Theoretical misconceptions and imaginary entities in astronomy, cosmology and physics[1]

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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 and General Relativity. Author have analyzed historical roots of discussed here misconceptions and misunderstandings and have 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. Our perception and reflection of physical reality is still very primitive and, foremost, mainly mechanistic, macrocentric and anthropo-limited. The unreality of black holes, Big Bang, non-baryonic dark matter, dark energy, photons and neutrinos is justified in details. The current usage of exponential scale instead of metrically homogeneous scale of cosmological time in cosmology is shown. Therefore, the ignorance of the fact that only the infinitely far cosmological past on the event horizon and infinitely far cosmological future on Schwarzschild sphere are simultaneous with any event in people's world is shown. The ignorance of the fact that this pseudo-horizon covers the past of all infinite Universe is also shown. 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 absence of gravitational fields in the Universe up to the moment of discontinuity of its uniform gas continuum is shown. The origination of the gravity phenomenon is related to the formation of spatially inhomogeneous thermodynamic states by the matter and to the tendency of the whole gravithermodynamically bonded matter to reach the minimum of the integral values of its inert free energy and Gibbs free energy. The temporal invariance of not only all thermodynamic parameters and potentials of matter and its momentum but also of Lagrangian of ordinary internal energy and of equivalent to it gravitational mass of matter (to which the inertial mass is identical only in intrinsic time of this matter) is justified. The fact that spatial distribution of gravitational field strength, defined by logarithmic gravitational potential, perfectly corresponds to astronomical observations is shown. 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. The possibility of spiral-wave nature of the matter microobjects – the terminal local drains of turns of the spiral waves of high frequency space-time modulations of the dielectric and magnetic permeabilities of the physical vacuum (singularities of the field according to Einstein hypothesis) – as a whole is shown.

Key words: black hole, quasar, Big Bang, non-baryonic dark matter, dark energy, redshift, luminosity distance, gravitational potential, Etherington's identity, Hubble's law.

> *Einstein had believed that the particles were singularities of the field in space In quantum field theory we have learned in the meantime that the particles are singularities – namely poles – in momentum space, not in ordinary space. For Einstein the field was real; it was in fact the ultimate reality and determined both the geometry of the world and the structure of the material bodies. In quantum theory, the field distinguishes, as in classical physics, between something and nothing; but its essential function is to change the state of the world, which is characterized by a probability amplitude, by a statement concerning potentialities.*
>
> *Werner Heisenberg* (*Single Field Theory*)

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Preamble (from the author)

Recently besides the epochal misunderstandings such as “Big Bang” of the Universe and “black holes” the two more not less significant misunderstandings appeared: “nonbarionic 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 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:

«So, we will not be wrong if we say that in all spiritual (and scientific, – P.D.) creation (art) of Turkic people the one basic mental trait prevails: clear schematization of relatively poor and rudimental material. From here one may make a conclusion about the Turkic psychology itself. The typical Turkic person (and any other Turanian person, – P.D.) does not like to go into intricate details. He prefers to operate with the main clearly perceptible images and to group those images into clear and simple schemes (paradigms, – P.D.). However once should beware of possible incorrect interpretations of those statements. It would be a mistake to think that Turkic mind notably tends to schematic abstraction. The specific ethnographic data, from which we extracted the reference to Turkic psychological type, does not give us basis to make such conclusion. Those schemes (stagnant paradigms, – P.D.), on which the Turkic spiritual art is based as we have seen, are indeed not the product of philosophical abstraction and do not have the character of something deliberately considered. Quite the contrary, those schemes are subconscious and exist in the psychics as unconscious cause of that psychical inertia, due to which all elements of psychical material group by themselves in exactly this certain order (and not in some another order): this is possible due to the special elementary quality and simplicity of those schemes. On the other hand, it would be a mistake to think that narrow-mindedness (metaphoricity, – P.D.) or sketchiness (paradigmality, – P.D.) of Turkic psychology hindered the wide scope and flight of fancy. The content of epic legends of Turkic people clearly contradicts to such ideas. Turkic fantasy is not poor and not timid, there is a brave swing in it but that swing is rudimentary: the force of imagination is directed not on the detailed working-out, not on the gathering of various details, but on the development in width and length; the picture drawn by this imagination is not replete with a variety of colors and transitional tones, but is drawn in basic tones, with wide, sometimes even colossally wide strokes. This tendency to development in width that is deeply characteristic to Turkic art is internally caused by the same basic traits of Turkic psychics… Described psychology of typical Turkic person determines also the lifestyle and worldview of the carrier of this psychology. Turkic person (as any other Turanian person, – P.D.) likes symmetry, clearness and stable equilibrium; but likes it to be given (in a form of purely mechanistic and other simple ordinary metaphors, – P.D.), and not determined, likes when it by inertia determines his thoughts, doings and lifestyle (and, therefore, does not go beyond the limits of generally accepted in his primitive society paradigms and traditions, – P.D.): to search for and to create those initial and basic schemes, on which the life and worldview should be based, is always painful for Turkic person since this search is always connected with the sharp feeling of lack of stability and lack of clearness. That is why Turkic people always took the ready-made schemes of others, accepted foreign beliefs. But, of course, not every foreign worldview is acceptable for Turkic person. In this worldview there should obligatory be clearness, simplicity and most importantly this worldview should be a convenient scheme, in

which everything can be included, all the world in all its concreteness. When Turkic person once started to believe in certain worldview and transformed it into subconscious law that determines his behavior, into universal scheme, and, thus, reached the condition of stable equilibrium on clear basis, he calms down and clings firmly to his beliefs (and scientific worldview, – P.D.). Looking at the worldview namely as at the unshakable basis of mental and everyday balance Turkic person shows the stiffness and stubborn conservatism in his worldview. Faith (and science, – P.D.), that came to Turkic environment inevitably freezes and crystallizes since there it is destined to play the role of an unshakable center of gravity – basic condition of stable equilibrium... And it is not a surprise that in his search for necessary basis for stable equilibrium Turkic person constantly choose the fruit of creativity of the Semitic spirit as the basis. However, wile appropriating this the fruit of creativity of the foreign spirit Turkic person simplifies it, perceives it statically in the ready-made form and when he transforms it into the only unshakable basis of his mental and everyday life he mummifies it and does not take any part in its internal development. So, the Turkic people did not give Islam a single prominent theologian, lawyer or philosopher: they took Islam as some ready given thing… Muscovite Rus, despite the force and tension of religious burn-up that determined not only its being but also its very occurrence, did not give a single prominent Orthodox theologian, in the same way as Turkic people did not give a single prominent Muslim theologian despite they always were more pious than Arabs. Here we see the influence of the common traits of religious (and scientific, – P.D.) psychology: in both cases the dogma of faith is considered as something given, as the main background of mental and everyday life and not as an subject of philosophical speculation; in both cases religious (and scientific, – P.D.) thinking is characterized by lack of flexibility, by disregard for abstractness and the desire for concretization, for the embodiment of religious experiences and (scientific, – P.D.) ideas in the forms of everyday life and culture… [Prince Nicholas Trubetskoy, 1925: 351].

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 [Ott, 1963: 70] and independently from him by Heinrich Arsels [Arzelies**,** 1966]. Due to heavy debates on this question H. Arsels told about the "modern crisis of thermodynamics" (and at all not 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 dilatation of the rate of intrinsic time of matter that moves in gravitational field only by inertia. Despite the principal possibility of gravity-relativistic dilatation of the intrinsic time of matter the matter that only inertially moves in the gravitational field is not affected in principle by this dilatation of intrinsic time [Danylchenko, 2021, 2022]. 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 internal and total energy of matter, but also of all its other thermodynamic and gravithermodynamical potentials and parameters [Danylchenko, 2021a: 37; 2022; 2022a: 101]. 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. These are 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 he 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 photometric distance in Hubble relation, as well as by ignoring the absence of relativistic dilatation of proper time for far galaxies that only free (inertial) 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 FR in expanding Universe. 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 FR in expanding Universe. However, these are only the peculiar simplest cases.

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 [Tolman, 1969], 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 velocity of light, 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 nation 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 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 dilatation 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 [Danylchenko, 2014: 21] and the fact that Universe eternally existed [Danylchenko, 2009: 47], 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 the General Relativity (GR) can be represented using either curvature of Riman's space-time continuum (STC) or metric inhomogeneity and metric instability of pseudo-Euclidean space [Danylchenko, 2004a: 33; 2004a: 62; 2008: 45]. The solution of this equation in metrically homogeneous Riman's STC corresponds to the solution in the background pseudo-Euclidean space [Zeldovich & Grischuk, 1988]. This background Euclidean space is metrically inhomogeneous. Either metrically homogeneous time scales or exponential time scales can be used in such space [Danylchenko, 2004a: 33; 2004a: 62]. 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 [Danylchenko, 2008a: 106]. 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 FR in the expanding Universe (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) [Danylchenko, 2008a: 19; 2020: 5; 2021] 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 [Danylchenko, 2004a: 33; 2004a: 62]. Metrical distance to the event horizon, thereby, tends to infinity while approaching event 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.

1. Imaginary Black Holes

For the reasons mentioned above, only the infinitely far cosmological future is always present on Schwarzschild's singular sphere [Danylchenko, 2004a: 33; 2004a: 62; 2005a: 95]. Finite value of its radius r_s in GT-FR corresponds to zero value of its radius R_s=0 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 [Penrose, 1968]. 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 [Danylchenko, 2004a: 33; 2008a: 4; 2008a: 19; 2009: 47; 2009a: 75; 2010: 38].

Therefore, real singular sphere can be only median sphere [Danylchenko, 2004a: 33; 2004a: 62; 2005]. 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).

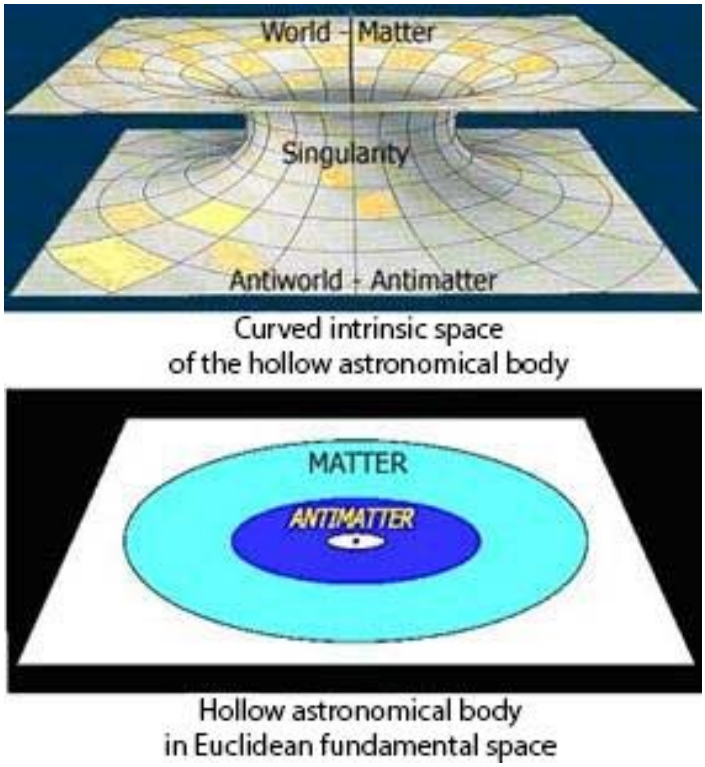


Fig.1. Curved intrinsic space of the hollow astronomical body and this body in Euclidean fundamental space of CFREU

Herewith the internal space inside the singular sphere is “turned inside out” like the shirt that is worn inside out [Danylchenko, 2004a: 33; 2004a: 62; 2005]. 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.

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. Only such phenomenon is acceptable for the long-lived existence of antimatter (diverging spiral wave formations) [Danylchenko, 2004a: 33; 2004a: 62; 2008: 45; 2009; 2009a: 75; 2010: 38; 2014: 21; 2020: 5]. Universe expansion phenomenon is acceptable only for the long-lived existence of matter (converging spiral wave formations).

2. 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 ν. The observed gravitationally-Dopler-like redshifts of wavelength $\lambda=c/\nu$ 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 [Danylchenko, 2004a: 33; 2004a: 62; 2005].

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.

3. Imaginary Big Bang

Only two known solutions of equations of GR gravitational field can be juxtaposed to expanding Universe. Those are: Schwarzschild solution [Schwarzschild, 1916: 189] when the value of cosmological constant is $\Lambda=3H_E^2c^{-2}$ [Danylchenko, 2004: 62], which corresponds to the local representation of the process of Universe expansion, and Friedman solution when $\Lambda=0$ [Friedman, 1922: 377] ($\Lambda\neq0$ in ΛCDM model [Semiz and Çamlibel, 2015]), which corresponds to the global representation of the pro-cess 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 pseudohorizon 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 [Zel'dovich&Grishchuk, 1988] of the CFREU. And this is, of course, related to the conformality [Penrose, 1968] of these two infinities that are mutually compensated in the gravithermodynamic FR (GT-FR) [Danylchenko, 2020: 5; 2021, 2022] of Schwarzschild solution. Exactly in this the background Euclidean space of the Universe, where physical vacuum rests [Danylchenko, 2004: 33; 2004: 62], according to Weyl hypothesis [Weyl, 1923; 1930] 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 ($r_g\approx0$), according to Schwarzschild solution in background Euclidean space $r=r_cR/(r_c+R)=cR/(c+H_ER)$ in infinitely far cosmological past had its own space that was limited by the sphere of maximal radius $r_{\max}=r_c\approx4812{,}4\ [Mpc]$ and that covered all infinite space of the Universe ($R=\infty$). 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 [Danylchenko, 2004: 33; 2004: 62] of identical comoving FR in the expanding Universe (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 pseudohorizon of events in the equations of Friedman solutions (as well as in the equations of Schwarzschild solution in background Euclidean space) event 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 gravi-quantum time, and to call all correspondent to that time values of physical characteristics as gravi-quantum values. The gravi-quantum time of any certain observer can be proportionally synchronized with the unified astronomical coordinate time (gravithermodynamic time [Danylchenko, 2009; 2020: 5]) t_E owing to the possibility of proportional synchronization of all gravi-quantum clocks in GT-FR of Earth. Thus, that gravi-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 [Danylchenko, 2004: 33; 2004: 62]. 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 $r_c\approx c/H_E=(\Lambda/3)^{-1/2}$ in the space of GT-FR. However it does not form the horizon of past events in GT-FR [Danylchenko, 2004: 33; 2004: 62]. 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 [Danylchenko, 2005b; 2008: 95; 2009: 47].

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. 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 [Danylchenko, 2004: 47] and finite cosmological proper 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 [Gordon, 1969, Weinberg, 2010; Koberlein, 2013]. 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 $\Lambda=3H_E^2c^{-2}$ 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 invariance (in time) of the Hubble constant, the same as the invariance of the constant of velocity of light, is the main sign of the rigidity of intrinsic FR of the observer [Danylchenko, 1994: 22]. 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.

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

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 [Danylchenko, 2004a: 62].

Thirdly, the gravitational gradients of coordinate velocity of light were absent in Universe gas continuum before its breaking. Therefore, no gravitational field yet existed [Danylchenko, 2004a: 62].

That's why it should be admitted that gravity is the purely macroscopic thermodynamic phenomenon [Danylchenko, 2008a: 19; 2009: 47; 2009a: 75; 2010: 38; 2020: 5; 2022]. 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 [Danylchenko, 2021, 2022] 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 [Danylchenko, 2008a: 19; 2009a: 75; 2010: 38; 2020: 5; 2022]. 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.

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 [Danylchenko, 2004a: 33; 2004a: 62; 2008: 45; 2009a: 75; 2010: 38; 2014: 21; 2020: 5; 2022]. 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.

5. Spatio-temporal noninvariance of the gravitational constant

There are two types of time in GR: intrinsic gravi-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 $v_{cj}(r)=cb_j^{1/2}$ is determined for certain point j in unified (for all gravithermodynamically bonded matter of the Earth) coordinate astronomical time t_E. It is identical to the critical velocity of baryonic matter in the relativistic gravithermodynamics (RGTD) [Danylchenko, 2009a: 75, 2020: 5; 2021, 2022] 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. Gravity-quantum value of coordinate velocity of light: ${}^iv_{cj}=cv_{cj}/v_{ci}=c(v_{c0j}/v_{c0i})^{(c/v_{ci})^2}$ $\left[{}^ib_j=(b_{0j}/b_{0i})^{1/b_i}\right]$ is also dependent on coordinate velocity of light v_{ci} in the point i of disposition of real or prospective observer. Here v_{c0j} and v_{c0i} are the values of coordinate velocity of light in intrinsic centric coordinate system of prospective observer. Metric eigenvalue of 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: ${}^iv_{ci}={}^jv_{cj}=c$.

Obviously, the momentum $\mathbf{P}_j=m_{00}v_jc(v_{cj}^2-v_j^2)^{-1/2}=\mathbf{inv}(t_i)$ 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 $m_{in0j}=m_{00}v_{cj}/c=m_{00}b_j^{1/2}$ and $m_{gr0j}=m_{00}v_{cj}/cb_j=m_{in0j}/b_j=m_{00}c/v_{cj}$. And their gravity-quantum values will be as follows: ${}^im_{in0j}=m_{00}c^{-2}v_{cj}v_{ci}=m_{00}c^{-2}v_{ci}^2(v_{c0j}/v_{c0i})^{(c/v_{ci})^2}=m_{00}b_i(b_{0j}/b_{0i})^{1/2b_i}$, ${}^im_{gr0j}=m_{00}c/{}^iv_{cj}=m_{00}(v_{c0i}/v_{c0j})^{(c/v_{ci})^2}=m_{00}(b_i/b_j)^{1/2b_i}$.

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

As it was shown by Tolman [Tolman, 1969] for the homogeneous matter that is in the state of mechanical equilibrium its enthalpy $H_0=U_0+pV=H_c c/v_c$ is also inversely proportional to coordinate velocity of light. And since for quasiequilibrium cooling down matter $pV/W_0=\mathbf{const}(r)$, then the ordinary internal energy of matter ${}^iW_{0j}=W_{0j}c/{}^iv_{cj}=(U_j-U_{ad})c/{}^iv_{cj}$ is also inversely proportional to coordinate velocity of light, where p is the pressure, V is the molar volume, $U_{ad}=\mathbf{consnt}(r)$ is the additive compensation of multiplicative decreasing (with time) of multiplicative component $W_{0j}=m_{gr0j}c^2=m_{00}c^3/v_{cj}$ [Danylchenko, 2021, 2022] of internal energy U_j of matter. And, consequently, the equivalence of gravitational mass of rest to the inert mass of rest ${}^im_{in0j}=m_{00}{}^iv_{cj}/c$ (that is used in Hamiltonian) takes place only by the intrinsic gravity-quantum clocks of point j (${}^jm_{gr0j}\equiv{}^jm_{in0j}$).

Thus: ${}^Ev_{cj}=(1-2G_E{}^SM_{gr0E}\,c^{-2}/r_j)^{1/2}=(1-2G_E{}^SM_{in0E}{}^Sv_{crE}^{-2}/r_j)^{1/2}=(1-2G_{eqE}M_{in0E}\,c^{-2}/r_j)^{1/2}$ in gravitational field of the Earth and similarly: ${}^Sv_{cE}=(1-2G_SM_{gr0S}\,c^{-2}/r_E)^{1/2}=(1-2G_{eqS}M_{in0S}\,c^{-2}/r_E)^{1/2}$ in gravitational field of the Sun, where: $M_{gr0E}=M_{00E}c/{}^Sv_{crE}=M_{in0E}c^2/{}^Sv_{crE}^2$ and $M_{gr0S}=M_{00S}c/{}^gv_{crS}=M_{in0S}c^2/{}^gv_{crS}^2$ are gravitational masses of rest of the Earth and the Sun correspondingly in FR of the Sun and in FR of the galaxy; $M_{in0E}=M_{00E}{}^Sv_{crE}/c$ and $M_{in0S}=M_{00S}{}^gv_{crS}/c$ are the inert 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; ${}^Sv_{crE}={}^Sv_{cE}(1-{}^Sv_E^2\,{}^Sv_{cE}^{-2})^{-1/2}$ and ${}^gv_{crS}={}^gv_{cS}(1-{}^gv_S^2\,{}^gv_{cS}^{-2})^{-1/2}$ are coordinate 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; ${}^Sv_E$ and ${}^gv_S$ are velocities of motion of the Earth in FR of the Sun and of the Sun in FR of the galaxy; $G_{eqE}=G_Ec^2/{}^Sv_{crE}^2$ and $G_{eqS}=G_Sc^2/{}^gv_{crS}^2$ are the equivalent values of Terrestrial and Solar gravitational constants relatively to inert 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 gravi-quantum values on Earth ${}^iG_E=G_Ev_{ci}^2c^{-2}$ and ${}^iG_{eqE}=G_E{}^Sv_{crE}^{-2}v_{ci}^2$ 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, gravi-quantum value of gravitational constant ${}^iG_E$ cannot be equal to solar gravitational constant G_S. This gravitational

constant G_S is determined in the coordinate astronomical time t_S unified for the whole gravitationally-bonded matter of Solar system. All the more so, ${}^{i}G_E$ is not equal to Universe gravitational constant G_u, that is determined in coordinate cosmological time τ. Solar value G_S that is used nowadays in astronomy slightly exceeds both Universal value G_u, and galactic values G_g.

But, of course, galactic values of gravitational constant: $G_g=G_u{}^{u}v_{cg}^{-2}c^2$ 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 ${}^{u}v_{cos}$, but also its galactic values ${}^{u}v_{cg}$ 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 [Dirac, 1978] not directly in time but indirectly due to gradual increasing of coordinate 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 G_E. Possibly, value of gravitational constants of the planets and the Moon can differ from the values predicted for them based on G_E. 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.

6. Logarithmic gravitational potential

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

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

where: a is square of the ratio between increment of metrical segment and increment of radial coordinate r, and r_g is gravitational radius of astronomical body, from where observation takes place.

Nowadays, the following gravitational potential is used in GR and in practical calculations:

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

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

$$k=-\frac{c^2r_g}{2r^2}=-\frac{GM_{gr0}}{r^2}\qquad\qquad\left(r_g=\frac{2GM_{gr0}}{c^2}\right).$$

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 [Logunov & Mestvirishvili, 1989].

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 Lagrangian L and its ordinary internal energy W_{0j} [Danylchenko, 2021, 3022], and of Hamiltonian H of inert free energy E_0 [Danylchenko, 2004a: 33; 2004a: 62]:

$$\varphi_j=c^2\ln(E_{0j}/E_{00})=c^2\ln(v_{cj}/c) \qquad (E_{0j}=E_{00}v_{cj}/c=m_{in0}c^2=m_{00}cv_{cj}) \qquad (1)$$

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 Hamiltonian of inert free energy and on proportionality of pseudo-force of gravitation to the Lagrangian of ordinary internal energy of matter. This corresponds to the principle of equivalence of mass and energy. Such representation also makes the proof of equivalence of inert and gravitational masses of body (by its intrinsic gravity-quantum clocks) redundant. Logarithmic gravitational potential forms the following spatial distribution of gravitational field strength:

$$k=\frac{F_{gr}}{m_{gr0r}}=\frac{v_{cr}F_{gr}}{m_{00}c}=\mathbf{grad}(c^2\ln W_0)=-\mathbf{grad}(c^2\ln E_0)=-\mathbf{grad}(c^2\ln v_c)=-\frac{1}{r^2}\frac{GM_{gr0}-H_E^2r^3}{\sqrt{1-(GM_{gr0}/r+H_E^2r^2)c^{-2}}}.$$

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

$$k_{eq}=\frac{F_{gr}}{m_{in0r}}=\frac{\mathrm{L}}{\mathrm{H}}k=\frac{m_{gr0r}}{m_{in0r}}k=\frac{c^2}{v_{cr}^2}k=-\frac{c^4}{v_{cr}^2}\mathbf{grad}(\ln v_c)=-\frac{c^2}{v_{cr}^2r^2}\frac{GM_{gr0}-H_E^2r^3}{\sqrt{1-(GM_{gr0}/r+H_E^2r^2)c^{-2}}}.$$

According to this the effective value of gravitational constant:

$$G_{eff}=(c^3/v_{cr}^2v_c)G=Gc^2v_{cr}^{-2}[1-(GM_{gr0}/r+H_E^2r^2)c^{-2}]^{-1/2} \qquad (2)$$

tends to infinity while approaching the Schwarzschild sphere and is continuously decreasing while distancing from the gravity center. And, of course, this should successfully prevent the false conclusions about the deficit of baryonic matter in the centers of the galaxies.

Usage of logarithmic gravitational potential does not require the adjustment of the values of mass of the Sun and the planets. If gravitational radius of Sun is 2.95 km then its mass should be decreased on just two millionth parts of it. It is 35 times less than the determination error of Sun mass. On the Mercury orbit the strength of Sun gravitational field should be decreased on just 20 billionth parts of it. The Earth itself has very small gravitational radius 0,887 cm. Due to this fact

Earth mass should be decreased on just one billionth part of it. At the same time, Earth mass determination error is 100000 bigger.

Unlike for the Solar System, the usage of logarithmic gravitational potential can be very essential for the far galaxies.

7. 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 [Danylchenko, 2008a: 106; Weisskopf, 1972]. 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 [Etherington, 1933: 761] for uncorrected luminosity distance D_L and for imaginary value of angular diameter distance ${}^iD_A$, that corresponds to it, in the calculations is also taken into account:

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

Etherington's identity is based on the imaginary relativistic dilation of intrinsic time of the galaxy by (1+z) times [Hogg, 2000]. 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 [Danylchenko, 2004a: 33; 2004a: 62].

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 observed in the GT-FR of each of the objects, is imaginary (fictive) for CFREU (and, therefore, for the global perception) [Danylchenko, 2009; 2021a: 26; 2022]. 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 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 dilatation 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 [Danylchenko, 2008a: 106]:

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

where: $v_c=c\sqrt{1-v_g^2v_c^{-2}}$; 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 [Danylchenko, 2021a: 26]:

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

when: $dx'_m=0$, $dy'_m=0$ and $dz'_m=0$ the $dx_m=v_g dt=(v_g/v_c)cdt$, $dy_m=0$, $dz_m=0$, will take place, and:

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

And, consequently, the dilatation 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 $\widehat{t}$. So, according to GR formalism not the dilatation but vice versa the fastening of the rate of intrinsic time of distant galaxies takes place by the observer's clock: $d\,t'=(1+v_g/v_c)d\,\widehat{t}>d\,\widehat{t}$. However, if just the gravitational dilatation of the rate of time of distant galaxies is completely compensated by the free fall of distant galaxies on the pseudo-horizon of events, then indeed there fundamentally cannot be any contraction or dilatation of the unified gravithermodynamic (not coordinate) time of matter of these galaxies. And this can take place in the case of 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.

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) [Danylchenko, 2009a: 75; 2010: 38; 2020: 5; 2021, 2022]. 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 dilatation of intrinsic time is absent at all for inertially moving bodies [Danylchenko, 2021, 2022]. The distancing from observer far galaxies are namely inertially fall onto the pseudo-horizon of events and, therefore, there, of course, should not be any relativistic dilatation 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 $(z+1)^2$ 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.

8. Non-identity of inertial and gravitational masses

In classical mechanics and in SR the inert free energy of rest $E_0=m_{in0}c^2=m_{00}cv_c$, which tends to the minimum and transforms into kinetic energy in the process of the fall of body in gravitational field, is the equivalent of Helmholtz and Gibbs free energies, which tend to the minimum in thermodynamic processes. The conservation of Hamiltonian of the inert free energy of rest of matter $H\equiv m_{in}c^2=E\Gamma=m_{in0}c^2\Gamma=m_{00}cv_c(1-v^2v_c^{-2})^{-1/2}=\mathbf{const}(r)$ ($v_c\Gamma=\mathbf{const}(r)$) is guaranteed due to the decreasing of inert mass of rest $m_{in0}=m_{00}v_c/c$ of matter in the process of its free fall. The Hamiltonian momentum $P_H=-(\partial L/\partial v)_{vc}=m_{00}c(v/v_c)(1-v^2v_c^{-2})^{-1/2}=m_{gr0}v\Gamma$, which is proportional to gravitational mass $m_{gr0}=m_{00}c/v_c$, is derived from Lagrangian $L=E/\Gamma=m_{00}cv_c\sqrt{1-v^2v_c^{-2}}$ of namely inert free energy of matter. The magnitude of matter momentum, according to Noether's theorem [Noether, 1918] 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.

As it was shown by Tolman [Tolman, 1969] and as it follows from the Schwarzschild internal solution for incompressible ideal liquid [Möller, 1972], the gravitational forces in it are proportional to ordinary enthalpy $H_0=U_0+pV=H_cc/v_c$ (where: $H_c=\mathbf{const}(r)$), 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 quasiequilibrium cooling down matter $pV/U_0=\mathbf{const}(r)$, then the ordinary internal energy of matter $W_0\equiv U_0=U-U_{ad}=W_{0c}c/v_c$ ($W_{0c}=\mathbf{const}(r)$) is also inversely proportional to coordinate velocity of light. Here p is the pressure, V is the molar volume, and $U_{ad}=\mathbf{consnt}(r)$ is the additive compensation of multiplicative decreasing (with time) of multiplicative component $W_0=m_{gr0}c^2=m_{00}c^3/v_c$ of internal rest energy U of matter.

And, consequently, it is quite obvious that inertial mass of moving matter is conventionally equivalent to its gravitational mass 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 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 Hamiltonian of its inert free energy, while the gravitational mass of matter is equivalent to the Lagrangian of its ordinary internal energy. And the ratio of these masses is invariant due to the conservation in time of Hamiltonians of inert free energy and of Lagrangians of ordinary internal energy of inertially moving gravity-quantum clock of observed matter and of observer:

$$m_{gr0}=m_{in0}\frac{\mathrm{H_i L_j}}{\mathrm{L_i H_j}}=m_{in0}\frac{v_{cri}^2}{v_{crj}^2}\equiv m_{in0}\,{}^{i}v_{lrj}^{-2}c^2=\mathbf{const}\ (t)\,,$$

where: $v_{cr}\equiv v_{lr}$, ${}^{i}v_{crj}\equiv {}^{j}v_{lrj}=cv_{lrj}/v_{lri}=(cv_{lj}/v_{li})(1-v_j^2v_{lj}^{-2})^{-1/2}(1-v_i^2v_{li}^{-2})^{1/2}$ are the values of coordinate velocity of light and of identical to it limit velocity of motion of matter in the points of its hypothetic rest relatively to hypothetic observer of the motion.

9. 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:

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

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

and the eigenvalues (that were corrected to eigenvalue of gravitational constant (to wit centered)) of Hamiltonian of inert free energy and of Lagrangian of ordinary internal energy of matter in its pseudocentric ${}^{rc}\mathrm{FR}_0$ will be as follows:

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

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

where: $\widehat{v}=vc/v_l$ is the really metrical value of velocity of matter motion [Danylchenko, 2006: 27; 2008: 60; 2021, 2022]; *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; ${}^{r}\widehat{a}_r\equiv\widehat{a}_r=\mathbf{inv}(t)$ and $\widehat{a}_r=(c/v_{lr})(d\widehat{v}/dt)=d\widehat{v}/dt_r=a_rv_{lr}^{-2}c^2=\mathbf{inv}(t)$ 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; ${}^{r}g_r=g_rv_{lr}^{-2}c^2={}^{r}GM_{gr0}r^{-2}$ 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 [Möller, 1972]) correspondingly; ${}^{r}m_{gr0r}\equiv m_{00}$, since ${}^{r}m_{gr0j}=m_{gr0}v_{lr}/c=m_{00}v_{lr}/v_{lj}$; ${}^{r}m_{in0r}=m_{00}v_{lr}^2c^{-2}$, since ${}^{r}m_{in0j}=m_{in0}v_{lr}/c=m_{00}v_{lj}v_{lr}c^{-2}$; ${}^{r}v_l=cv_l/v_{lr}=\sqrt{c^2-\widehat{v}^2}$ is the limit velocity of motion of matter in arbitrary

point in the intrinsic gravity-quantum time of the point r; ${}^{r}G=Gc^{2}v_{lr}^{-2}$ 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:

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

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 $v_l/v_{lr}=\sqrt{1-\hat{v}^2c^{-2}}$, 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 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 of motion of matter ${}^{i}v_{lj}=cW_{0i}/W_{0j}=cE_{0j}/E_{0i}$, as well as the identical 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 internal energy ${}^{i}v_{lj}=cU_{0i}/U_{0j}$ in different points of gravitational field because in those points matter is in not the same thermodynamic states. The minimum possible value of thermodynamic internal energy $U_{\min}=U_0+U_{ad}$ ($U=U_0c/v_l+U_{ad}$) is, as other thermodynamic parameters, the intrinsic characteristics of matter. Moreover, the multiplicative component of thermodynamic internal energy of matter is identical to its mechanical ordinary internal energy ($U_0\equiv W_0$) 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 quasiequilibrium cooling down gases and simplest liquids:

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

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

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, internal energy, thermodynamic enthalpy and temperature that are identical to their coordinate values in GT-FR:

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

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 [Danylchenko, 2008: 4].

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 [Danylchenko, 2020: 85; 2021, 2022]. And the velocities and accelerations of object remained the same as in 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 internal energy of matter (and, consequently, the ratio

between masses equivalent to those energies) remains the same ${}^{i}E_{0i}/{}^{i}W_{0i}={}^{i}m_{in0i}/{}^{i}m_{gr0i}=v_{li}^{2}c^{-2}$, as in common for all gravithermodynamically bonded matter gravithermodynamic time. After all:

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

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

where: ${}^{i}\widehat{a}_{i}=a_{i}v_{li}^{-2}c^{2}$, a_i and ${}^{i}g_{i}=g_{i}v_{li}^{-2}c^{2}$, g_i are the accelerations of motion and gravitational accelerations in gravity-quantum time of the *i* point and in common for all gravithermodynamically bonded matter gravithermodynamic time correspondingly; ${}^{ic}G_{0i}=Gv_{li}^{-2}c^{2}$ is the equivalent value of gravitational constant.

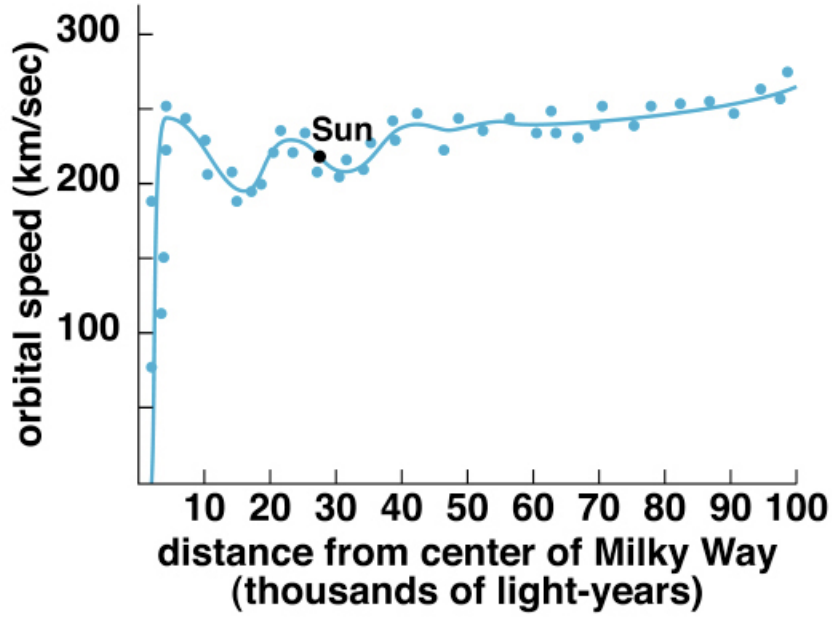
Thus, in pseudo-centric ${}^{i}\mathrm{FR}_0$ of *i* point we will have the similar thing that is accepted in both classical physics and GR. Namely, due to the correction of gravitational constant we will receive in the *i* point not only the equality of the velocity of light to the constant *c*, but also the equality of inertial mass to gravitational mass. That is why with the exception of inert free energy and equivalent to it inertial mass all other really metrical mechanical and thermodynamic parameters and characteristics of matter do not depend on the readings of gravity-quantum clock and, consequently, are invariant under time transformation.

Within the limits of atmosphere and outer space of the Earth this equivalent 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” [Anderson et al., 2002; Masreliez, 2005; Jacobson, 2009]. If we go deeper in the distant outer space, where v_{li} is the maximum possible value of limit velocity of 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.

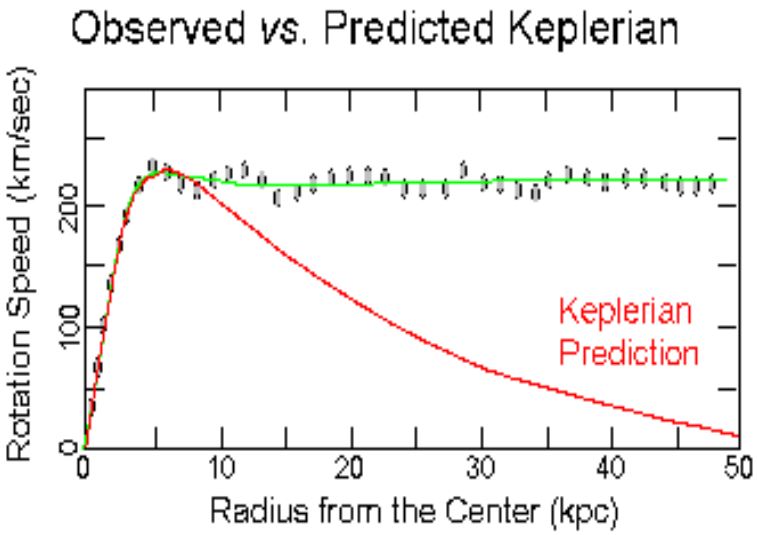
10. The inconsistency of the motion of galaxies with Kepler's laws

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[3] remains quasi constant on quite far distance from galaxy center for many galaxies, including ours [Pogge, 2006; Bennett et al., 2012].



a)



b)

Fig.2. Dependencies of velocity of rotation of astronomical objects on the distance to gravity center: *(a) our Milky Way galaxy* [Bennett et al., 2012; Rieke, 2016]**,** *(b) comparing to prognosed Keplerian velocities* [Pogge, 2006; Thompson, 2011]).

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

[3] 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.

The quite close dependency to the observed one is the following dependence of really metrical value $\hat{v}=v/\sqrt{b}=vc/v_c$ 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:

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

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

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

μ_0, 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 inertion $\mathbf{F}_{in}=\mathrm{H}v^2c^{-2}a^{-1/2}/r$ and pseudo force of gravity $\mathbf{F}_{gr}=\mathrm{L}c^{-2}a^{-1/2}d(\ln v_c/c)/dr$:

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

very slightly depends on $r>>r_e$ 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.

Here "galactic" value of coordinate velocity of light $v_c=cb^{1/2}$, Lagrangian and Hamiltonian:

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

are determined by the parameters b, $a=1/(1-\eta-\Lambda r^2/3)$ and $b_r=(v_{cr}/c)=b/(1-\hat{v}^2c^{-2})$ of the equations of GR gravitational field:

$$b'/abr-r^{-2}(1-1/a)+\Lambda=\kappa p,$$

$$a'/a^2r+r^{-2}(1-1/a)-\Lambda=\kappa(\mu_{gr0}c^2+p\hat{v}^2c^{-2})/(1-\hat{v}^2c^{-2})=\kappa\mu_{grc}c^2.$$

However, instead of eigenvalues of density of the mass μ_{00} and pressure p_{00} [Möller, 1972] their gravitational values in FR are used in tensor of energy-momentum $\mu_{gr0}=\mu_{00}/\sqrt{b}$ and $p=p_{00}/\sqrt{b}$ ($p/\mu_{gr0}=p_{00}/\mu_{00}=\mathbf{const}(r)$). This is related to temporal invariance of really metrical mechanical and thermodynamic parameters and characteristics of matter. An insufficient amount of the mass in the Universe denotes the fact that not only in RGTD but also in GR the tensor of energy-momentum should be based on the ordinary internal energy of matter that includes not only inert free energy but also bound energy of matter.

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

$$(T_N S_N - p_N V_N)/V=\mu_{in0}c^2(1/b-1)=\mu_{gr0}c^2(1-b)=\mu_{00}c^2(1/\sqrt{b}-\sqrt{b})>>p\,,$$

since, in contrast to GT-FR$_0$ of the central astronomical object of the observed galaxy, in GT-FR of terrestrial observer all other astronomical objects of this galaxy belong to the same moment of cosmological time $\tau_p=\tau_e$..

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

The 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. That is why in the RGTD the four-momentum is formed not by enthalpy but by the ordinary internal energy of matter (multiplicative component of its total energy). 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 [Danylchenko, 2020: 5; 2021; 2021a: 33; 2022]:

$$b'/abr-r^{-2}(1-1/a)+\Lambda=\kappa(T_N S_N - p_N V_N)/V=\kappa\mu_0 c^2[1/\sqrt{b}-\sqrt{b}]=\kappa\mu_{in0}c^2(1/b-1)=\kappa\mu_{gr0}c^2(1-b)\,, \quad (5)$$

$$a'/a^2r+r^{-2}(1-1/a)-\Lambda=\kappa[\mu_{00}c^2\sqrt{b}+(T_N S_N - p_N V_N)\hat{v}c^{-2}/V\sqrt{b}]/(1-\hat{v}^2c^{-2})=\kappa\mu_{in0}c^2[1+\hat{v}^2/b(c^2-\hat{v}^2)]\,. \quad (6)$$

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

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

where:
$$\sqrt{b}=\frac{v_l}{c}=\frac{1}{\sqrt{a}}\left(1+\frac{\kappa c^2}{2}\int_{r_e}^{r}\frac{m_{00}a^{3/2}rdr}{V[1-\hat{v}^2c^{-2}]}\right),$$

$\mu_{00}=m_{00}/V$; V is volume of matter, $m_{00}=b^{-1/2}m_{in0}$ is the eigenvalue of the mass of one mole of matter; [Danylchenko, 2021, 2022; 2021a: 33] in GT-FR, and $v_l\equiv v_c$ is maximum possible (extreme) value of velocity of matter in the outer space of the galaxy [Danylchenko, 2009; 2020: 5, 2022].

According to this we find the square of the rotation velocity of astronomical object relatively to the galaxy center according to the equations of gravitational field of RGTD:

$$[\hat{v}^2]_{RGTD}=\frac{c^2r}{b_r}\frac{d\ln(v_l/c)}{dr}=\frac{c^2a}{2b_r}\left\{\eta+\left[\frac{\kappa(T_NS_N-p_NV_N)}{V}-\frac{2}{3}\Lambda\right]r^2\right\}=\frac{c^2\{\eta+[\kappa\mu_{00}c^2(1/\sqrt{b}-\sqrt{b})-2\Lambda/3]r^2\}}{2b_r(1-\eta-\Lambda r^2/3)}=$$

$$=\frac{c^2}{2b_r(1-\eta-\Lambda r^2/3)}\left[\frac{\kappa\mu_{inc}c^2r^2}{b+(1-b)\hat{v}^2c^{-2}}-\chi_0r-\frac{2}{3}\Lambda r^2\right]=\frac{c^2}{2b_r(1-\eta-\Lambda r^2/3)}\left[\frac{\eta+\chi r}{b+(1-b)\hat{v}^2c^{-2}}-\frac{2}{3}\Lambda r^2\right]>>[\hat{v}^2]_{GR}, \quad (7)$$

where: $\chi=(1-b)(1-\hat{v}^2c^{-2})\chi_0=\kappa\mu_{00}c^2(1-b)(1-\hat{v}^2c^{-2})[r_e\exp(-r/r_e)+2\pi\sigma\, r_m\cos(2\pi\, r/r_m)]$.

As we can see, at the same radial destribution of the average density of the inertial mass μ_{inc} 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:

$$(T_NS_N-p_NV_N)/V=\mu_{in0}c^2(1/b-1)=\mu_{00}c^2(1/\sqrt{b}-\sqrt{b})>>p\,.$$

Therefore, we can get rid of the imaginary necessity of dark non-baryonic matter in galaxies that follows from the equations of GR gravitational field if we analyze the motion of their astronomical objects using the equations of gravitational field of RGTD.

If we do not take into account local peculiarities of distribution of average density of the mass in galaxies and examine only the general tendency of typical dependence of the orbital velocity of their objects on radial distance to the galaxy center, then the following dependence of this velocity on parameter b and, thus on radial distance r, can be matched with the graphs on Fig.2 [Danylchenko, 2021, 2021a: 33; 2022]:

$$\hat{v}=\sqrt{\frac{2\mathrm{LH}_e(b/b_e)^n}{\mathrm{H}L_e[1+(b/b_e)^{2n}]}}\hat{v}_e=\sqrt{\frac{2b_{re}(b/b_e)^n}{b_r[1+(b/b_e)^{2n}]}}\hat{v}_e=\sqrt{\frac{2(b/b_e)^n}{b_r[1+(b/b_e)^{2n}]}}\hat{v}_{\max}=c\left\{\frac{1}{b}+\frac{(c^2b_e-\hat{v}_e^2)[1+(b/b_e)^{2n}]}{2\hat{v}_e^2b_e(b/b_e)^{n-1}}\right\}^{-1/2},$$

where according to (4):

$$b=b_e\left[(\hat{v}_{\max}c/\hat{v}v_{lr})^2\pm\sqrt{(\hat{v}_{\max}c/\hat{v}v_{lr})^4-1}\right]^{1/n}=b_e\left[\pm2nv_e^2v_{lre}^2c^{-4}\ln(r/r_e)+\sqrt{1+[2nv_e^2v_{lre}^2c^{-4}\ln(r/r_e)]^2}\right]^{1/n},$$

$$r=r_e\exp\left[\pm(c^4/2n)\sqrt{(\hat{v}v_{lr})^{-4}-(\hat{v}_e\,v_{lre})^{-4}}\right]=r_e\exp\left\{\pm(c^2\hat{v}_{\max}^{-2}/4n)\left[(b/b_e)^n-(b_e/b)^n\right]\right\},$$

$$b_r=\frac{b}{1-\hat{v}^2c^{-2}/b}=b+\frac{2\hat{v}_{\max}^2(b/b_e)^{n-1}}{c^2b_e[1+(b/b_e)^{2n}]}=b+\frac{2\hat{v}_e^2(b/b_e)^{n-1}}{(c^2-\hat{v}_e^2/b_e)[1+(b/b_e)^{2n}]},\qquad b_{re}=b_e+\frac{\hat{v}_e^2}{c^2-\hat{v}_e^2/b_e}=\frac{c^2b_e^2}{c^2b_e-\hat{v}_e^2},$$

and: r_e is radius of the conventional friable galactic nucleus, on the surface of which the corrected value $\hat{v}=b_r^{1/2}\hat{v}=v_{lr}\hat{v}/c=\{[(b_e/b)^n+(b/b_e)^n]/2\}^{-1/2}\hat{v}_{\max}$ of the orbital velocity of objects can take its maximum possible value $\hat{v}_{\max}=b_{re}^{1/2}\hat{v}_e(b_e)=v_{lre}\hat{v}_e/c$.

In case $\hat{v}\approx\mathbf{const}(b)$ outside the loose nucleus of galaxy, b_r takes its minimum value $b_{r\min}=4\hat{v}^2c^{-2}$ when $b=2\hat{v}^2c^{-2}$. In this case, when $b_e=2\hat{v}_e^2c^{-2}$ ($b_{re}=4\hat{v}_e^2c^{-2}$, $\hat{v}_{\max}=2\hat{v}_e^2/c$) the linear velocities of rotation of galactic objects and the radial distances to them will be as follows:

$$\hat{v}=2\hat{v}_e\sqrt{\frac{k_b^{n-1}}{1+2k_b^{n-2}+k_b^{2n}}},\qquad \hat{v}=\frac{2\hat{v}_e^2}{c}\sqrt{\frac{2k_b^n}{1+k_b^{2n}}}=c\left[4n^2\ln^2\left(\frac{r}{r_e}\right)+\frac{c^8}{16\hat{v}_e^8}\right]^{-1/4},\qquad r=r_e\exp[c^4\hat{v}_e^{-4}(k_b^n-k_b^{-n})/16n],\ (8)$$

when: $$k_b=b/b_e=\left[\sqrt{1+64n^2\hat{v}_e^8c^{-8}\ln^2(r/r_e)}+8n\hat{v}_e^4c^{-4}\ln(r/r_e)\right]^{\frac{1}{n}}.$$

The large value k_b corresponds to the larger value n of the index of density of friable galactic nucleus on the same big radial distances. However, only when values are extremely large $n>>2^{34}$ the significantly lesser average density of matter beyond the friable galactic nucleus takes place and that is why the dependence of orbital velocities of galactic objects on radial distances can be close to Keplerian. For example, when $n=2^{40}$ ($k_b^n=16{,}780$) the orbital velocity of peripheral objects of the galaxy is less than half of the maximum velocity (when $r_p/r_e=20$, $\hat{v}_p=0{,}461\hat{v}_e$), while when $n=2^{45}$ ($k_b^n=535$) it is already significantly smaller of maximum velocity ($\hat{v}_p=0{,}086\hat{v}_e$). However, not only in the weak gravitational fields ($n<<2^{34}$, $k_b^n<<1{,}1391$), but even in quite strong gravitational field ($n=2^{34}$, $k_b^n<1{,}1391$, $k_{bp}=1{,}00000000000758$) the orbital velocities of extra-nuclear objects (when $b_e=1{,}12656\cdot10^{-6}$) are, according to (8), quite close to their maximum values $\hat{v}_e<225$ *km/s* (Fig. 2 b)) on quite big radial distances $r/r_e<20$:

$$\Delta\hat{v}=\hat{v}_e-\hat{v}=\hat{v}_e-(c^2/2\hat{v}_e)\left\{\left[2^{35}\ln(r/r_e)\right]^2+c^8/16\hat{v}_e^8\right\}^{-1/4}\le 0{,}95\ [km/s].$$

The FR that is almost equivalent to this FR of observed galaxy is its intrinsic GT-FR$_0$, in which when $b_{re0}=1$, $b_{e0}=0{,}5+(0{,}25-\hat{v}_e^2c^{-2})^{1/2}\approx0{,}99999943672$, $n_0=b_rn=4(\hat{v}_e/c)^2n=2^{36}(\hat{v}_e/c)^2=38708{,}24438\approx2^{15{,}24}$:

$$k_{bp0}=b_{p0}/b_{e0}=\left[\sqrt{1+2^{32{,}48}\hat{v}_e^4c^{-4}\ln^2(r_p/r_e)}+2^{16{,}24}\hat{v}_e^2c^{-2}\ln(r_p/r_e)\right]^{\frac{1}{15{,}24}}=1{,}000003366\quad(k_{bp0}^n=1{,}1391,\ n_0=2^{15{,}24}),$$

$$\Delta\hat{v}=\hat{v}_e-\hat{v}=\hat{v}_e-c\left\{\left[2^{16{,}24}\ln(r/r_e)\right]^2+(c/\hat{v}_e)^4\right\}^{-1/4}\le 0{,}95\ [km/s].$$

Not only the Lagrangian of ordinary internal energy and equivalent to it gravitational mass of matter, but also the following relations are invariant under such a transformation:

$$\hat{v}_0/\hat{v}_{e0}=\hat{v}/\hat{v}_e=\mathbf{inv},\qquad n_0\ln k_{b0}=n\ln k_b=\mathbf{inv}\qquad[n_0(k_{b0}-1)\approx n(k_b-1)].$$

This, of course, is related to the fact that big gradients of gravitational field on the periphery of such galaxies are formed not by their nuclei but by all large set of their objects. This is also related to the fact that the coordinate value of Hamiltonian of inert free energy of matter is significantly smaller than the coordinate value of Lagrangian of its ordinary internal energy when b_{re}=2,253·10^{-6} ($\hat{v}_{\max}$=0,3377 km/s).

Then, taking into account the negligible smallness of cosmological constant and of the pressure in the outer space of the galaxy, the following typical radial distribution of average density of gravitational mass of matter in the galaxy will take place in GR:

$$[\mu_{gr0}]_{GR}\approx\frac{1}{\kappa c^2}\left[\frac{a'}{a^2 r}+\frac{1}{r^2}\left(1-\frac{1}{a}\right)\right]\left(1-\frac{\hat{v}^2}{c^2}\right)=\frac{2\hat{v}^2(1-\hat{v}^2c^{-2})[1+2\hat{v}^2c^{-2}-4n^2\hat{v}^4c^{-4}\ln(r/r_e)]}{\kappa c^6 r^2(1+2\hat{v}^2c^{-2})^2}\approx\frac{\hat{v}^2}{4\pi G r^2}\approx\frac{\hat{v}_e^4}{\pi G c^2 r^2}=\frac{\hat{v}_e^2}{4\pi G_{g0} r^2},$$

where $G=\kappa c^4/8\pi$ is Newton's gravitational constant, the intrinsic galactic values $G_{g0}=G/b_r=Gn/n_0=\hat{v}_e^{-2}c^2G/4\approx443833\ G$ of which (according to Dirac hypothesis [Dirac, 1978]) in far cosmological past possibly were significantly larger than it is now due to the very large average density of matter in the Universe [Danylchenko, 2021, 2022], and:

$$a\approx1+2\hat{v}^2c^{-2}=1+8\hat{v}_e^4c^{-4}/[(k_b^{-n}+k_b^n)/2]=1+2\{[2n\ln(r/r_e)]^2+(c/\hat{v}_{\max})^4\}^{-1/2}=1+2[4n^2\ln^2(r/r_e)+c^8/16\hat{v}_e^8]^{-1/2}. \quad (10)$$

Thus, according to GR, the bigger the index n and the lesser the value of parameter b_e, the lesser is minimum possible value of average density of gravitational mass of the matter on the edge of the galaxy. However, when $\hat{v}_e$=225 km/s, r_e=5 kpc, r_p/r_e=20, n=2^{34} and b_e=1,12656·10^{-6} (k_b^n=1,1391) the exact value of the density of gravitational mass $[\mu_{gr0p}]_{GR}$ =1,4 10^{-29} kg/m^3 is only 1% smaller than its approximate value. And, therefore, due to $\hat{v}<<c$ it quite weakly depends[4] on the index n of the density of friable galactic nucleus. Namely due to the decreasing (H/L=$m_{in}/m_{gr}=\Gamma^2 m_{in0}/m_{gr0}=v_{lr}^2c^{-2}=b_r$ times) the minimum possible accepted value of average density of inertial mass of matter on the edge of the galaxy is decreasing significantly. And this all fits well with the dependence of the value of gravitational constant on the rate of time of gravity-quantum clock, by which this value is being determined.

The following dependence of the orbital velocity of objects of galaxies on parameter b and, thus on radial distance r, can be matched to these objects in intrinsic GT-FR$_{g0}$ of galaxy [Danylchenko, 2020: 85; 2021; 2021: 33; 2022]:

$$\hat{v}_0=\sqrt{\frac{2(b/b_e)^{n_0}}{1+(b/b_e)^{2n_0}}}\hat{v}_{e0}=c\left[4n_0^2\ln^2\left(\frac{r}{r_e}\right)+\left(\frac{c}{\hat{v}_{e0}}\right)^4\right]^{-\frac{1}{4}},$$

[4] This weak dependence can indicate the fact that index n is a macrowave function that can take different values with certain probability. The galaxy is not something freezed. Its starts continuously move in their orbits and chaotically create different instantaneous states of its stellar conglomerate.

where:

$$b_0=b_{e0}\left[(\widehat{v}_{e0}/\widehat{v}_0)^2\pm\sqrt{(\widehat{v}_{e0}/\widehat{v}_0)^4-1}\right]^{\frac{1}{n_0}}=b_{e0}\left[\pm 2n_0\widehat{v}_{e0}^2c^{-2}\ln(r/r_e)+\sqrt{1+[2n_0\widehat{v}_{e0}^2c^{-2}\ln(r/r_e)]^2}\right]^{\frac{1}{n_0}},$$

$$r=r_e\exp\left[\pm\frac{c^2}{2n_0}\sqrt{\widehat{v}_0^{-4}-\widehat{v}_{e0}^{-4}}\right]=r_e\exp\left\{\pm\frac{c^2}{4n_0\widehat{v}_{e0}^2}\left[\left(\frac{b_0}{b_{e0}}\right)^{n_0}-\left(\frac{b_{e0}}{b_0}\right)^{n_0}\right]\right\}.$$

According to the dependence $n_0\ln k_{b0}=n\ln k_b=$**inv** in intrinsic GT-FR$_0$ of the galaxy there is stronger gravitational field than in FR of distant external observer:

$$\mathbf{F}_{gr0}=\frac{\mathrm{L}_0}{2\sqrt{a}}\frac{d\ln k_{b0}}{dr}=\frac{n}{n_0}\frac{\mathrm{L}}{2\sqrt{a}}\frac{d\ln k_b}{dr}=\frac{n}{n_0}\mathbf{F}_{gr}=\frac{G_{g0}}{G}\mathbf{F}_{gr}=\frac{1}{b_r}\mathbf{F}_{gr},$$

where: $\mathrm{L}_0=\mathrm{L}$ due to the fact that Lagrangian of ordinary internal energy of inertially moving matter does not depend on galactic rates of gravithermodynamical (astronomical) time [Danylchenko, 2021; 2021: 37; 2022][5].

By using the reverse transformations we, of course, can switch to the observation of objects of the galaxy with the conservation of Lagrangians of ordinary internal energy of their matter from the points with another gravitational potentials, for which there are another values of their parameters b and b_r. This indicates the fact that Lagrangian of ordinary internal energy of inertially moving matter does not depend on the gravitational potentials in the points of dislocation of inertially moving observers and, consequently, on the rates of time of their gravity-quantum clock.

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It is obvious that the essential dilatation of rate of time, which is being observed for far galaxies (due to b_e=1,12656·10^{-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. If the value of radius r_e of the surface of loose nucleus of the galaxy is the minimum possible in mirror symmetric configuration of intrinsic space of the galaxy, then its nucleus will de facto be the

[5] In contrast to the Lagrangian of ordinary internal energy of matter, the value of Hamiltonian of its inert free energy depends on the difference between gravitational potentials in the point of hypothetical rest of moving matter and in the point of disposition of the clock of the observer of its motion. And, consequently, in contrast to relativistic transformations, the gravitational transformations change the value of Hamiltonian of inert free energy of moving matter, which is observed without taking into account the true value of gravitational constant in distant cosmological past.

loose quasar. 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 [Danylchenko, 2005; 2008: 45; 2008: 96; 2020: 5; 2021, 2022] confirms the principal possibility of existence of such loose structure of galaxies.

Due to the low strength of gravitational field outside the loose nuclei of galaxies they can indeed be considered as "island Universes" [Gordon, 1969, Weinberg, 2010; Koberlein, 2013] (non-isolated island systems [Möller, 1972]) that have individual intrinsic values of gravitational constant:

$$G_{g0dop}=G/b_{rdop}=(1+z_{dop})^2G=D_M^2D_A^{-2}G\equiv R^2r^{-2}G\,.$$

Let us examine the movements of objects of such galaxy using metrically homogeneous scale of cosmological time, by which the frequency of radiation of its stars does not change in time and the redshift of its wavelengths appears because of the evolutionary decreasing of velocity of light in comoving FR in expanding Universe. By the synchronous to it scale s of intrinsic times in FR_{obs} of distant observer ($z_{dop}>0$, $b_{rdop}=(1+z_{dop})^{-2}$, $m_{in0}(z)=m_{gr0}(z)(1+z_{dop})^{-2}$, r, G) and in comoving FR_{g0} of the galaxy ($z_0=0$, $b_r=1$, $m_{in0}(z_0)=m_{gr0}(z_0)$, $R=r(1+z_{dop})$, $G_{g0dop}=G(1+z_{dop})^2$) we will have the following ratios of pseudo forces of gravity and inertia in these FRs:

$$\mathbf{F}_{gr}(z_0)=m_{gr0}M_{gr0}\frac{G_{g0dop}}{\rho_0^2}=m_{gr0}M_{gr0}\frac{G_{g0dop}}{R^2\mathrm{Sin}^2\mathrm{A}}=m_{gr0}M_{gr0}\frac{G}{r^2\mathrm{Sin}^2\mathrm{A}}=\frac{\mathrm{Sin}^2\alpha}{\mathrm{Sin}^2\mathrm{A}}\mathbf{F}_{gr}(z)=\frac{\rho^2(1+z_{dop})^2}{\rho_0^2}\mathbf{F}_{gr}(z)\,,$$

$$\mathbf{F}_{in}(z_0)=m_{in0}(z_0)\Omega_0^2\rho_0=m_{gr0}(z_0)\Omega_0^2R\mathrm{Sin}\,\mathrm{A}=m_{in0}(z)\Omega_0^2\rho\mathrm{Sin}\,\mathrm{A}(1+z_{dop})^3=\frac{\Omega_0^2\mathrm{Sin}\,\mathrm{A}(1+z_{dop})^3}{\Omega^2\mathrm{Sin}\alpha}\mathbf{F}_{in}(z)=\frac{\Omega_0^2\rho_0(1+z_{dop})^2}{\Omega^2\rho}\mathbf{F}_{in}(z)\,,$$

where: $G_{g0}R^{-2}=Gr^{-2}$; $\rho_0=R\mathrm{Sin}\,\mathrm{A}$ and $\rho=r\mathrm{Sin}\alpha$ are the radiuses of orbits of objects of galaxy in FR_{g0} and in FR_{obs} correspondingly; A and α are the aperture angles of radiuses of orbits of galaxy in CFREU and in FR_{obs} correspondingly; Ω_0 and Ω are the angular velocities of rotation of galactic objects in FR_{g0} and in FR_{obs} correspondingly

In order for centrifugal pseudo forces of inertia to compensate the pseudo forces of gravity the following conditions should be fulfilled according to this:

$$\rho_0^3\Omega_0^2=\rho_0v_0^2=\rho v^2=\rho^3\Omega^2=M_{gr0}G/b_{rdop}=M_{gr0}G_{gdop0}=M_{gr0}G(1+z_{dop})^2=M'_{gr0}G\,,$$

$$\rho'_0=\rho=M_{gr0}G/b_r=M_{gr0}/b_{rdop}b_{rgr}=M_{gr0}G_{g0}=M_{gr0}(1+z)^2=M_{gr0}G(1+z_{dop})^2(1+z_{gr})^2=M''_{gr0}G$$

where: $b_r=b_{rdop}b_{rgr}$; $b_{rdop}=(1+z_{dop})^{-2}$; $b_{rgr}\equiv b_{ros}=v_{\cos}^2c^{-2}=(1+z_{gr})^{-2}$; $(1+z)=(1+z_{dop})(1+z_{gr})$; $v_{\cos}$ is the value of coordinate velocity of light in the outer space; z_{dop} and z_{gr} are the Dopplerian and gravitational redshifts of the spectrum of radiation of distant galaxies correspondingly; $\hat{v}_0$ and $\hat{v}$ are the linear velocities of rotation of galactic objects in FR_{g0} and in FR_{obs} correspondingly.

So, mostly namely due to the ignoring of essentially bigger value of gravitational constant in distant cosmological past the imaginary necessity in the bigger mass $M''_{gr0}=M_{gr0}G_{g0}/G=M_{gr0}(1+z)^2>>M_{gr0}$ and, therefore the imaginary necessity in fictive dark matter, appears.

Observed radiuses of orbits of galactic objects do not differ from their eigenvalues ρ_0 only in case of the absence of gravitational dilatation of intrinsic time of galactic objects by the outer space that surrounds them: $\rho=\rho_0\hat{v}_0^2\hat{v}^{-2}=\rho_0c^2v_{\cos}^{-2}=\rho_0/b_{ros}=\rho_0(1+z_{gr})^2$ or in case when the gravitational dilatation of the time rate ($\rho=\rho'_0$) is taken into account in the eigenvalue of gravitational constant. All this is in a good agreement with the theory of dimensions.

The most significant fact id the absence of relativistic dilatation of intrinsic time of galaxies according to received transformations. And this confirms the correspondence of namely Lorentz-conformal transformation of increments of metrical intervals and metrical time to the galaxies [Danylchenko, 2021]. 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 dilatation of their time rate. The dilatation 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 ($\Omega\approx\Omega_0$). And, consequently, radiuses of orbits of their objects in CFREU are practically not decreased since that distant time ($\rho\approx\rho_0$).

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 $G_R=G_{R0}\exp[-2H_E(\tau-\tau_0)]$ 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 [Danylchenko, 2004a: 35; 2004b: 44; 2008: 45; 2014: 21]. Of course, by using the gauge transformation of scales of intrinsic time of galaxies [Danylchenko, 2008a: 106] we can guarantee the invariance of gravitational constant in their non-rigid FRs [Danylchenko, 1994: 52]. However, the galactic objects will anyway move in CFREU in spiral orbits.

In RGTD (taking into account the negligible smallness of only cosmological constant) the completely different typical radial distribution of the average density of gravitational mass of the matter in the galaxy takes place [Danylchenko, 2021; 2021a: 33; 2022]:

$$[\mu_{gr0}]_{RGTD} \approx \frac{\delta}{\kappa c^2 r^2 a(1-b)} = \frac{[2\hat{v}^2 c^{-2} - (a-1)]}{\kappa c^2 r^2 a(1-b)} = \frac{[4\hat{v}_{\max}^2 c^{-2} k_b^n - (a-1)(k_b^{2n}+1)]}{\kappa c^2 r^2 a(1-b)(k_b^{2n}+1)}, \quad (11)$$

according to which it becomes infinitely small. The tendency to 1 of not only parameter a, but also parameter b (when b_{re}=1), prevents the limitless decrease to zero of average density of mass of matter on the edge of the galaxy. That is why in RGTD, in contrast to GR, there cannot be in principle any shortage of baryonic mass not only in the center, but also on the edge of the galaxy. And this is related namely to the fact that tensor of energy-momentum of RGTD is formed based on the ordinary internal energy of matter and corresponds (in contrast to the tensor of energy-momentum of GR[6]) not to cooled down to the limit matter, but to the infinitely cooling down matter of astronomical objects of the galaxy.

Taking into account that in the outer space, when the values of b_r are close to 1, on the periphery of the galaxy a_p-1≈1-b_p and, thus, a_p=1,00000111973203677 (when $2\hat{v}_p^2 c^{-2}$=1,1197320378 $\cdot 10^{-6}$, b_p=0,99999888026796323), having $\hat{v}_{\max}=\hat{v}_e$, $n=2^{15}$ and the same initial data we can find the acceptable value of the average density of mass of matter on the edge of the galaxy: $[\mu_{gr0p}]_{RGTD}$= =5 10^{-26} kg/m^3. However, of course, when we have value b_e, that guarantees $\delta_{\lim}<10^{-15}$, the significantly smaller average density of mass of the matter on the edge of the galaxy can take place in RGTD also when b_{re}=1. When n=1 ($\hat{v}_p$=224,9999999993 6 km/s) and the same value $\delta_{\lim}=10^{-15}$ (b_e=0,99999606363264543, b_p=0,999999436721227408) $[\mu_{gr0p}]_{RGTD}$=1,4 10^{-27} kg/m^3. And in case when n=1, a_p≈1 and when $\delta_{\lim}=10^{-15}$ there will also be $2\hat{v}_p^2 c^{-2}$=1,1197320378 $\cdot 10^{-6}$, then we will receive $[\mu_{gr0p}]_{RGTD}$ ≈1,24·10^{-38} kg/m^3.

As we can see in RGTD, in contrast to GR, index $n=2^{15}$ (when b_{re}=1) quite significantly (almost 36 times) increases the acceptable average value of density of inertial mass of matter on the edge of the galaxy. However, due to mutual dependence of variable parameters n, b_e and a_e, that is defined by the principles of expedience and by corresponding to them negative feedbacks, the increasing of $[\mu_{gr0p}]_{RGTD}$ will be indeed significantly smaller. The increasing of $[\mu_{gr0p}]_{RGTD}$ on the galaxy periphery due to $n=2^{15}$ can be partially compensated by its decreasing due to decreasing of the value $\delta_{\lim}$.

As a result of evolutional decreasing of average density of matter in the Universe and gradual cooling down of the galaxy nuclei their parameters n, b_e (b_p) and a_e (a_p) are gradually changing. It is manifested in a gradual distancing of astronomical objects from the galaxy center. The speeds of gradual change of these parameters are not equal for different galaxies that may result in the non-

[6] Enthalpy of GR, in contrast to enthalpy of thermodynamics and RGTD, de facto does not include the bound internal energy of matter.

equality of galactic values of Hubble constant. However, the difference of galactic values from the global value of Hubble constant, which corresponds only to evolutional expansion of the Universe, is negligibly small in modern time. But in far cosmological past it could be more significant due to the big values of average density of matter in the Universe and, thus, due to the smaller values of parameter b (and, consequently, of defined by them values of coordinate velocity of light) in the outer space of the Universe. Nowadays it is more significant only in non-rigid FRs [Danylchenko, 1994: 52] of cooling-down astronomical bodies.

Radial distribution of parameter a (when b_{re}=1) can be found via the solution of differential equation:

$$\frac{ra'}{a}+(a-1)-\kappa\mu_{in0}c^2\left[1+\frac{\hat{v}^2}{b(c^2-\hat{v}^2)}\right]=$$

$$=\frac{ra'}{a}+(a-1)-\frac{[(1-a)(b^{2n}+b_e^{2n})+4\hat{v}_e^2c^{-2}b_e^nb^n][b(b^{2n}+b_e^{2n})+2\hat{v}_e^2c^{-2}b_e^nb^n(1-b)]}{(1-b)(b^{2n}+b_e^{2n})[(b^{2n}+b_e^{2n})-2\hat{v}_e^2c^{-2}b_e^nb^n]}=$$

$$=\frac{ra'}{a}+\frac{(b^{2n}+b_e^{2n})(a-1)}{(1-b)[(b^{2n}+b_e^{2n})-2\hat{v}_e^2c^{-2}b_e^nb^n]}-\frac{4\hat{v}_e^2c^{-2}b_e^nb^{n+1}[(b^{2n}+b_e^{2n})+2\hat{v}_e^2c^{-2}b_e^nb^{n-1}(1-b)]}{(1-b)(b^{2n}+b_e^{2n})[(b^{2n}+b_e^{2n})-2\hat{v}_e^2c^{-2}b_e^nb^n]}=0$$

and, taking into account that $dr=(rc^2/2\hat{v}^2b)db$, and $\hat{v}_e<<c$, – of another equation:

$$\frac{1}{a}\frac{da}{db}+\frac{c^2(b^{2n}+b_e^{2n})^2(a-1)}{4\hat{v}_e^2b_e^nb^{n+1}(1-b)[(b^{2n}+b_e^{2n})-2\hat{v}_e^2c^{-2}b_e^nb^n]}-\frac{(b^{2n}+b_e^{2n})+2\hat{v}_e^2c^{-2}b_e^nb^{n-1}(1-b)}{(1-b)[(b^{2n}+b_e^{2n})-2\hat{v}_e^2c^{-2}b_e^nb^n]}\approx$$

$$\approx\frac{1}{a}\frac{da}{db}+\frac{c^2(b^{2n}+b_e^{2n})(a-1)}{4\hat{v}_e^2b_e^nb^{n+1}(1-b)}-\frac{1}{(1-b)}=\frac{1}{a}\frac{da}{db}+\frac{c^2(a-1)}{2\hat{v}^2b(1-b)}-\frac{1}{(1-b)}=\frac{1}{a}\frac{da}{db}+\frac{(a-1)}{(1-b)r}\frac{dr}{db}-\frac{1}{(1-b)}=0 \quad (12)$$

11. Imaginary non-baryonic dark matter

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:

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

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

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

And, therefore, it is $(1+z)^{1/2}$ times smaller than the radial coordinate $R=\,^rD_M$ of the galaxy in Euclidean space of CFREU in the moment of registration of its radiation [Danylchenko, 2004a: 33;

2004a: 62]. And it is also $(1+z)^{1/2}$ times bigger that the Schwarzschild radius of the galaxy in GT-FR:

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

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:

$$\frac{{}^{r}D_M}{{}^{r}D_A} = \frac{R}{r} = \frac{R}{R_0} = 1+z.$$

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

$${}^{i}D_A = \frac{{}^{i}D_M}{1+z} = \frac{D_L}{\left(1+z\right)^2}$$

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 (2) tends to infinity while approaching to median singular sphere of the quasar when logarithmic gravitational potential is used. G_{eff} depends on angular diameter α of circular orbit in the following way:

$$G_{eff} \approx \frac{c^2 v_{cr}^{-2} G}{\sqrt{1-\dfrac{4GM_{gr0}}{c^2 D_A \sin\alpha}}} = \frac{c^2 v_{cr}^{-2} G}{\sqrt{1-\dfrac{4GM_{gr0}\sqrt{(1+z)^3}}{c^2 D_L \sin\alpha}}}.$$

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 friable 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 gravi-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 [Danylchenko, 2004a:

33; 2004a: 62] velocities of astronomical objects in the picture plane in intrinsic gravi-quantum time of the observer do not depend at all on the dilation of intrinsic gravi-quantum time of GT-FR in the points of instantaneous disposition of those objects.

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

$$^{j}G_E = \frac{G_E c^2}{v_{cj}^2} = \frac{G_E (1+z)^2}{1+2z}.$$

Results of such imaginary "observation" of the motion in the picture plane of distant astronomical object in dilated gravi-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:

$$^{r}D_A = R_0 = r = \frac{^{r}D_M}{1+z} = \frac{^{i}D_M}{\sqrt{1+z}}.$$

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 [Danylchenko, 2004a: 33; 2004a: 62].

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.

It is obvious, that according to results of galaxies observations in more wide spectral diapason there would be no deficit of ordinary matter [McGaugh et al., 2016: 201101] (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 [Danylchenko, 2006; McGaugh et al., 2016: 201101]. 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) [Danylchenko, 2020: 85].

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 [McGaugh et al., 2016: 201101].

12. 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:

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

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 velocity of light ${}^{u}v_{cos}$ 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 commoving 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:

$$\frac{\Delta^{i} t_j}{\Delta^{j} t_j} = \frac{1}{{}^{i}v_{cj}} = \frac{1+z}{\sqrt{1+2z}}.$$

13. 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:

$$\kappa = 8\pi\ c^{-2}\left({}^{u}v_{\cos}^{-2}\right)G\,.$$

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: $v_{cj}=c\sqrt{1+2z_j}/(1+2z_j)$ 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 defined by the *Λ*-part may be connected by certain proportionality coefficient *m* with the increment of gravitational potential of outer space: $\varphi_{os} = c^2 \ln\left({}^{u}v_{\cos} / c\right)$.

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:

$$\varphi_H = -c^2 \ln\left(v_{cj} / c\right),$$

$$\frac{d\ln(H/H_0)}{dz} = m\frac{d\varphi_{os}}{dz} = -k\frac{d\varphi_H}{dz}.$$

Then, evolutional change of Hubble's parameter can be defined by the following empirical dependency:

$$H = H_0\left(\frac{v_{cj}}{c}\right)^k = H_0\left(\frac{\sqrt{1+2z}}{1+z}\right)^k.$$

Table

H, km/ sMpc	*D, Gpc*	Z						
		0,2	0,4	0,6	0,8	1,0	1,2	1,4
62,164	${}^{r}D_M$	0,96	1,93	2,89	3,86	4,82	5,79	6,75
	${}^{r}D_A$	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	${}^{r}D_M$	0,96	1,92	2,89	3,85	4,81	5,77	6,74
	${}^{r}D_A$	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) ${}^{g}D_L$	1,03	2,25	3,65	5,2	6,9	8,65	10,5
65	${}^{r}D_M$	0,93	1,85	2,77	3,69	4,62	5,54	6,46
	${}^{r}D_A$	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) ${}^{g}D_L$	1,00	2,16	3,50	4,95-5,0	6,4-6,8	8,2-8,8	9,9-11,0

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

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

Dependencies of luminosity distance D_L to supernovas of type Ia on the redshift z of their radiation spectrum have been modeled [Riess, Adam G. et al, 1998: 1009; Semiz and Çamlibel, 2015; Dempsey, 2016; Soloviev, 2016] based on the results of astronomical observations of supernovas of type Ia [Perlmutter, et al, 1999: 565; Riess, Adam G. et al, 1998: 1009]. According to graphs of that dependencies (q.v. Fig. 3) evolutionary change of Hubble's parameter is almost not observed (k=0).

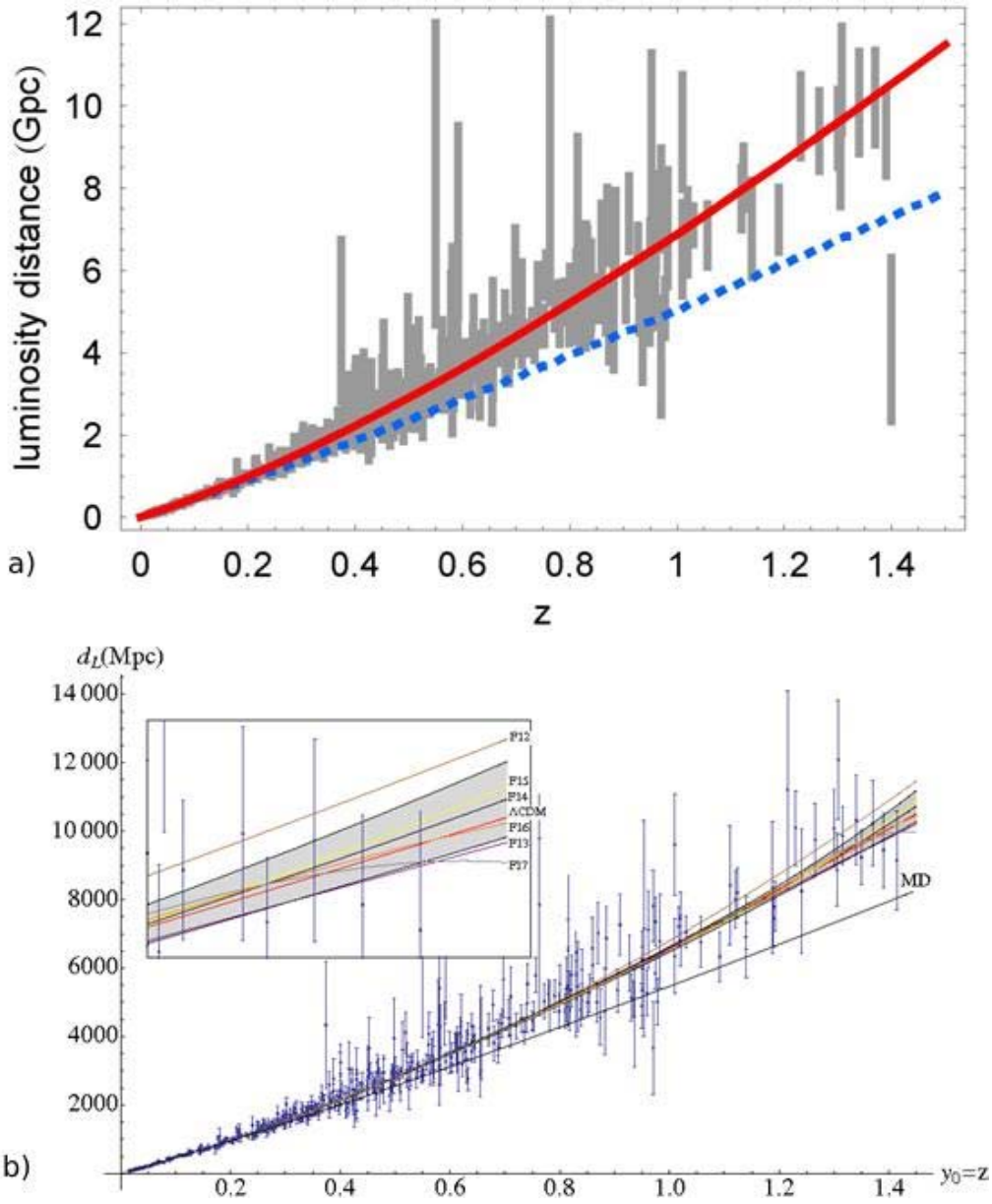

Fig. 3. Dependencies of distances to astronomical objects on the redshift of radiation of astronomical objects *z*:

a) *luminosity distance D_L (solid line) to those objects* [Soloviev, 2016] *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* [Semiz and Çamlibel, 2015].

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 [Danylchenko, 2021a: 29; 2022]:

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

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 commoving 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 [Danylchenko, 1994: 22]. 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:

$$H = c\sqrt{\Lambda/3} = \frac{\pi^4\alpha}{8N_{Dn}}\nu_{Bn} = \frac{2}{3}\pi\alpha\ t_p^2\left(\frac{\pi}{2}\nu_{Bn}\right)^3 = \frac{2}{3}\pi G e^2\left(\frac{m_n}{4\hbar}\right)^3 = 2{,}018859\cdot10^{-18}[s^{-1}] = 62{,}29548\left[\frac{km}{sMpc}\right],$$

where: Λ is the cosmological constant, $N_{Dn}=1{,}5(t_p\nu_{Bn})^2 = 3\pi chm_n^{-2}/G = 0{,}999885\cdot10^{40}$ is the neutron large Dirac number, $\alpha=e^2/c\hbar$ is the fine structure constant, $\nu_{Bn}=m_nc^2/2\pi\hbar$ 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 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 $H=(\pi^4\alpha/8N_{DH})\nu_{BH}=62{,}1642$ [$km/sMpc$] ($\Lambda=1{,}35457\cdot10^{-52}$ [m^{-2}]), that corresponds to the de Broglie wave frequency of hydrogen atom $\nu_{BH}=m_Hc^2/2\pi\hbar=2{,}270262\cdot10^{23}$ [s^{-1}] ($m_H=1{,}67375\cdot10^{-27}$ [kg], $N_{DH}=1{,}5(t_p\nu_{BH})^{-2}=1{,}001292\cdot10^{40}$), 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

[Danylchenko, 2004a: 33; 2004a: 62; 2008: 45; 2008a: 106] the redshift is linearly dependent only on the transverse comoving distance D_M:

$$z=\frac{\Delta\lambda_D}{\lambda_0}=\frac{HR}{c}=\frac{HD_M}{c}$$

and on the angular diameter distance:

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

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 ${}^{u}v_{cos}$ 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 [Sheldrake, 2012; Asprem, 2013; Rutskiy, 2015]). 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 [Danylchenko, 2004a: 33].

Noether has explained the conservation of energy and momentum by the uniformity, respectively, of time and space [Noether, 1918: 235]. 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 an phantom neutrino (it never appears as a constituent of matter [Weisskopf, 1965]). 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 [Weisskopf, 1964: 290], and not a particle [Danylchenko, 2004a: 33; 2014: 21]. 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.

Weisskopf has repeatedly pointed out that not only the photon, but also the neutrino are not particles [Weisskopf, 1965; 1972]: "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 [Danylchenko, 2004a: 33; 2014: 21; Winfree & Strogatz, 1983]. 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 [Danylchenko, 2004a: 33; 2008: 45; 2010: 38; 2014: 21; 2020: 5; 2021, 2022].

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