=\frac{c}{v_{lr}}\frac{d\mathbf{P}}{dt}=\frac{d\mathbf{P}}{dt_r}=-{}^{r}\mathbf{F}_{gr},$$

$$^{r}\mathbf{F}_{gr}=\mathbf{F}_{gr}c/v_{lr}={}^{r}m_{gr0r}\,{}^{r}g=m_{gr0r}gc/v_{lr}=m_{00}gc^2v_{lr}^{-2}={}^{r}m_{gr0r}v_{lr}^{-2}c^2\frac{d\ln(v_l/v_{lr})}{d\widehat{r}}=m_{00}\frac{c^3G_{00}M_{gr0}}{v_{lr}^3r^2}\frac{dr}{d\widehat{r}}=m_{gr0}\frac{^{r}GM_{gr0}}{r^2}\frac{dr}{d\widehat{r}},$$

and the eigenvalues (that were corrected to eigenvalue of gravitational constant (to wit centered)) of Newtonian of inert free energy and of Keplerian of ordinary rest energy of matter in its pseudo-centric ^{rc}FR$_0$ will be as follows:

$$^{rc}\mathrm{N}\equiv{}^{r}\mathrm{N}=\mathrm{N}c/v_{lr}=m_{00}\,{}^{r}v_lc(1+\widehat{v}^2c^{-2})^{1/2}=m_{00}c^2,$$

$$^{rc}\mathrm{K}=(G_{00}/{}^{r}G)\;{}^{r}\mathrm{K}=(G_{00}/{}^{r}G)\mathrm{K}c/v_{lr}=m_{00}c^4v_l^{-2}G_{00}/{}^{r}G(1+\widehat{v}^2c^{-2})=m_{00}c^2$$

where: $\widehat{v}=vc/v_l$ is the really metrical value of velocity of matter motion [4, 5, 47, 48]; v is the coordinate velocity of motion of matter in background regular space, where its local kinematic curvature (that is contributed by the moving matter itself) is not taken to account; ${}^{r}\widehat{a}_r \equiv \widehat{a}_r = \mathbf{invar}(t)$ and $\widehat{a}_r = (c/v_{lr})(d\widehat{v}/dt) = d\widehat{v}/dt_r = a_r v_{lr}^{-2} c^2 = \mathbf{invar}(t)$ are the really metrical values of accelerations of body free fall in the intrinsic gravity-quantum time of the point r and in the gravithermodynamic time correspondingly; a_r is coordinate acceleration of motion of matter in background regular space; ${}^{r}g_r = g_r v_{lr}^{-2} c^2 = {}^{r}GM_{gr0} r^{-2}$ and g_r are the gravitational accelerations in the point r by its intrinsic gravity-quantum clock and in gravithermodynamic time (world time of GR [41]) correspondingly; ${}^{r}m_{gr0r} \equiv m_{00}$, since ${}^{r}m_{gr0j} = m_{gr0} v_{lr}/c = m_{00} v_{lr}/v_{lj}$; ${}^{r}m_{in0r} = m_{00} v_{lr}^{2} c^{-2}$, since ${}^{r}m_{in0j} = m_{in0} v_{lr}/c = m_{00} v_{lj} v_{lr} c^{-2}$; ${}^{r}v_l = c v_l / v_{lr} = (c^2 + \widehat{v}^2)^{-1/2}$ is the limit velocity of individual motion of matter in arbitrary point in the intrinsic gravity-quantum time of the point r; ${}^{r}G = G_{00} c^2 v_{lr}^{-2}$ is the value of gravitational constant by the intrinsic clock of point r; $dt_r = (v_{lr}/c)dt$ is the value of the increment of intrinsic gravity-quantum time of point r.

So, by the gravity-quantum clock of any point i inertial and gravitational rest masses of matter will be determined in the following way[7]:

$${}^{ic}\widetilde{m}_{in0j} = m_{00}\,{}^{i}v_{lj}/c = m_{00} v_{lj}/v_{li}, \qquad {}^{ic}\widetilde{m}_{gr0j} = m_{00} c/{}^{i}v_{lj} = m_{00} v_{li}/v_{lj}.$$

However, with the help of examined here transformations the transition happens only to coordinate (and not to metrical) values of inertial and gravitational mass. And these values of masses in pseudo-centric ${}^{rc}\mathrm{FR}_0$ do not correspond to real values of internal energy of matter and to its thermodynamic states in general. And inert bound energy is absent at all in a new center of coordinates. That is why they cannot be considered as really metrical values of inertial and gravitational masses.

As we can see, the pseudo-force of inertia is increased only due to the increasing of inert free energy and equivalent to it inertial mass c/v_l times. The metric value of acceleration of free fall of the body, as well as the metric value of velocity of its fall, is not changed. The equations of free fall of matter $v_l / v_{lr} = (1 + \widehat{v}^2 c^{-2})^{-1/2}$, as well as of any other its movements, are equally formulated with the usage of any gravity-quantum clocks. Not the absolute values but the relative values of parameters of motion are used in these equations. So the gravity-quantum clock of matter has only the hidden influence on its mass and does not have an influence on really metrical values of

[7] Here, only the readings of gravity-quantum clocks proportionally synchronized with gravithermodynamic (astronomical) time are used, and not gravity-quantum time itself, according to which the spatial distribution of relative gravity-quantum values of the coordinate velocity of light is the same for all observers, and therefore, is invariant to any spatiotemporal transformations.

parameters of matter motion, which do not depend on the rate of time of gravity-quantum clock at all. And this is, of course, due to the fact that quantum change of collective microstate of the whole gravithermodynamically bonded matter takes place simultaneously and, consequently, with the same frequency. That is why this all is quite logical. The limit velocity ${}^{i}v_{lj}=cW_{0i}/W_{0j}=cE_{0j}/E_{0i}$ of individual motion of matter, as well as the equivalent to it coordinate velocity of light of GR, is the hidden mechanical and thermodynamic parameter and is already taken into account in its parameters and characteristics that are practically used. And, that is why it fundamentally cannot directly influence on the majority of mechanical and thermodynamic parameters of matter. Its value only characterizes the difference between multiplicative components of thermodynamic Gibbs free energy ${}^{i}v_{lj}=cG_{0i}/G_{0j}$ in different points of gravitational field because in those points matter is in not the same thermodynamic states. The minimum possible value of Gibbs free energy $G_{\min}=G_0+U_{ad}$ $(G=G_0c/v_l+U_{ad})$ is, as other thermodynamic parameters, the intrinsic characteristics of matter. Moreover, the multiplicative component of thermodynamic Gibbs free energy of matter is identical to its mechanical ordinary rest energy ($G_0\equiv W_0$) and, therefore, similarly to it, cannot depend on the rate of time of gravity-quantum clock of the observer (of course, if their rate of time is calibrated by the rate of uniform gravithermodynamic time of the whole gravithermodynamically bonded matter). And, consequently, all other thermodynamic potentials also do not depend on it. And, not only extensive but also intensive thermodynamic parameters a fortiori do not depend on it.

So the usage of formalism of gravity-quantum time helps to perform only the relative measurements of mechanical and thermodynamic parameters and characteristics of matter. In order to determine (based on it) their really metrical values for observed matter we also need to know – to what values the readings of gravity-quantum clock of the observer correspond to. And only in this case the observed values of mechanical and thermodynamic parameters of matter will be equal for all observers. For example, taking into account that for quasi-equilibrium cooling down gases and simplest liquids:

$$m_{gr0j}=m_{00}c/v_{lj}\ \ (m_{gr0i}=m_{00}c/v_{li}),\quad U_{0j}=U_{00}c/v_{lj}\ \ (U_{0i}=U_{00}c/v_{li}),$$

$$H_{T0j}=H_{T00}c/v_{lj}\ \ (H_{T0i}=H_{T00}c/v_{li}),\ T_{0j}=T_{00}c/v_{lj}\ \ (T_{0i}=T_{00}c/v_{li}),$$

we will receive really metrical values (that are observed by gravity-quantum clocks of point i in point j) of such characteristics of matter as gravitational mass, Gibbs free energy, thermodynamic enthalpy and temperature that are identical to their coordinate values in GT-FR:

$${}^{i}\widehat{m}_{gr0j}=(c/{}^{i}v_{lj})m_{gr0i}\equiv m_{gr0j},\quad {}^{i}\widehat{G}_{0j}=(c/{}^{i}v_{lj})G_{0i}\equiv G_{0j},\quad {}^{i}\widehat{H}_{T0j}=(c/{}^{i}v_{lj})H_{T0i}\equiv H_{T0j},\quad {}^{i}\widehat{T}_{0j}=(c/{}^{i}v_{lj})T_{0i}\equiv T_{0j}.$$

That is why it is expedient to use not the gravity-quantum clock of the observers, but universal (common for the whole gravithermodynamically bonded matter) gravithermodynamic clock. It is possible that the gravity-quantum clocks, which are located in specially created for them standard thermodynamic conditions, can be used as those clocks. However, it is required for this that in all points of space, which is filled with gravithermodynamically bonded matter, the same intranuclear gravithermodynamical parameters and characteristics of matter should correspond to the same standard thermodynamic conditions, as it takes place for homogeneous ideal liquid [22].

Of course, the inertial mass of rest of matter became equal to its gravitational mass of rest by the intrinsic gravity-quantum clock of point *r* and to the eigenvalue of mass. Moreover, by the intrinsic clock of this point the strength of gravitational field is increased more significantly than based only on the usage of logarithmic gravitational potential [4, 5, 49]. And the velocities and accelerations of object remained the same as in proportionally adjusted gravithermodynamic (astronomical) time.

In addition to this in intrinsic gravity-quantum time of any arbitrary point *i* the ratio of values of inert free energy to values of ordinary rest energy of matter remains the same ${}^{i}E_{0i}/{}^{i}W_{0i}=v_{li}^{2}c^{-2}$, as in common for all gravithermodynamically bonded matter gravithermodynamic time. After all:

$$ {}^{i}E_{0i}=\frac{{}^{i}\mathbf{F}_{ini}}{\mathbf{F}_{ini}}E_{0i}=\frac{{}^{i}m_{in0i}}{m_{in0i}}\;\frac{{}^{i}a_{i}}{a_{i}}m_{in0i}c^{2}=\frac{m_{in0i}c^{3}}{v_{li}}=m_{00}c^{2}, \qquad {}^{i}m_{in0i}\equiv m_{00}, $$

$$ {}^{i}W_{0i}=\frac{{}^{i}\mathbf{F}_{gri}}{\mathbf{F}_{gri}}W_{0i}=\frac{{}^{i}m_{gr0i}}{m_{gr0i}}\;\frac{{}^{i}g_{i}}{g_{i}}m_{gr0i}c^{2}={}^{i}m_{gr0i}v_{li}^{-2}c^{4}=\frac{m_{gr0i}c^{3}}{v_{li}}=m_{00}v_{li}^{-2}c^{4}=\frac{m_{00}c^{2}G_{i}}{{}^{ic}G_{0i}}, \qquad {}^{i}m_{gr0i}\equiv m_{00}, $$

where: ${}^{i}a_{i}={}^{i}v_{i}^{2}/r_{i}=v_{i}^{2}v_{li}^{-2}c^{2}/r_{i}=a_{i}$ and a_{i} are the centrifugal accelerations in gravity-quantum time of the *i* point and in common for all gravithermodynamically bonded matter gravithermodynamic time correspondingly; ${}^{i}g_{i}=g_{i}v_{li}^{-2}c^{2}$ and g_{i} are the accelerations of motion and gravitational accelerations in gravity-quantum time of the *i* point and in gravithermodynamic time correspondingly; ${}^{ic}G_{0i}\equiv{}^{E}G_{00}=G_{i}v_{li}^{2}c^{-2}=\mathbf{const}(r)$ and $G_{i}\neq\mathbf{const}(r)$ are the values of the gravitational constant, respectively, in the gravity-quantum time of the *i* point and in gravithermodynamic (astronomical) time of the Earth.

But the identical to each other (in the gravity-quantum time of any arbitrary point *i*) inertial and gravitational masses of matter are no longer equivalent, respectively, to the inert free energy and ordinary rest energy of matter. And therefore, the gravitational mass of matter is erroneously considered identical to its inertial mass in the general astronomical time of all gravithermodynamically bound matter due to the impossibility of experimental detecting of the spatial variability of the gravitational "constant" in Earth conditions.

Thus, in pseudo-centric ${}^{i}FR_0$ of i point we will have the similar thing that is accepted in both classical physics and GR. Namely, due to the correction of gravitational constant we will receive in the i point not only the equality of the velocity of light to the constant c, but also the equality of gravitational mass to inertial mass. Therefore, with the exception of the gravitational "constant" and the coordinate vacuum velocity of light of the GR, all other truly metric mechanical and thermodynamic parameters and characteristics of matter do not depend on the readings of gravity-quantum clocks, and therefore are temporally invariant in the general astronomical time of all gravithermodynamically bound matter. After all, the coordinate pseudo-vacuum velocity of light of the GR is an internal hidden parameter of most parameters and characteristics of matter.

Within the limits of atmosphere and outer space of the Earth this value of gravitational constant not essentially depends on the height above its surface. While on the edge of the Solar system namely this could cause the abnormal movement of spacecrafts "Pioneer" [50–52]. If we go deeper in the distant outer space, where v_{li} is the maximum possible value of limit velocity of individual motion of matter in the outer space, then we will receive the quite essential difference between the value gravitational constant there and its value on the Earth. Moreover, for the distant galaxies, this will already be not the pseudo-centric but real centric galactic FRs.

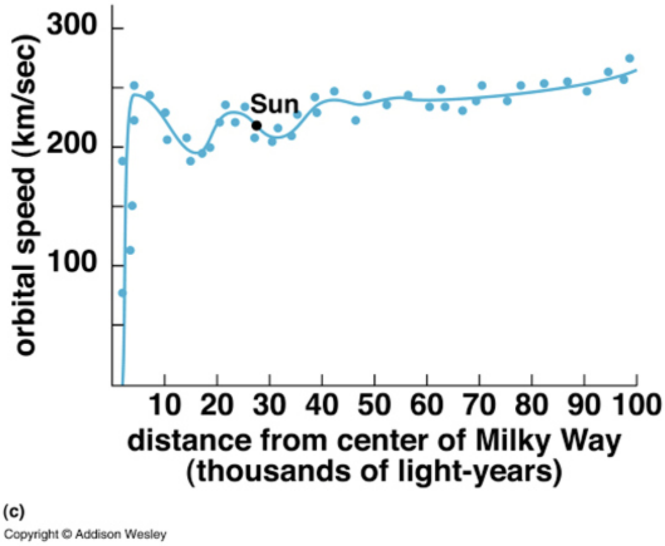
The inconsistency of the motion of galaxies with Kepler's laws

Laws of motion of single astronomical objects, found by Kepler, are based on gravitational influence of mainly central massive body. According to that 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[8] remains quasi constant on quite far distance from galaxy center for many flat (or superthin) galaxies, including ours [53, 54].

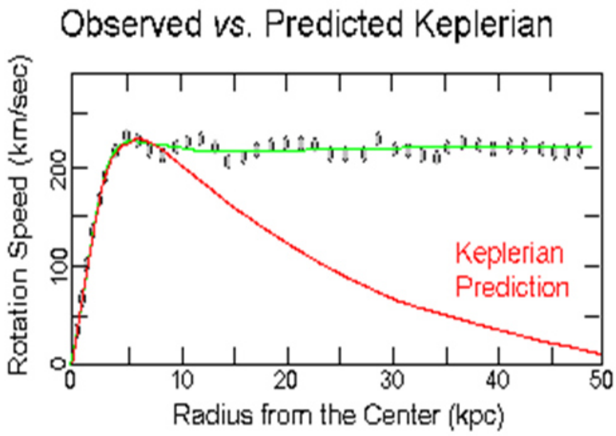
When single objects and their aggregates form big collection (cluster) their total mass can essentially exceed the mass of central astronomical body (supermassive neutron star or quasar). The attraction of astronomical objects of the internal spherical layers of the galaxy can be much stronger

[8] Obviously this velocity decreases very slowly due to the same very slow radial decreasing of coordinate velocity of light that is identical to the slow radial decreasing of temperature on the periphery of very massive hot bodies. And, so, it is the indication of very big mass of a stellar formation which galaxy is.

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)

Fig.2. Dependencies of velocity of rotation of astronomical objects on the distance to gravity center: (a) our Milky Way galaxy [54, 55], (b) comparing to prognosed Keplerian velocities [53, 56]).

The quite close dependency to the observed one is the following dependence of really metrical value $\widehat{v} = v/\sqrt{b} = vc/v_l$ 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 are 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 really metrical value of linear 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 $\mathbf{F}_{in} = \mathrm{N}\hat{v}^2 c^{-2} a^{-1/2}/r$ and pseudo-force of gravity $\mathbf{F}_{gr} = \mathrm{K}d\ln(v_l/c)/d\hat{r}$:

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

very slightly depends on $r >> r_e$ [9] due to the smallness of $\exp(-r/r_e)$, pressure p in the outer space of 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.

One of the reasons for the imaginary need for dark non-baryonic matter may be the erroneous conclusion about the presence of relativistic dilation of intrinsic time for objects of distant galaxies. Because of this, objects of distant galaxies should move in their intrinsic time at much higher speeds than according to the clock of an observer from the Earth. In fact, galaxies “fall” onto the event pseudo-horizon by inertia, and therefore their objects, which also rotate relative to centers of galaxies by inertia, do not have dilation of intrinsic time at all [4, 5]. 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

[9] 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 $(dr/dt = 0)$.

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 RGTD correspond to spatially inhomogeneous thermodynamic states of gradually cooling 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 equilibrium processes, instead of the usage of ordinary Hamiltonians and Lagrangians, in RGTD the GT-Hamiltonians [Newtonians N] and GT-Lagrangians [Keplerians K] should be used. Therefore, in RGTD for matter that cools quasi-equilibrially the Newtonian four-momentum is formed not by the Hamiltonian of enthalpy, but by the Newtonian of the inert free energy, and Keplerian four-momentum is formed by the Keplerian of ordinary rest energy (multiplicative component of thermodynamic Gibbs free energy) of matter of astronomical object.

The Keplerian [GT-Lagrangian] of the ordinary rest energy of the matter:

$$\mathrm{K} = W_0 c / v_{lc} = m_{gr} c^2 = m_{gr0} c^2 (1 + v^2 v_l^{-2})^{-1/2} = m_{00} c^3 / v_{lc} = \mathrm{N}/b(1 + \hat{v}^2 c^{-2}) = \mathrm{N}/b(1 + v^2 v_l^{-2}) = \mathrm{N}/b_c$$

forms the four-momentum not with the Newtonian [GT-Hamiltonian] momentum:

$$\mathbf{P}_{\mathrm{N}} = m_{in0} c^2 v_l^{-2} v = m_{00} c v / v_l ,$$

but with the Keplerian [GT-Lagrangian] momentum:

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

where: $\mathrm{N} = E_0 v_{lc} / c = m_{in} c^2 = m_{00} c \sqrt{v_l^2 + v^2}$, $E_0^2 = \mathrm{N}^2 - v_l^2 \mathbf{P}_N^2 = m_{00}^2 c^2 v_l^2 = m_{in0}^2 c^4$,

$$W_0^2 = \mathrm{K}^2 + c^4 v_l^{-2} \mathbf{P}_{\mathrm{K}}^2 = m_{00}^2 c^6 v_l^{-2} / (1 + v^2 v_l^{-2}) + m_{00}^2 c^6 v_l^{-4} v^2 / (1 + v^2 v_l^{-2}) = m_{00}^2 c^6 v_l^{-2} = m_{gr0}^2 c^4 ,$$

$$\hat{v} = v b_c^{-1/2} = vc / v_{lc} = vc / v_l \hat{\Gamma}_c , \quad \hat{\Gamma}_c = (1 + v^2 v_l^{-2})^{1/2} , \quad v_{lc}^2 = b_c c^2 = b c^2 + v^2 = v_l^2 + v^2 = \mathbf{const}(t) ,$$

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

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:

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

Here: $b_c c^2 (dt)^2 = \mathbf{const}(r)$; $(ds_c)^2 = bc^2(dt)^2 \neq \mathbf{const}(r)$ is the square of the increment of the relativistic interval; $d\widehat{l} = vdt = \sqrt{(d\widehat{x})^2 + (d\widehat{y})^2 + (d\widehat{z})^2}$, $d\widehat{x} = v_x dt$, $d\widehat{y} = v_y dt$, $d\widehat{z} = v_z dt$ are increments of metric segments, not increments of coordinates.

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 increase (during approaching gravity center) in the frequency of extranuclear intermolecular 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 [4 – 7], the parameters a_c and b_c 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: $v_{lcg}^2 \equiv c^2 = v_{lg}^2 + v_g^2$. 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 $\Lambda = 3H_E^2 c^{-2}$ and a zero value of the gravitational radius: $v_{lg}^2 = c^2(1 - \Lambda r^2/3) = c^2 - H_E^2 r^2 = c^2 - v_g^2$. And for planets that move only by inertia around stars this dependence $v_{lc}^2 = v_l^2 + v^2 = \mathbf{const}(t, r)$ also works. After all, according to Kepler's laws, which are actually based on Newton's theory of gravity, it is not Hamiltonians and Lagrangians that are conserved in the process of planetary motion, but rather Newtonians of inert free rest energy:

$$\mathrm{N} = E_0 v_{lc}/c = m_{00} c v_{lc} = m_{00} c \sqrt{v_l^2 + v^2} \approx m_{00} c^2 \sqrt{1 - r_g/(r_1 + r_2)} = \mathbf{const}(t, r)$$

and Keplerians of ordinary rest energy:

$$\mathrm{K} = W_0 c/v_{lc} = m_{00} c^3/v_{lc} = m_{00} c^3/\sqrt{v_l^2 + v^2} \approx m_{00} c^2/\sqrt{1 - r_g/(r_1 + r_2)} = \mathbf{const}(t, r)$$

of the planetary matter. Here r_1 and r_2 are the radii of the planet's elliptical orbit at aphelion and perihelion, respectively, and r_g is the gravitational radius of the Sun.

At the same time, since:

$$b_c = v_{lc}^2 c^{-2} = b + v^2 c^{-2} = 1 - r_g / r + v^2 c^{-2} = 1 - r_g /(r_1 + r_2) = \mathbf{const}\,(t, r) \,,$$

the squares of the real velocities $v^2 \approx c^2 r_g [1/r - 1/(r_1 + r_2)]$ of the planets significantly differ from their gravitational values $v_{gr}^2 = (c^2 r\sqrt{ab}/2) d \ln b / d\hat{r} = (c^2/\sqrt{b})(r_g / 2r - \Lambda r^2/3) \approx c^2 r_g / 2r$, which allow to compensate for centrifugal pseudo-forces of inertia only with gravitational pseudo-forces. And therefore, the centrifugal pseudo-forces of inertia indeed compensate not only for gravitational pseudo-forces, but also for the pseudo-forces of evolutionary self-contraction of matter in the CFREU, which force planets to move in the observer's FR not in circular, but in elliptical orbits:

$$\mathbf{F}_{ev} \approx \frac{m_{00}}{r\sqrt{ab}}(v_{gr}^2 - v^2) = \frac{m_{00}c^2}{r\sqrt{ab}}\left[\frac{1}{\sqrt{b}}\left(\frac{r_g}{2r} - \frac{\Lambda r^2}{3}\right) - r_g\left(\frac{1}{r} - \frac{1}{r_1 + r_2}\right)\right] \approx \frac{m_{00}c^2 r_g (2r - r_1 - r_2)}{2r^2 (r_1 + r_2)} \,.$$

These pseudo-forces act in such a way that at perihelion the Sun is a little closer to the planet, and at aphelion, on the contrary, a little further from the planet:

$$\mathbf{F}_{ev(aph)} \approx \frac{m_{00}c^2 r_g \eta}{2r_1^2} = \frac{m_{00}c^2 r_g}{2r_1^2}\left(\frac{r_1 - r_2}{r_1 + r_2}\right) = \frac{m_{00}}{r_1}\left(\frac{c^2 r_g}{2r_1} - v_1^2\right),$$

$$\mathbf{F}_{ev(per)} \approx -\frac{m_{00}c^2 r_g \eta}{2r_2^2} = -\frac{m_{00}c^2 r_g}{2r_2^2}\left(\frac{r_1 - r_2}{r_1 + r_2}\right) = \frac{m_{00}}{r_2}\left(\frac{c^2 r_g}{2r_2} - v_2^2\right).$$

Since the compensation of the gravitational and evolutionary pseudo-forces by centrifugal pseudo-forces of inertia occurs only at the aphelions and perihelions of planets, for all planets and other independent objects we obtain a single dependence of the pseudo-forces of evolutionary self-contraction of all matter of the Solar System to its center on the radial distance to the center and on the velocities of orbital motion at aphelions and perihelions:

$$\mathbf{F}_{ev} = -(\mathbf{F}_{gr} + \mathbf{F}_{in}) \approx m_{00}c^2 (r_g r^{-2}/2 - 2\Lambda r/3 - v^2 c^{-2}/r) \,.$$

The values of the velocities of orbital motion of independent objects of the Solar System at aphelions and perihelions are determined by the initial conditions of their inclusion in the Solar System. Based on the identity of both the values of the Newtonians and the Keplerians, and the values of angular momentum ($v_2 r_2 = v_1 r_1$) at aphelion and perihelion of the planet:

$$b_c = v_{lc}^2 c^{-2} \approx (1 - r_g / r_1) + v_1^2 c^{-2} \approx (1 - r_g / r_2) + v_2^2 c^{-2} = (1 - r_g / r_2) + v_1^2 r_1^2 r_2^{-2} c^{-2} \,,$$

we can find the gravitational radius of the Sun: $r_g \approx v_1^2 c^{-2}(r_1 + r_2) r_1 / r_2 = v_2^2 c^{-2}(r_1 + r_2) r_2 / r_1$.

Table 1. Parameters of planets and the Sun.

Planet	r_1 mln. km	r_2 mln. km	v_1 km/s		v_2 km/s theoret.	η	$(1-b_c)$ x10^{10}	r_g km actual
			actual	theoret.				
Mercury	69.82	45.90	38.85	38.88	59.14	0.2067	255.95	2.96
Venus	108.94	107.48	34.78	34.83	35.30	0.0067	136.74	2.95
Earth	152.09	147.10	29.29	29.33	30.32	0.0167	98.92	2.95
Mars	249.23	206.60	21.98	22.00	26.54	0.0935	64.92	2.96
Jupiter	816.62	740.52	12.44	12.45	13.73	0.0489	19.00	2.96
Saturn	1505.4	1353.6	9.10	9.15	10.18	0.0531	10.35	2.93
Uranus	3006	2740	6.50	6.50	7.13	0.0463	5.15	2.96
Neptune	4537	4456	5.39	5.39	5.49	0.0091	3.29	2.96
Pluto	7375	4437	3.68	3.68	6.12	0.2487	2.51	2.96

The table shows that the calculated values of the gravitational radius of the Sun, obtained on the basis of using approximate values of the orbital parameters and actual and theoretical (at $r_g = 2.96$ km) velocities of different planets, are almost identical. And this takes place despite the neglect (in the calculations) of the presence of both a slight evolutionary weakening (Λ-reduction) of centrifugal pseudo-forces of inertia, and the influence of planets on each other. And this confirms not only the correspondence of Newtonians and Keplerians to these planets, but also the absence of relativistic time dilation in them.

The analysis of motion of the planets can also be carried out in a dynamic gravitational field corresponding to the hypothetical circular orbital motion of astronomical objects:

$$b_c = v_{lc}^2 c^{-2} = b + v^2 c^{-2} = 1 - r_g / r + v^2 c^{-2} = 1 - r_g / 2r = 1 - r_{gc} / r \neq \mathbf{const}(r),$$

where: $v^2 = c^2 r_g / 2r = c^2 r_{gc} / 2$; $r_{gc} = r_g / 2$ is gravitational radius of the dynamic gravitational field of the Sun. In this field, the pseudo-forces $\mathbf{F}_{cev}$ of unobservable evolutionary attraction (towards the Sun) of astronomical objects are centripetal and act on astronomical objects regardless of the trajectory of their motion.

The centripetal pseudo-force of unobservable evolutionary attraction (towards the Sun) of hypothetical astronomical objects that can move in circular orbits in the dynamic gravitational field of the Sun is as follows:

$$-\mathbf{F}_{cev0} = \mathbf{F}_{in0} + \mathbf{F}_{gr} = \frac{m_{00}(v_0^2 - v_{cgr}^2)}{r_0\sqrt{a_c b_c}} = \frac{m_{00}c^2}{r_0\sqrt{a_c b_c}}\left[\frac{r_g}{2r_0} - \frac{1}{\sqrt{b_c}}\left(\frac{r_g}{4(r_0 - r_g)} - \frac{\Lambda r^2}{3}\right)\right] \approx \frac{m_{00}c^2 r_{gc}}{2r_0^2} = \frac{m_{00}v_0^2}{2r_0},$$

where: $r_0 = (r_1 + r_2)/2$ corresponds to the maximum possible value of the angular momentum of the object ($v^2r^2 - v_0^2r_0^2 = -c^2r_g(r - r_0)^2/2r_0 \le 0$).

Also we obtain the centripetal pseudo-force of unobservable evolutionary attraction of planets in the dynamic gravitational field of the Sun at aphelions and perihelions:

$$-\mathbf{F}_{cev(aph)} \approx m_{00}c^2\left[\frac{2r_2r_{gc}}{r_1^2(r_1 + r_2)} - \frac{r_{gc}}{2r_1^2}\right] = \frac{m_{00}c^2r_{gc}(3r_2 - r_1)}{2r_1^2(r_1 + r_2)} = \frac{m_{00}v_1^2(3r_2 - r_1)}{4r_1r_2},$$

$$-\mathbf{F}_{cev(per)} \approx m_{00}c^2\left[\frac{2r_1r_{gc}}{r_2^2(r_1 + r_2)} - \frac{r_{gc}}{2r_2^2}\right] = \frac{m_{00}c^2r_{gc}(3r_1 - r_2)}{2r_2^2(r_1 + r_2)} = \frac{m_{00}v_2^2(3r_1 - r_2)}{4r_1r_2}.$$

Thus, if in a dynamic gravitational field the centripetal pseudo-forces of unobservable evolutionary attraction (towards the Sun) of hypothetical astronomical objects that can move in circular orbits are strictly equal to the gravitational pseudo-forces, then the pseudo-forces of unobservable evolutionary attraction of planets moving in elliptical orbits are not equal to them, but for all planets they are precisely centripetal.

The use of the parameter $b_s = b\Gamma_s^2 = b/(1 - v^2c^{-2}/b) = v_{ls}^2c^{-2} = \mathbf{const}(t)$[10], 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 [4–6]. 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

[10] 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.

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 this into account, a dynamic gravitational field of a flat (or superthin) galaxies is examined here: the field in which the velocities *v* of the hypothetical equilibrium circular motion ($r = \mathbf{const}$) of astronomical objects do not depend directly on the radial coordinates *r*, but depend only on the values of the coordinate pseudo-vacuum velocity v_{cv} of light of GR or on the equivalent limit velocity v_l or v_{lc} of matter group motion of the RGTD [4, 5]. 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 in GR and RGTD on the cosmological fundamental constant $\Lambda = 3H_E^2 c^{-2} = \mathbf{const}(t)$ and, therefore, on the 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 [4, 5, 37].

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 CFREU.

The solution of the equation of the dynamic gravitational field of flat galaxies obtained here may also correspond to other galaxies. After all, spherical and elliptical galaxies can have a multi-sector structure, in which each sector can contain a separate flat microgalaxy. Such a sectoral configuration of the general dynamic gravitational field of the entire galaxy will actually isolate its individual microgalaxies from each other.

At the edge of the galaxy ($r_p \approx \Lambda^{-1/2}$), 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 fundamental (background) Euclidean space of comoving with expanding Universe FR, and not by the weak gravitational pseudo-forces at the edge of the galaxy.

The dependence of Λ-reduced 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 [5, 49], 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 [4, 5, 16]:

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

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

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

where: b_c and a_c are the parameters of the dynamic gravitational field equations of the non-continuous matter of the galaxy; $p_N V_N = \tilde{\beta}_{pVN}E = b_c\tilde{\beta}_{pVN}m_{gr}c^2 = \tilde{\beta}_{pVN}m_{in}c^2$, $\tilde{\beta}_{pVN} \neq \mathbf{const}(r)$, $S_N = m_{gr}c^2/T_N = m_{00}c^2/T_{00} = \mathbf{const}(r)$, $T_{00N} = T_N\sqrt{b_c} = \mathbf{const}(r)$, $m_{00} = m_{gr}\sqrt{b_c} = m_{in}/\sqrt{b_c} = \mathbf{const}(r)$, $\mu_{00} = m_{00}/V \neq \mathbf{const}(r)$, $\mu_{gr} = m_{00}/\sqrt{b_c}V = \mu_{in}/b_c \neq \mathbf{const}(r)$, $\mu_{in} = m_{00}\sqrt{b_c}/V \neq \mathbf{const}(r)$, $V \neq \mathbf{const}(r)$ 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, 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 diffeomorphically-conjugated forms [57] 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 [13] 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 *r* 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, can be matched with the graphs on Fig.2 [4, 5, 56]:

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

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

where: b_{c0} and b_{ce0} are the parameters of the gravitational field in the galaxy's centric intrinsic FR_g; $(dv/db_c)_e = (dv/dr)_e = 0$, $q = b_{ce}r_{ge}/2r_e = {}^E G_{eeff} M_{00g} b_{ce} c^{-2}/r_e = \varsigma M_{grg} m_{gre}\, {}^E G_{00} c^{-2}/m_{00e} r_e = \varsigma M_{00g}\, {}^E G_{00} c^{-2}/r_e b_{ce}$, $n = {}^E G_{00}/{}^E G_{0ge} = b_{ce} < 1$, $n_0 = {}^g G_{00}/{}^g G_{0e} = b_{ce0} < 1$; ${}^E G_{eeff} = \varsigma\, {}^E G_{0ge}/b_{ce} = \varsigma\, {}^E G_{00} b_{ce}^{-2}$ 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 the galactic star *e*; ${}^g G_{00}$ and ${}^g G_{0e}$ are the gravitational constants in FR_g, respectively, of the galaxy and its star *e* in 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; $u(r)$ is the indicator of the presence of non-rigidity of the FR_{0g} of a galaxy that was cooling in quasi-equilibrium state ($\mathbf{F}_{in} < -\mathbf{F}_{gr}$); 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 $v_{\max} \equiv v_e = b_{ce}^{1/2}\widehat{v}_e(b_e) = v_{lce}\widehat{v}_e/c$; 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 moving in a circular orbit at the maximum possible speed.

In the first approximate dependence [4, 5, 16, 49], 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 [57]:

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

$$r = r_e \exp\left[\pm(1/2q)\sqrt{v^{-4}v_e^4 - 1}\right] = r_e \exp\left\{1/4q)\left[(b_c/b_{ce})^n - (b_{ce}/b_c)^n\right]\right\},$$

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

$$b'_c = \frac{db_c}{dr} = \frac{2qb_c}{nr\sqrt{1+[2n_g v_e^2 c^{-2}\ln(r/r_e)]^2}} = \frac{4qb_c}{nr[(b_c/b_{ce})^n + (b_{ce}/b_c)^n]} = \frac{4b_c \varsigma M_{00g}\,{}^E G_{00}\exp\left\{\mp(1/4q)\left[(b_c/b_{ce})^n - (b_{ce}/b_c)^n\right]\right\}}{c^2 b_{ce}^2 r_e^2[(b_c/b_{ce})^n + (b_{ce}/b_c)^n]},$$

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

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

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

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

and: r_g and r_{ge} [11] 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).

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

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:

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

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 the 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 ($db_c/dr \neq 0$ at all points of its infinite space).

The second dependence, on the contrary, ensures the presence of the event pseudo-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. Due to:

$$\frac{r\sqrt{a_c b_c}}{m_{00}}\mathbf{F}_{in} = \frac{v^2(1-\Lambda r^2)}{(1-\Lambda r^2/3)} = \frac{r\sqrt{a_c b_c}}{m_{00}}\mathbf{F}_{gr} = \frac{rc^2}{2}\frac{d\ln b_c}{dr} = \frac{2c^2 q(1-\Lambda r^2)}{n(1-\Lambda r^2/3)[(b_c/b_{ct})^n+(b_{ce}/b_c)^n]} \quad \text{(when: } u=0\text{)},$$

$$v^2 = \frac{2c^2 q}{n[(b_c/b_{ct})^n+(b_{ce}/b_c)^n]}, \qquad v_e^2 = \frac{c^2 q}{n} = \frac{c^2(b_{ce}r_{ge}/2r_e)}{b_{ce}} = \frac{c^2 r_{ge}}{2r_e},$$

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

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

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

$$b_c = k_b b_{ce} = b_{ce}\left(v_e^2 v^{-2} \pm \sqrt{v_e^4 v^{-4}-1}\right)^{1/n} = b_{ce}\left(v_e^2 v^{-2} \mp \sqrt{v_e^4 v^{-4}-1}\right)^{-1/n} =$$

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

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

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

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

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

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

$$\mu_{grst} = \frac{m_{00}}{\sqrt{b_c}V} = \frac{2\varsigma M_{00g}\,{}^E G_{00}(1-\Lambda r^2)(r^{-2}-r_g r^{-3}-\Lambda/3)}{\kappa c^4 r_e b_{ce}^2 (1-b_c)(1-\Lambda r^2/3)\left(\sqrt{1+A^2}-B\right)} + \frac{2\Lambda/3 - r_g r^{-3}}{\kappa c^2 (1-b_c)},$$

$$\mu_{grpst} = \frac{2\Lambda/3}{\kappa c^2 (1-b_{c\max})} = \frac{H_E^2}{4\pi\,{}^E G_{00}(1-b_{c\max})}, \qquad r_g = r_{ge} + \int_{r_e}^{r} r_g' dr,$$

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

μ_{grst} is standard value of the gravitational mass density of the galaxy matter,

$\mu_{grpst} = 4.8596 \cdot 10^{-27}/(1-b_{c\max})$ $[kg/m^3]$ is non-zero standard value at the edge of the galaxy ($r_p = \Lambda^{-1/2} = 8.5734 \cdot 10^{25}$ $[m]$ =2,778 $[Gpc]$) 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 [39]), 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:

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

or using dependent on it parameter S:

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

$$r_g = r-\frac{\Lambda r^3}{3}-(1-b_c)\exp\left[-\int\frac{b_cdr}{(1-b_c)r}\right]\times\int\left\{\frac{1-\Lambda r^2}{(1-b_c)^2}\exp\left[\int\frac{b_cdr}{(1-b_c)r}\right]\right\}dr = r-\frac{\Lambda r^3}{3}-\frac{n(r_e-\Lambda r_e^3/3)(1-b_c)}{4q}\exp\left[-\int\frac{b_cdr}{(1-b_c)r}\right]\times$$

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

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

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

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

At $u = -1$ ($\mathbf{F}_{in} << -\mathbf{F}_{gr}$) 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:

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

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 ($u = -v_e^2 v^{-2}/2$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$), 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 $u = -\varepsilon(z_e)v_e^2 v^{-2}/2$ ($\mathbf{F}_{in} < -\mathbf{F}_{gr}$), 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.

Also what is important is that even in an incredibly weak gravitational field (when $\varepsilon(z_e) = 1$, $u = -v_e^2 v^{-2}/2$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$) and even at large radial distances, astronomical objects will rotate around the center of the galaxy with orbital velocities very close to the maximum possible speed [53, 54]. 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 $u = -v_e^2 v^{-2}/2$ ($\varepsilon(z_e) = 1$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$) at very large distances from the center of the galaxy. After all, when $u = -v_e^2 v^{-2}/2$ ($\varepsilon(z_e) = 1$, $\mathbf{F}_{in} << -\mathbf{F}_{gr}$), 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 $u = 0$ ($\mathbf{F}_{in} = -\mathbf{F}_{gr}$):

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

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

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

$$>> \frac{n(r-\Lambda r^3/3)}{4qb_c(1-\Lambda r^2)}\left[\left(\frac{b_c}{b_{ce}}\right)^n+\left(\frac{b_{ce}}{b_c}\right)^n\right].$$

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:

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

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

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

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-FR$_{g0}$, 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 centric intrinsic GT-FR$_{g0}$ (^{ec}FR$_{g0}$) of galaxy [4, 5, 49, 57]:

$$v_0 = v_{e0}\sqrt{\frac{2}{(b_{c0}/b_{ce0})^{b_{ce0}} + (b_{ce0}/b_{c0})^{b_{ce0}}}} = v_{e0}\left\{1+4q_0^2\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_{c0})\ln\left(\frac{1-b_{c0}}{1-b_{ce0}}\right)\right]^2\right\}^{-\frac{1}{4}},$$

where: $q_0 = qb_e/b_{e0}$, $v_{e0}^2 = v_e^2 b_{e0}/b_e$, $b_{c0} = b_{ce0}(b_c/b_{ce})^{\frac{b_{ce}}{b_{ce0}}} = b_{ce0}\left[(v_{e0}^2 v_0^{-2} \pm \sqrt{v_{e0}^4 v_0^{-4} - 1}\right]^{\frac{1}{b_{ce0}}} =$

$$= b_{ce0}\left\{\sqrt{1+4q_0^2\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_{c0})\ln\left(\frac{1-b_{c0}}{1-b_{ce0}}\right)\right]^2} \pm 2q_0\left[\ln\left(\frac{r-\Lambda r^3/3}{r_e-\Lambda r_e^3/3}\right)-u(b_{c0})\ln\left(\frac{1-b_{c0}}{1-b_{ce0}}\right)\right]\right\}^{\frac{1}{b_{ce0}}},$$

$$r-\frac{\Lambda r^3}{3} = \frac{(r_e-\Lambda r_e^3/3)(1-b_{c0})^u}{(1-b_{ce0})^u}\exp\left[\pm\frac{1}{2q_0}\sqrt{v_0^{-4}v_{e0}^4-1}\right] = \frac{(r_e-\Lambda r_e^3/3)(1-b_{c0})^u}{(1-b_{ce0})^u}\exp\left\{\frac{1}{4q_0}\left[\left(\frac{b_{c0}}{b_{ce0}}\right)^{b_{ce0}}-\left(\frac{b_{ce0}}{b_{c0}}\right)^{b_{ce0}}\right]\right\}.$$

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 ${}^{ec}\mathrm{FR}_g$ of a distant galaxy and in the ${}^{E}\mathrm{FR}$ 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 values of gravitational pseudo-force and the centrifugal pseudo-force of inertia acting on the star *e* in the observer's ${}^{E}\mathrm{FR}$ 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 GT-FR_{0g} of the galaxy when $u = -v_e^2 v^{-2} / 2$ the following typical radial distribution of the average density of gravitational mass of the matter in the galaxy takes place:

$$ \mu_{grst0} = \frac{m_{00}}{\sqrt{b_{c0}} V} = \frac{2 q_0 (1 - \Lambda r^2)(r^{-2} - r_{g0} r^{-3} - \Lambda / 3)}{n_0 \kappa c^2 (1 - b_{c0})(1 - \Lambda r^2 / 3)\left(\sqrt{1 + A^2} - B\right)} + \frac{2\Lambda / 3 - r_{g0} r^{-3}}{\kappa c^2 (1 - b_{c0})} \,, \tag{9} $$

$$ A = 2 q_0 \left[\ln\left(\frac{r - \Lambda r^3 / 3}{r_e - \Lambda r_e^3 / 3} \right) + \frac{v_{e0}^2}{2 v_0^2} \ln\left(\frac{1 - b_{c0}}{1 - b_{ce0}} \right) \right], \quad B = \frac{1}{2} \left\{ n_0 \ln\left(\frac{1 - b_{c0}}{1 - b_{ce0}} \right) \left[\left(\frac{b_{c0}}{b_{ce0}} \right)^{n_0} - \left(\frac{b_{ce0}}{b_{c0}} \right)^{n_0} \right] - \frac{b_{c0}}{1 - b_{c0}} \left[\left(\frac{b_{c0}}{b_{ce0}} \right)^{n_0} + \left(\frac{b_{ce0}}{b_{c0}} \right)^{n_0} \right] \right\}. $$

According to this distribution, when at the edge of the galaxy ($r_p = \Lambda^{-1/2} = 8.5734 \cdot 10^{25}$ [m] $= 2.778$ [Gpc]) 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:

$$\mu_{grpst\,0} = 2\Lambda / 3\kappa c^2 (1 - b_{c0\max}) = H_E^2 / 4\pi\, {}^E G_{00} (1 - b_{c0\max}) .$$

It is obvious that the essential time dilation, which is being observed for far galaxies (due to $b_{ce} = 1.12656 \cdot 10^{-6}$), can be considered as evolutionary-gravitational phenomenon that is consistent with the linear Hubble dependence of redshift of wavelength of radiation and that significantly differs from this dependence only for quasars that have very strong gravitational field.

Due to the low strength of gravitational field outside the loose nuclei of galaxies they can indeed be considered as "island Universes" [34–36] (non-isolated island systems [41]) that have individual intrinsic values of gravitational constant. Taking into account the larger values in the past of the gravitational masses not only of the attracted bodies, but also of the bodies that attract them, the complete galactic value of the gravitational "constant" (2) will be as follows:

$${}^g G_{00} \approx {}^g G_{00dop} = \frac{{}^E G_{00}}{b_{cdop}^2} = \left(\frac{1 + z_{dop}}{f(z_{dop})} \right)^2 {}^E G_{00} = \frac{D_M^2}{D_A^2} \frac{{}^E G_{00}}{[f(z_{dop})]^2} \equiv \left(\frac{1 + z_{dop}}{1 + 2z_{dop}} \right)^2 \frac{R^2}{r^2} {}^E G_{00} = \frac{(1 + z_{dop})^4}{(1 + 2z_{dop})^2} {}^E G_{00} .$$

The most significant fact id the absence of relativistic dilation of intrinsic time of galaxies according to received transformations. And this confirms the correspondence of the orbital motion of galactic astronomical objects to GT-Hamiltonians [Newtonians] and GT-Lagrangians [Keplerians] or to Lorentz-conformal transformation of increments of metrical intervals and metrical time for the galaxies [4]. Since the galaxies in FR of people's world are inertially falling onto the pseudo-horizon of the past, then according to these conformal relativistic transformations there fundamentally should be no relativistic dilation of their time. The dilation of their intrinsic time rate could be only gravitational in cosmological past because the gas-dust matter, in which they were immersed, had big density at that time. For the nearest galaxies, which (as our galaxy) are located now in the outer space, we can accept that angular velocity of observed orbital motion of their objects was not essentially smaller at that time than it is now. And, consequently, radiuses of orbits of their objects in CFREU are practically not decreased since that distant time.

And, consequently, in contrast to FR of superficially cooled down astronomical objects, the galaxies itself (similarly to their evolutionary cooling down stars) have non-rigid FR. Radial distances to their stars $R_s = R_{s0} \exp[-H_E(\tau - \tau_0)]$ in FRs of their superficially cooled down planets are evolutionary decreasing by the reverse Hubble law due to evolutionary decreasing of gravitational constant ${}^E G_R = {}^E G_{R0} \exp[-2H_E(\tau - \tau_0)]$ in these FRs. So due the stars of the galaxy indeed move not in closed orbits but in spiral orbits. And, consequently, this fits well with the spiral-wave nature of matter and of the Universe as a whole [9, 11, 17]. Of course, by using the gauge transformation of scales of intrinsic time of galaxies [14] we can guarantee the invariance of gravitational constant in their non-rigid FRs [38]. However, the galactic objects will anyway move in CFREU in spiral orbits.

True relativistic transformations of coordinate and time increments

In GR, as in RGTD, astronomical (gravithermodynamic) time is used to describe the motion of matter in a gravitational field. Due to this astronomical (gravithermodynamic) time the coordinate pseudo-vacuum velocity of light and the alternative maximum possible (limit) velocity of matter motion can take any values less than the constant of the velocity of light in different FRs. Lorentz transformations of velocity are designed to preserve the value of the velocity of light in any inertial FRs and, therefore, use not gravithermodynamic, but gravity-quantum time to describe the motion of matter. In addition, they are based on classical Hamiltonians and Lagrangians, and not on the relativistic Newtonians and Keplerians considered here, and therefore are not suitable for a true reflection of reality in GR and RGTD.

Under the condition of non-uniform motion of matter, the transformations of the increments of spatial coordinates and time based on the parameter of the dynamic gravitational field used in the Newtonian and the Keplerian [76] will be as follows:

$$dx = \frac{\sqrt{b}}{\sqrt{b_c}}(dx' - v'_k dt') = \frac{dx' - v'_k dt'}{\sqrt{1+v'^2_k v'^{-2}_l}} = d\hat{x}' - \hat{v}'_k dt', \quad dt = \frac{dt' + v'_k v'^{-2}_l dx'}{\sqrt{1+v'^2_k v'^{-2}_l}}, \quad dy = dy', \quad dz = dz',$$

$$dx' = \frac{\sqrt{b}}{\sqrt{b_c}}(dx + v_k dt) = \frac{dx + v_k dt}{\sqrt{1+v^2_k v^{-2}_l}} = d\hat{x} + \hat{v}_k dt, \quad dt' = \frac{dt - v_k v^{-2}_l dx}{\sqrt{1+v^2_k v^{-2}_l}}, \quad v'_y = \frac{v_y\sqrt{1+v^2_k v^{-2}_l}}{1-v_k v_x v^{-2}_l},$$

$$v'_z = \frac{v_z\sqrt{1+v^2_k v^{-2}_l}}{1-v_k v_x v^{-2}_l}, \quad v_x = \frac{dx' - v'_k dt'}{dt' + v_k v^{-2}_l dx'} = \frac{v'_x - v'_k}{1+v'_k v'_x v'^{-2}_l} = \frac{(\hat{v}'_x - \hat{v}'_k)\sqrt{1+v'^2_k v'^{-2}_l}}{1+v'_k v'_x v'^{-2}_l},$$

$$v'_x = \frac{v_x + v_k}{1-v_k v_x v^{-2}_l} = \frac{(\hat{v}_x + \hat{v}_k)\sqrt{1+v^2_k v^{-2}_l}}{1-v_k v_x v^{-2}_l}, \quad v = \frac{\sqrt{[(\hat{v}'_x - \hat{v}'_k)^2 + v'^2_y + v'^2_z](1+v'^2_k v'^{-2}_l)}}{1+v'_k v'_x v'^{-2}_l},$$

$$v' \neq \frac{\sqrt{[(\hat{v}_x + \hat{v}_k)^2 + v^2_y + v^2_z](1+v^2_k v^{-2}_l)}}{1-v_k v_x v^{-2}_l},$$

$$\hat{v}_x = \frac{v_x}{\sqrt{1+v'^2_k v'^{-2}_l}} = \frac{v'_x - v'_k}{(1+v'_k v'_x v'^{-2}_l)\sqrt{1+v'^2_k v'^{-2}_l}} = \frac{(\hat{v}'_x - \hat{v}'_k)}{1+v'_k v'_x v'^{-2}_l},$$

$$\widehat{v}'_x = \frac{v_x + v_k}{(1 - v_k v_x v_l^{-2})\sqrt{1 + v_k^2 v_l^{-2}}} = \frac{(\widehat{v}_x + \widehat{v}_k)}{1 - v_k v_x v_l^{-2}}, \quad v_{ly} = \frac{v'_{ly}\sqrt{1 + v_k'^2 v_l'^{-2}}}{1 + v'_k v'_{lx} v_l'^{-2}}, \quad v_{lz} = \frac{v'_{lz}\sqrt{1 + v_k'^2 v_l'^{-2}}}{1 + v'_k v'_{lx} v_l'^{-2}},$$

$$v_{lx} = \frac{v'_{lx} - v'_k}{1 + v'_k v'_{lx} v_l'^{-2}} = \frac{(\widehat{v}'_{lx} - \widehat{v}'_k)\sqrt{1 + v_k'^2 v_l'^{-2}}}{1 + v'_k v'_{lx} v_l'^{-2}}; \quad v_l = v'_l\left(\frac{v'_l - v'_k}{v'_l + v'_k}\right) = v'_l\left(\frac{v_l - v_k}{v_l + v_k}\right), \quad \widehat{v}_l = \widehat{v}'_l\left(\frac{v_l - v_k}{v_l + v_k}\right)$$

and $v'_l = v_l\left(\frac{v_l + v_k}{v_l - v_k}\right)$ (when $v_{ly} = 0$ and $v_{lz} = 0$); $dt_p = \frac{dt'_k}{\sqrt{1 + v_k'^2 v_l'^{-2}}}$, $dt'_k = \frac{dt_p}{\sqrt{1 + v_k^2 v_l^{-2}}}$,

where: $b = v_l^2 c^{-2}$, $v'_k = -v'_p = v_k v'_l / v_l = v_k (1 + v_k^2 v_l^{-2})^{-1/2} < v_k$;

$d\widehat{x}_k = (1 + v_k^2 v_l^{-2})^{-1/2} dx_k < dx_k$ and $d\widehat{x}'_p = (1 + v_p'^2 v_l'^{-2})^{-1/2} dx'_p = (1 + v_k^2 v_l^{-2})^{-1/2} dx'_p$ are increments of fundamentally invariable metric segments in space, which has a kinematic "curvature" [4,5].

In these transformations, as in the Lorentz transformations, there is mutual observation, but not at all a slowdown, but an acceleration of the flow of time of the opposite observed object that moves with speed v_k or v'_k accordingly. But in fact, the flow of time is accelerated only for a body that is freely falling onto a massive planet that has a gravitational field. After all, the gravitational time dilation (deceleration of the flow of time) of the falling body is actually compensated due to the high speed of the fall of the body.

Thanks to these transformations, there will be no dilation of astronomical time for any body (of the Solar System) moving in a gravitational field by inertia. After all, all astronomical bodies came from the distant outskirts of the Solar System, where their velocity was low, and the parameter $b \approx b_c \approx 1$. And therefore, thanks to the preservation (in the process of movement by inertia) of their rapid peripheral rate of flow of gravity-quantum time, supported now by the high speed of their orbital motion and by the increase in the velocity of light $v_l = v'_l[(v'_l + v'_k)/(v'_l - v'_k)]$ at perihelions and aphelions caused by it, they did not experience gravitational dilation of their time. Therefore, in the gravity-quantum time of conditionally stationary clocks located along their orbit of movement, instead of slowing down the rate of flow of their proper time, there is on the contrary its acceleration.

Due to the high speed of rapid distancing from the observer p of distant galaxies ($dx = d\widehat{r} = \sqrt{a}dr$), the gradual decrease in the coordinate pseudo-vacuum velocity of light is also compensated along with their approach to the pseudo-horizon of the infinitely distant cosmological past. And that is why distant galaxies do not experience a dilation of their proper time. According to these transformations, there is also mutual observation, but not a reduction, but an increase (along the direction of motion) of the increments of the coordinates (and not metric segments $d\widehat{x}$ and $d\widehat{x}'$) of the observed moving objects. After all, the relativistic increase (or Lorentz reduction) of the sizes of bodies in the FR of people's world should be considered fundamentally unobservable, as well as their isotropic gravitational decrease in the background Euclidean space [13] CFREU. Instead of the relativistic deformation of moving bodies, one should consider the presence of a kinematic "curvature" [4,5] of the observer's intrinsic space created by their motion. But in the comoving space of the expanding Universe, moving bodies, on the contrary, undergo a comprehensive isotropic reduction in their size, similarly to how it occurs near the center of gravity.

Similar relativistic Lorentz transformations, which use (instead of this parameter b_c) the parameter $b_w = 1/b_s = \Gamma^{-2}/b = (1 - v_k^2 c^{-2}/b)/b$ [76] not identical to this parameter b_c, do not guarantee this. After all, according to them, during the free fall of a body in a gravitational field, which is a motion by inertia, kinematic effects do not compensate for the gravitational dilation of its proper time, but on the contrary increase it. And therefore, the Lorentz transformations, under which, when the y' and z' axes are orthogonal to axis x', the axes y and z are also not orthogonal to axis x, are suitable only for uniform (pseudo-inertial) motion of matter in the process of its evolutionary self-contraction in the background Euclidean space of the CFREU or during artificial acceleration of quasiparticles in accelerators.

Imaginary non-baryonic dark matter

The gravitational mass of the stars of distant galaxies greatly exceeds the inertial mass of these stars in the GT-FR of the observer. And it is precisely this, and not at all imaginary need for dark non-baryonic matter, that corresponds to the results of observations in the distant galaxies of the Universe. And besides, this indicates the presence of a very large value of gravitational "constant" in the own GT-FR stars of distant galaxies in that distant cosmological epoch. It exceeds Newton's gravitational constant not even by the square, but by the bisquare (to the fourth power) of the ratio of the constant velocity of light to the coordinate velocity of light. But in the GT-FR of the Earth observer, it can be considered only as the effective value of the gravitational "constant" (2). After all, the observed results in a distant galaxy are actually. After all, it is precisely the non-usage of logarithmic gravitational potentials in the GT-FR of observer, as well as the failure to take into account in it the significant excesses of the observed gravitational masses of its stars over their inertial masses (that is, in fact, the failure to take into account the significant excess of the

Lagrangian of the ordinary rest energy of each of the stars over the Hamiltonian of its inert free energy [4, 5]) are responsible for unacceptable results of observations in a distant galaxy.

According to fictive Etherington's identity (paralogism) only imaginary (wrong) value of transverse comoving distance to the galaxy is determined nowadays in astronomical photometric calculations:

$$^{i}D_M = \frac{D_L}{1+z}.$$

It is $(1+z)^{1/2}$ times smaller than the right (real) value of transverse comoving distance to the galaxy:

$$^{r}D_M = \frac{D_L}{\sqrt{1+z}}.$$

And, therefore, it is $(1+z)^{1/2}$ times smaller than the radial coordinate $R={}^{r}D_M$ of the galaxy in Euclidean space of CFREU in the moment of registration of its radiation [11, 12]. And it is also $(1+z)^{1/2}$ times bigger that the Schwarzschild radius of the galaxy in GT-FR:

$$r = R_0 = {}^{r}D_A = {}^{i}D_A\sqrt{1+z} = D_L(1+z)^{-3/2}.$$

This radius is equal to radial coordinate R_0 of the galaxy in CFREU in the moment of radiation emission. And, therefore, it is identical to corrected photometric distance to the galaxy in GT-FR and is equal to the right (real) value of angular diameter distance $^{r}D_A$. That is because of:

$$^{r}D_M / {}^{e}D_A = R/r = R/R_0 = 1+z.$$

However, usage of the wrong value of the angular diameter distance to the galaxy:

$$^{i}D_A = {}^{i}D_M/(1+z) = D_L(1+z)^{-2}$$

allows only to reduce the imaginary necessity in phantom non-baryonic "dark matter" in the Universe. According to many astronomical observations the usage of $^{i}D_A$ does not allow to completely get rid of that fictive need.

It is obvious that not very massive bilayered shell-like quasars that have strong gravitational field only in their close neighbourhood are located in the centers of many galaxies. That is possible because the effective value of gravitational constant $^{E}G_{eff} = {}^{E}G_{00}b^{-2} = {}^{E}G_{00}k(z, \mu_{os})$ (2) tends to infinity while approaching to median singular sphere of the quasar when logarithmic gravitational potential is used $^{E}G_{eff}$ depends on angular diameter α of circular orbit in the following way:

$$^{E}G_{eff} \approx {}^{E}G_{00}[1 - 2c^{-2}M_{gr}\,{}^{E}G_{00}(1+z)^{3/2}/D_L \sin(\alpha/2) - z^2(1+z)^{-2}]^{-2},$$

when the orbital plane of astronomical body is perpendicular to the radius-vector of the galaxy center.

It is possible that imaginary deficit of baryonic matter in loose nucleus of the galaxy is indeed compensated by quite big effective value of gravitational constant for all its astronomical objects. And exactly that deficit of baryonic matter allows us to consider logarithmic gravitational potential (1) as the most effective alternative to phantom non-baryonic dark matter.

Of course, the radiation spectrum of far galaxies for sure cannot depend on the imaginary time dilation, “observed” in GT-FR in the points of instantaneous disposition of these galaxies, because the relativistic dilation of the GT-FR's intrinsic gravity-quantum time occurs only within the extended empty space of the Earth. This expanded empty space is only formally (imaginary) evolutionarily self-contracting in CFREU along with the Earth. Therefore, the time dilation is also only formally “observed” in the GT-FR. That’s why, according to line element of GT-FR [11, 12] velocities of astronomical objects in the picture plane in intrinsic gravity-quantum time of the observer do not depend at all on the dilation of intrinsic gravity-quantum time of GT-FR in the points of instantaneous disposition of those objects.

Of course, the counting of intrinsic gravity-quantum time of the observer could be replaced by the counting of dilated gravity-quantum time in those points of GT-FR. However, then the gravity-quantum value of gravitational constant (calibrated accordingly) should be used:

$$^{jE}G_{00} = {}^{E}G_{0j}c^2 v_{lj}^{-2} = {}^{E}G_{0j}(1+z)^2/(1+2z) = {}^{E}G_{00}(1+z)^4(1+2z)^{-2}$$

Results of such imaginary “observation” of the motion in the picture plane of distant astronomical object in dilated graviti-quantum time of point j of its disposition, of course, will be changed. However, those results will correspond to the same regularities as the results of observation in standard astronomical time of observer’s GT-FR.

It is worth mentioning that analysis of the motion of astronomical objects can be done in accordance to CTMHS in CFREU using the real metrical distance ${}^{r}D_M = R$ to them instead of ${}^{i}D_M$. Such analysis would require taking into account that length standard in CFREU (at the moment of observation) is (1+z) times smaller than its size during the emission radiation. Therefore, it would be also required to use in CFREU $(1+z)$ times bigger values of accelerations and velocities of those objects, as well as, values of the velocity of light in the points of dispositions of those objects. Furthermore, it would be required to use $(1+z)^3$ times bigger value of gravitational constant in the points of disposition of observed objects. However it is much simpler to use in CFREU not the ${}^{r}D_{M}$, but the normalized by $(1+z)$ its value. That is because it is identical to the angular diameter distance:

$$ {}^{r}D_{A} = R_{0} = r = {}^{r}D_{M}/(1+z) = {}^{i}D_{M}/\sqrt{1+z}. $$

If we follow mentioned above simpler approach, we would not need to perform all mentioned here transformations of all other characteristics and of gravitational constant. The total mutual correspondence of the motion of distant astronomical objects in picture plane in GT-FR and in CFREU denotes the possibility of mentioned above. That correspondence takes place due to invariance of angular characteristics in the case of radial transformations. Members of line elements of GT-FR and CFREU that correspond to that motion exactly match each other when performed normalization of distance ${}^{r}D_{M} = R$ (usage of the distance ${}^{r}D_{A} = R_{0} = r$ instead of it) is taken into account [11, 12].

It is obvious, that one of the possible reasons of fictive necessity of imaginary non-baryonic dark matter in the Universe is the significantly smaller density of stellar substance in CFREU and, therefore, in corresponding to it picture plane of distant observer, than in GT-FR of observed galaxy.

However, along with the absence of usage of effective value of gravitational constant the main reason for imaginary necessity to have non-baryonic dark matter in the Universe is the misconception about relativistic dilation of intrinsic time of the galaxies that are distancing from the observer at a high velocity. Exactly due to this misconception it is wrongly considered that in the intrinsic time of such galaxy the stars rotate around its center at significantly larger velocities than in the time of distant observer. The centrifugal forces of inertia (in case they are significantly larger than in reality) require the false necessity to have significantly bigger gravitational field (namely to form which the imaginary dark matter is required).

It is obvious, that according to results of galaxies observations in more wide spectral diapason there would be no deficit of ordinary matter [58] (of course when using the real value of the angular diameter distance ${}^{r}D_{A} = R_{0}$ in CFREU or the Schwarzschild coordinate $r = R_{0}$ in GT-FR). However we can totally get rid of fictive necessity of non-baryonic dark matter only when using the logarithmic gravitational potential as well as tensor of energy-momentum of RGTD. It means that, all motions of astronomical objects, observed in picture plane, can be explained without involving of phantom non-baryonic dark matter [58, 59]. For any arbitrary low value of density of the mass of matter on the edge of the galaxy μ_{in0p} the corresponding to it values of variable parameters a_e and n can be found according to (12) [49].

If imaginary deficit of mass occurs during some astronomical observations and when using logarithmic gravitational potential and tensor of energy-momentum of RGTD in calculations, then it can be caused by the ignoring of the possibility of self-organization of astronomical objects into cluster with extraordinary topology. That could be, for example, spiral and toroidal-like elliptical galaxies or shell-like globular clusters and spherical elliptical galaxies. These clusters and galaxies have multitude of gravity centres in the form of median line or median surface accordingly. In this case even the presence of central massive astronomical object is not required [58].

On the possible correlation between the imaginary relativistic and real gravitational time dilation on distant astronomical objects

Earth and Solar system are under the gravitational influence of not only our Milky Way galaxy and neighboring galaxies that are the part of “Local group”, but also of more distant astronomical objects. That is due to the fact that gravitational potentials of all of them are summed up in the points of Earth disposition:

$$\varphi_{S\Sigma} = c^2 \sum \ln\left({}^u v_{lj} / c\right).$$

Nowadays that total gravitational potential is quite close to zero. However, in far cosmological past it could be much bigger. The distances between our galaxy and clusters of other distant galaxies were much smaller in far cosmological past in GT-FR. Coordinate gravitational value of the limit velocity of matter motion ${}^u v_{los}$ in the outer space that surrounds astronomical objects was much smaller than the constant of the velocity of light c.

Isn’t it possible that the value of gravitational time dilation on distant astronomical objects correlates with the value of imaginary relativistic time dilation on them in GT-FR? And, therefore, astronomers are probably right that they decrease the distance to objects during their photometric calculations due to mentioned above facts. And that deceasing is performed via the multiplication of measured radiation flow $(1+z)^2$ times instead of $(1+z)$ times (as it is required using the CTMHS). Then, the real metrical value of comoving distance ${}^r D_M$ could be considered as equal to its imaginary calculated value ${}^i D_M$.

However, it would mean that only half of registered redshift could be related to gravitational redshift as well as to Doplerian redshift: $z_{1/2} = \sqrt{1+z} - 1$. Therefore, the problem of mutual inconsistencies of distances that are determined via photometric calculations and based on the redshift could become more significant. Thus, bigger quantity of dark energy could be required to be present in the Universe. That's why we should deny the possibility of such correlation.

It is obvious, that we can admit the correlation of gravitational time dilation in that far past only in outer space to essentially smaller time dilation in appropriate distant point of intrinsic space of GT-FR: $\Delta^i t_j / \Delta^j t_j = c / {}^i v_{lj} = (1+z)(1+2z)^{-1/2}$.

Imaginary Dark energy

Equations of GR gravitational field, in fact, describe the isolated from outer world states of matter and of its STC. Spatial distribution of the mass of matter in those equations specifies how the STC should be curved, while the STC specifies in what spatially inhomogeneous thermodynamic state matter should be. Consequently, the external gravitational influence on that isolated matter and on its STC is not taken into account in those equations. That external influence can be reflected in the tensor of energy-momentum due to the normalization (calibration) of gravitational constant that is the part of the expression for the Einstein's constant:

$$\kappa_{os} = 8\pi\, c^{-2} \left({}^u v_{los}^{-2} \right) G_{00}\,.$$

It can be reflected in the tensor of space-time curvature only using the normalization of cosmological Λ-part. That is because in contrast to coordinate velocities of light that are defined by the tensor of energy-momentum: $v_{lj} = c\sqrt{1+2z_j}/(1+z_j)$ the constant of the velocity of light c (which is used in the space-time curvature tensor) cannot be normalized. It is the spatially-temporal invariant. It is obvious, that the increment of logarithm of Hubble's parameter H defined by the Λ-part may be connected by certain proportionality coefficient m with the increment of gravitational potential of outer space:

$$\varphi_{os} = c^2 \ln\left({}^u v_{los} / c \right).$$

And, probably, this increment can be also connected by proportionality coefficient k with the increment at the distant point j of GT-FR of gravitational Hubble's potential:

$$\varphi_H = -c^2 \ln\left(v_{lj}/c\right), \qquad \frac{d\ln(H/H_0)}{dz} = m\frac{d\varphi_{os}}{dz} = -k\frac{d\varphi_H}{dz}.$$

Then, evolutional change of Hubble's parameter can be defined by the following empirical dependency: $$H = H_0\left(\frac{v_{lj}}{c}\right)^k = H_0\left(\frac{\sqrt{1+2z}}{1+z}\right)^k.$$

The dependency of the increment of metrical value of comoving distance ${}^rD_M$ to distant galaxy in CFREU on the increment of redshift z of radiation spectrum will be the following:

$$\frac{d({}^rD_M)}{dz} = \frac{c}{H_0}\left(\frac{1+z}{\sqrt{1+2z}}\right)^k.$$

Dependencies of luminosity distance D_L to supernovas of type Ia on the redshift z of their radiation spectrum have been modeled [30.6 ‑ 62.0] based on the results of astronomical observations of supernovas of type Ia [60. 63]. According to graphs of that dependencies (q.v. Fig. 3) evolutionary change of Hubble's parameter is almost not observed ($k = 0$).

Table 2. Dependencies of distances to astronomical objects on the redshift *z* of radiation of astronomical objects.

H, km/ sMpc	*D, Gpc*	Z						
		0.2	0.4	0.6	0.8	1.0	1.2	1.4
62.164	${}^rD_M$	0.96	1.93	2.89	3.86	4.82	5.79	6.75
	${}^rD_A$	0.80	1.38	1.81	2.14	2.41	2.63	2.81
	D_L	1.06	2.28	3.66	5.18	6.82	8.58	10.46
62.295	${}^rD_M$	0.96	1.92	2.89	3.85	4.81	5.77	6.74
	${}^rD_A$	0.80	1.37	1.80	2.14	2.41	2.62	2.81
	D_L	1.05	2.28	3.65	5.17	6.81	8.57	10.44
	a) ${}^gD_L$	1.03	2.25	3.65	5.20	6.90	8.65	10.50
65	${}^rD_M$	0.93	1.85	2.77	3.69	4.62	5.54	6.46
	${}^rD_A$	0.77	1.33	1.73	2.05	2.31	2.52	2.69
	D_L	1.01	2.18	3.50	4.95	6.52	8.21	10.01
	b) ${}^gD_L$	1.00	2.16	3.50	4.95-5.0	6.4-6.8	8.2-8.8	9.9-11.0

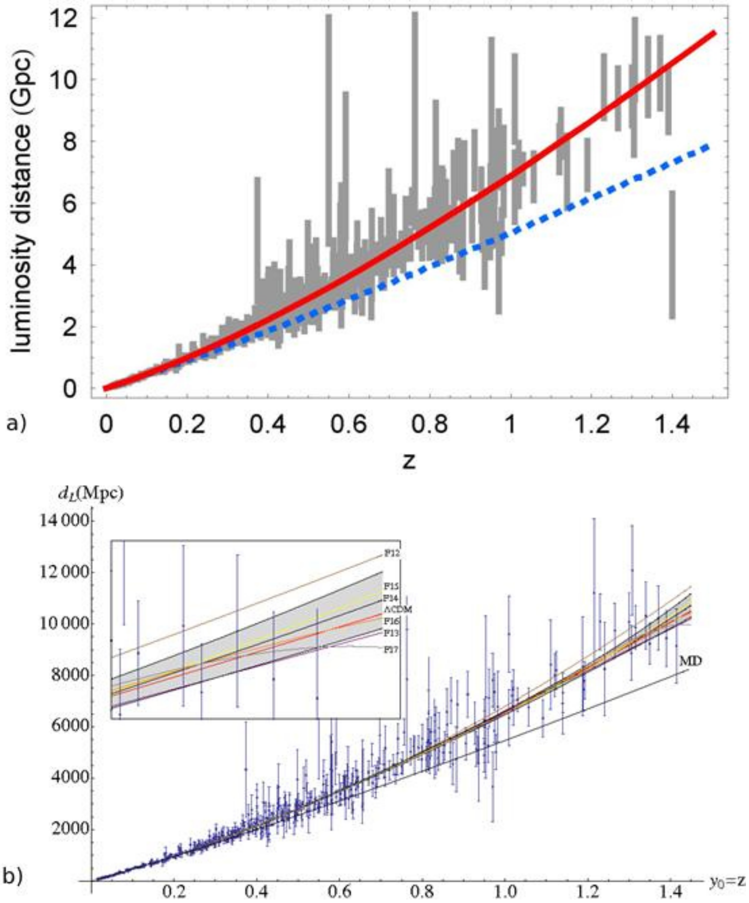


Fig. 3. Dependencies of distances to astronomical objects on the redshift of radiation of astronomical objects z:

a) luminosity distance D_L (solid line) to those objects [62] and metrical transverse comoving distance ${}^{r}D_M$ (dotted line) to astronomical objects in CFREU, as it is justified here;

b) graphical MD (straight) and ΛCDM (curve) models, and the one-sigma confidence-levels. The inset shows the right end, magnified [30].

That is because in case we use the most suitable values of Hubble constant the values of luminosity distance ${}^{g}D_L$ shown on graphs (see Table) are very slightly different from their calculated values [5, 64]:

$$D_L = {}^{r}D_M \sqrt{1+z} = (c/H) z \sqrt{1+z} \,.$$

Thus, teams of astronomers leaded by Perlmutter and Riess indeed confirmed (with high precision) the linearity of the dependence of redshift of radiation wavelength of distant galaxies on transverse comoving distance to them. And this their achievement is not at all less than attributed to them "discovery" (in reality – false one) of accelerated expansion of the Universe.

It is taken into account that the Hubble constant, like the length standards and the constant of the velocity of light, is a fundamentally unchangeable quantity in the rigid FRs. And this follows from the condition of continuity of spatial continuum in rigid FRs [37]. The most corresponding to astronomical observations value of Hubble constant is the value determined by the following empiric dependencies of it on the well known physical constants and characteristics:

$$H = c\sqrt{\Lambda/3} = \frac{\pi^4\alpha}{8N_{Dn}}\nu_{Bn} = \frac{2}{3}\pi\alpha\, t_p^2\left(\frac{\pi}{2}\nu_{Bn}\right)^3 = \frac{2}{3}\pi G e^2\left(\frac{m_n}{4\hbar}\right)^3 = 2.018859\cdot 10^{-18}[s^{-1}] = 62.29548\left[\frac{\text{km}}{\text{sMpc}}\right],$$

where: Λ is the cosmological constant, $N_{Dn} = 1.5(t_p\nu_{Bn})^2 = 3\pi chm_n^{-2}/G = 0.999885\cdot 10^{40}$ is the neutron large Dirac number, $\alpha = e^2/c\hbar$ is the fine structure constant, $\nu_{Bn} = m_n c^2/2\pi\hbar$ is the de Broglie wave frequency of the neutron, $t_p = (c^5\hbar G)^{1/2}$ is the Planck time, $\hbar = h/2\pi$ is the Dirac-Planck constant, $G \equiv G_{00}$ is the Newton's gravitational constant, e is the electric charge of the proton and electron, m_n is the mass of neutron.

However, the value of Hubble constant $H = (\pi^4\alpha/8N_{DH})\nu_{BH} = 62.1642$ [km/sMpc] $(\Lambda = 1.35457\cdot 10^{-52}\ [\text{m}^{-2}])$, that corresponds to the de Broglie wave frequency of hydrogen atom $\nu_{BH} = m_H c^2/2\pi\hbar = 2.270262\cdot 10^{23}\ [\text{s}^{-1}]$ ($N_{DH} = 1.5\cdot(t_p\nu_{BH})^{-2} = 1.001292\cdot 10^{40}$; $m_H = 1.67375\cdot 10^{-27}$ [kg]), only for small distances guarantees slightly worse correspondence to the data of graphical extrapolation of the results of astronomical observations. It is possible that Hubble constant took “hydrogen” value only after spontaneous transformation of quark or neutron medium of the Universe into hydrogen medium. However, of course, it was impossible before that to metrically characterize its continuous protomatter and, therefore, it is senseless to characterize it by “neutron” Hubble constant. Therefore, the final choice of one of these two close values of Hubble constant can be done based on the more precise results of astronomical observations.

It is obvious that supposed need in the presence of dark energy in The Universe is based not only on the taking into account the imaginary (fictive) dilation of the time on distant astronomical objects (postulated by Etherington’s identity), but also on the wish to have the linear dependence of redshift of radiation spectrum z on luminosity distance D_L to those objects. In fact, according to GR [11, 12, 14] the redshift is linearly dependent only on the transverse comoving distance D_M:

$$z = \Delta\lambda_D/\lambda_0 = HR/c = HD_M/c$$

and on the angular diameter distance:

$$\hat{z} = \Delta\nu_D/\nu_0 = -z/(1+z) = -Hr/c = -HD_A/c.$$

Moreover, the supposed dark energy could not be a certain physical entity at all. It could be just the effect of ubiquitous negative feedback. The deceleration of evolutionary self-contraction of matter in CFREU could take place in the distant past due to the presence of this negative feedback. Thus, evolutionary decrease of the velocity of light in CFREU using CTMHS in the distant past would also be decelerated. This deceleration, of the outer space course, could have been the greater the smaller the coordinate velocity of light ${}^{u}v_{c/os}$ in the outer space in GT-FR had been in distant past.

However, it is quite probable that Hubble's parameter is indeed unchangeable in time, as we had to make sure of it here. It even can be a spatially-temporal invariant alike the proper value of the velocity of light. The value of Hubble's constant can be precised after the more accurate processing of results of astronomical observations.

Conclusion

Isn't it the right time to proceed from the generation of new physical entities to the essential reduce of the number of previously invented mythical things-in-themselves?

Worship of the unknown is peculiar to human. And science society itself as a whole is subject not only to long-term theoretical misconceptions (science delusions [65–67]). He constantly needs new "idols", which are sometimes endowed with even fantastic properties. Physics did not avoid such fate. Microworld has been flooded by various exotic particles that are the "things-in-themselves". Our fantasy is not timid. That is why such imaginary particles as neutrino have even acquired the ability to spread faster than the velocity of light. But after all, the neutrino was actually introduced only in order to have the possibility to ignore the physical submicroinhomogeneity of the intranuclear space [11].

Amalie Emmy Noether has explained the conservation of energy and momentum by the uniformity, respectively, of time and space [40]. That is why the free fall of the bodies in physically inhomogeneous space, in which the gradient of coordinate velocity of light (related to gravitational field) is present, is accompanied by a continuous change of their momentum. What kind of the momentum balance can we talk about in the process of nuclear decay? After all, the restructuring of the intranuclear STC occurs during nuclear decay. Moreover, total energy of central nucleons is less that total energy of peripheral nucleons in physically microinhomogeneous space of nucleus. Only the eigenvalue of energy is the same for those nucleons. That is why the energy excess (not taken away by the decay products) is only redistributed within the remaining nucleons. And, consequently, that energy excess is not contained in a phantom neutrino (it never appears as a constituent of matter [68]). Indeed this energy excess is "consumed" on the decreasing of absolute value of total negative energy of the bond of all protons and neutrons of nucleus. Moreover, neutrino, in fact, is not recorded during the process of nuclear β-decay. The changes of collective space-time microstate of the whole gravithermodynamically bonded matter are indeed recorded. Only those changes can spread de facto instantly (with the superluminal velocity attributed by neutrino). That is because of the fact that every moment of intrinsic time of the matter corresponds precisely to the certain collective space-time (gravithermodynamical) microstate of that matter (and, consequently, to its specific Gibbs thermodynamic microstate).

Photon is also just a quant of energy of electromagnetic field [69, 70], and not a particle [9, 11]. After all, radiation and absorption of electromagnetic energy only in the form of its quanta (proportional to the frequency of an electromagnetic wave) is a property of micro-objects of matter, and not at all of the electromagnetic wave itself. And it is natural that electromagnetic wave cannot contain photons in principle. That is the same as there can be no raindrops in the rainwater tank. The appearance of two mutually correlated photons in the process of annihilation of any micro-object of matter and its corresponding micro-object of antimatter (that allows not to obey the Heisenberg Uncertainty Principle according to Einstein-Podolsky-Rosen paradox) also points on this. If we measure the coordinates of one of those photons with arbitrary high accuracy, then we can find the value of its momentum with the same arbitrary high accuracy due to the possibility to measure the momentum of correlated with it second photon with high accuracy.

Victor F. Weisskopf has repeatedly pointed out that not only the photon, but also the neutrino are not particles [43, 68]: "We do not count the light quantum among particles, since it is the quantum of the electromagnetic field and obeys Bose statistics. The neutrino is not included since it never appears as constituent of matter."

Moreover, it is quite possible that so called corpuscular-wave dualism is just the dualism of our primitive description of physical reality and not the dualism of physical reality. And the particle (corpuscle), obviously, is only a macroscopic concept. And, consequently, our physical representations are still mainly mechanistic, macrocentric and anthropo-limited. And we are simply unable to understand that in the microworld there is no, and in principle there can be no elementary particles. Terminal local drains of turns of the single global spiral-wave formation in the Universe are indeed taken for "elementary particles". Certain topological restrictions are imposed on the terminal spiral-wave formations [9, 11, 71–74]. Those restrictions are similar to the restrictions imposed by quantum physics on quarks and the baryons and mesons consisting of them. And the possible number of types of terminal spiral-wave formations is, thus, also limited, as is the possible number of so-called elementary particles. And this points to the inadmissibility of the presence of physical micro-objects that do not have the spiral-wave nature – phantom “things in themselves”.

Therefore, both intranuclear and external electromagnetic waves are just the imposed oscillations of the electrical and magnetic field strength. They are imposed on higher-frequency space-time modulations of the dielectric and magnetic permeabilities of the physical vacuum. They are those very modulations that actually transfer the changes of the collective space-time microstate of the entire gravithermodynamically bonded matter. They spread in intrinsic GT-FR of matter instantly (for an outside observer – at superluminal velocity and with de Broglie frequency). And it all fits in well with synergetics since, according to synergetics, the protomatter in the evolving (“ageing”) physical vacuum should have been self-organized exactly in a form of spiral-wave formation [4, 5, 9, 11, 16, 24].

The tensor of energy-momentum of matter (right side of the gravitational field equation) should be formed not being based on external thermodynamic parameters, but being based exactly on the intranuclear gravithermodynamic parameters. Therefore, the standard value of the average density of matter gravitational mass 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. Consequently, the presence of dark non-baryonic matter in the Universe is unnecessary [57, 75, 76].

The transformations of spatial coordinates and time of the SR are suitable for describing reality only in the gravity-quantum proper time of matter, in which the velocity of light is fundamentally invariable. And therefore, they are absolutely unsuitable for describing reality in the gravithermodynamic (astronomical) time (intrinsic to matter), in which on hypothetical singular surfaces the velocity of light can take (both in the GR and in the RGTD) even zero value. The realization of this in gravity-quantum time on the pseudo-horizon of the infinitely distant cosmological past is prevented by the complete compensation of the gravitational dilation of time on it by the kinematic acceleration of time flow in the dynamic gravitational field of the Universe [4, 76]. And it is the use in thermodynamic potentials of such a hidden variable parameter as the maximum possible (limit) velocity of motion of matter (which is almost identical to the coordinate pseudo-vacuum velocity of light of the GR) that is a guarantee of the gravitational-relativistic invariance of thermodynamics [4–7].

Only relativistic Newtonians [GT-Hamiltonians] and Keplerians [GT-Lagrangians] (and not the alternative to them classical Hamiltonians and Lagrangians) of astronomical objects moving by inertia in the surrounding gravitational field can strictly correspond to the reality and the modernized SR, GR and RGTD [4, 76].

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