

The Physical Essence of Observer Horizon (Event Pseudo-Horizon) and Schwarzschild Sphere. Cosmological Age of the Universe*

Pavlo Danylchenko*

SPE "GeoSystem", Vinnytsia, Ukraine

***Corresponding Author**

Pavlo Danylchenko, SPE "GeoSystem", Vinnytsia, Ukraine.

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Abstract

The possibility to avoid physical realizability of cosmological singularity (singularity of Big Bang of the Universe) is substantiated. This can take place in the case of counting of cosmological time in frame of reference of spatial coordinates and time (FR) not comoving with matter, in which by the Weyl hypothesis galaxies of the expanding Universe are motionless. It is proved that only in the case of the joint application in the Universe of a metrically homogeneous scale of unified gravithermodynamic (beginningless cosmological) time and a dynamic gravitational field, which ensure the invariance in space and time of the vacuum velocity of light and the Hubble constant, it is possible to ensure not only the general covariance of all physical laws, but also the gravitational-relativistic invariance of thermodynamic parameters and potentials of matter. It is the beginningless cosmological time together with the infinite dynamic space of the Universe that form a global dynamic frame of reference of spatial coordinates and time of the people's world (GDFRPW), which is equivalent to the frame of reference comoving with the expanding Universe.

Keywords: General Relativity, Gravithermodynamics, Universe, Cosmological Singularity, Big Bang, Dynamic Gravitational Field

1. Introduction

The existence of singularities in the General Relativity (GR) is considered by Einstein and later by the most authoritative specialists in this branch of physics (Ivanenko, Möller, Hawking) not only as the most apparent difficulty of this theory, but also as the sign of limitation of its application area [1-5]. Being based on this and on the evidence of mathematical inevitability of existence of singularities in GR, many attempts of the radical upgrade of GR via applying it to high densities of matter are undertaken [6,7]. We have chosen another way to solve this problem in Relativistic Gravithermodynamics (RGTD) [8-10].

The process of expansion of the Universe as whole can take place only, if it takes place in every single point of its infinite space. The presence of this process may be caused only by evolutionary variability of the properties of physical vacuum and, therefore, by "adaptation" of matter elementary quasiparticles to continuously renewed terms of their interaction. Therefore, apparently, distances between quasi-motionless in the comoving with expanding Universe frame of reference of spatial coordinates and time (CFREU or Weyl FR [11]) galaxies (according to Weyl hypothesis, in this FR they take part only in small peculiar motions [12-14]) lengthen in FR, comoving with evolutionarily self-contracting matter, not because of the expansion of cosmic space into "nowhere", but because of the continuous shrinkage of length standard in CFREU. The last is caused by gauge change (which is unobservable in principle in FR of people's world (FRPW or matter FR [11]) because of gauge invariance of people's world [15]) of values of spatial parameters of elementary quasiparticles, evolutionarily self-contracting in this infinite fundamental space of RGTD (Newton-Weyl absolute space [11]). This is the cause of continuous decreasing of dimensions of all Universe objects in CFREU.

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The fact that process, which takes place in megaworld, is caused by the processes, which take place in microworld, is in good agreement with existence of many correspondences in correlations between atomic, gravitational and cosmological characteristics – Eddington-Dirac “large numbers” and doesn't contradict modern physical notions [2,16,17]. That's why we can consider the expansion of the Universe, in analogy to daily solar motion on the celestial sphere, only as phenomenon that is observed in some selected FR. Already ancient Greeks (Aristarchus of Samos (ca.310 – ca.230 BC) and Seleucus of Seleucia (ca.190 - unknown BC)) presumed, that in fact Earth revolves around its axis and around the Sun. But it took nearly two thousand years to make this the apparent truth for all. We can only hope, that phenomenon of Universe expansion won't have such fate.

Thermodynamic states of matter, examined in GR, are self-induced by spatially inhomogeneous states of this matter. This fact is caused by the presence of gravitational field in matter: Gravitational field is the cause of spatial inhomogeneity of rates of intra-atomic physical processes in matter and, therefore, it induces not only the curvature, but also physical inhomogeneity of intrinsic space of matter [10,11,18].

2. Dynamic Gravitational Field in the People's World

It was shown by Lemaitre and independently by Robertson, that there is an appropriate transformation of coordinates, using which we can proceed from rigid FR, comoving with matter, to non-comoving FR, in which dimensions of both macro- and micro-objects of body matter mutually proportionally vary with time [14,19,20]. When values of gravitational radius of this astronomical body, located far from other astronomical objects, are negligible ($r_{ge} \approx 0$, that only formally corresponds to de Sitter Universe), we will have the following value of the radius of the event horizon: $r_c \approx \sqrt{3/\Lambda} = c/H_E$, where $\Lambda = 3H_E^2 c^{-2}$ is the cosmological constant, H_E is the Hubble constant, and c is the constant of the velocity of light.

Then, the linear element of body both in the FR of the people's world (FRPW) and in the CFREU will have the following form [14,15]:

$$ds^2 = \left(1 - \frac{r^2}{r_c^2}\right)^{-1} dr^2 + r^2(d\theta^2 + \sin^2 \theta d\varphi^2) - \left(1 - \frac{r^2}{r_c^2}\right) c^2 dt^2 = \frac{[dR^2 + R^2(d\theta^2 + \sin^2 \theta \cdot d\varphi^2)]}{\exp[-2c(\tau - \tau_k)/r_c]} - c^2 d\tau^2 = \frac{dL^2 - c^2 d\tilde{\tau}^2}{[1 - H_E(\tilde{\tau} - \tilde{\tau}_k)]^2}, \quad (1)$$

where:

$$dL = \sqrt{dR^2 + R^2(d\theta^2 + \sin^2 \theta \cdot d\varphi^2)}; \quad r \equiv R_k = R \exp[H_E(\tau - \tau_k)] = R[1 - H_E(\tilde{\tau} - \tilde{\tau}_k)]^{-1} < r_c \quad (2)$$

R_k is radial coordinate of optional world point of the space-time continuum (STC) of evolutionarily self-contracting body in CFREU in the time moment τ_k ($\tilde{\tau}_k$) of calibration of the dimension of length standard in CFREU by its dimension in intrinsic FR of this body;

$\tau = t + (r_c/2c) \ln(1 - r^2/r_c^2)$ is the time, which is counted in CFREU by the metrically homogeneous scale, by which the rate of quasi-equilibrium physical processes in matter doesn't vary, despite gradual shrinkage of distances between its interacting elementary quasiparticles. Therefore, this time will be considered by us further as cosmological time; $\tilde{\tau} = \tilde{\tau}_k + (1/H_E)[1 - \exp\{H_E(\tau_k - \tau)\}]$ is the time, which is counted in CFREU by physically homogeneous scale, which is metrically non-calibrated, but guarantees invariance of values of limit velocity of matter $\tilde{V}_l = (\partial L / \partial \tilde{\tau})_s$ and energy of radiation quanta during the process of light propagation [18,21].

Therefore, this scale (like the length scale in CFREU) requires continuous renormalization. Due to renormalization of this time scale the moment of imaginary singularity (moment of matter self-contraction to zero dimensions) will be “expected” by it after the same finite time interval $\tilde{\tau} - \tilde{\tau}_k = H_E^{-1}$ independently of duration of passed time. And, therefore, in fact this moment of time is unreachable in principle. This means the physical unrealizability of such singularity.

$H_E = V_H/R$ is Hubble constant, which determines in CFREU by metrically homogeneous time scale proportionality between velocity $V_H = -dR/d\tau$ of the points of self-contracting body and radial distance R to these points in Euclidean space of CFREU. The value of H_E does not evolutionary vary and, consequently, does not depend on the average value of density of matter in expanding Universe. Therefore, precise determination of the average value of this density, as well as the related problem of existence of hidden mass or so called dark non-baryonic matter in the Universe, are irrelevant. The value of the ratio $\tilde{V}_H/R \neq \text{const}(\tilde{\tau})$, which is determined in CFREU by physically homogeneous time scale, on the contrary, evolutionarily varies and becomes invariant only when it's being continuously renormalized: $(\tilde{V}_H/R)[1 - H_E(\tilde{\tau} - \tilde{\tau}_k)] \equiv H_E$. Analogously, only continuously renormalized (in compliance with evolutionary decreasing of material length standard in CFREU) value of the limit velocity of matter is invariant by the metrically homogeneous time scale in CFREU.

According to this, velocities of radial motion not only of macroparticles of self-contracting body matter, but also of all points of conventionally empty intrinsic space of gauge-self-contracting (fundamentally unobservable in the FRPW [15]) body are determined in CFREU by metrically homogeneous time scale via Hubble relation:

$$V = -dR/d\tau = H_E R_k \exp[-H_E(\tau - \tau_k)] = H_E R. \quad (3)$$

Taking into account relativistic time dilation, values of limit velocities of matter in FR of evolutionarily self-contracting body (v_l) and in CFREU (V_l) will be connected by relationship:

$$v_l = c\sqrt{b} = V_l \sqrt{1 - (V/V_l)^2} r/R, \quad (4)$$

from where:

$$V_l = c\sqrt{b + (Vr/cR)^2} R/r = \sqrt{c^2b + H_E^2 r^2} R/r = \sqrt{b_c} cR/r \neq \mathbf{const}(\tau). \quad (5)$$

is the value of the limit velocity of matter in the CFREU, which is actually a metrically renormalized value of the limit velocity of matter $v_{lc} = c\sqrt{b_c} = \sqrt{c^2b + H_E^2 r^2}$ in the dynamic gravitational field of FRPW [22-24].

It should be kept in mind here that relativistic time dilation, like the ordinary Lorentz transformations (OLT) in general, is related only to the equilibrium process of the evolutionary self-contraction of matter in the CFREU and is related only to the rate of a hypothetical, absolutely motionless in the FRPW clock. This relativistic time dilation should be considered gravitational in the FRPW. Astronomical objects moving by inertia in the dynamic gravitational field of the Universe do not experience this time dilation, since the inertial motion of matter compensates for the gravitational change in the rate of time flow. Therefore, distant galaxies moving away from the observer at high velocity do not experience relativistic time dilation. After all, they are freely falling by inertia toward the events pseudo-horizon of the Universe. This is a significant difference between the non-uniform inertial motion of matter in a dynamic gravitational field and its uniform equilibrium motion during the process of evolutionary self-contraction of its size in the CFREU.

And thus, only a physically homogeneous unified gravithermodynamic (universal astronomical) time, which is based on the correspondence of the dynamic (and not static) gravitational field of the Universe to the true general covariance of physical laws, can be metrically homogeneous. The assumption that the metrically inhomogeneous (exponential) scale of proper time currently used in cosmology is physically homogeneous and, therefore, ensures the general covariance of physical laws is actually completely false. And therefore, the general covariance of physical laws in the FRPW is actually ensured by matter and the corresponding dynamic gravitational field of the Universe, and not at all by the hypothetical empty space and the corresponding static gravitational field. And this is confirmed both by the motion of the planets of the Solar System and by the gravitational-relativistic invariance of the thermodynamic parameters and potentials of matter. And that is why the relativistic transformations of the energy of matter, which is fundamentally unchanged in the FRPW, moving in a gravitational field by inertia, do not correspond to reality.

Front of intrinsic time t of physical body corresponds to simultaneous (when intrinsic time is inhomogeneous – to coincident [21,25]) events and propagates in intrinsic FR of body instantly in principle ($v_t = \infty$). In CFREU this front will propagate, as it follows from Lorentz transformation for velocities, with finite velocity:

$$V_t = dR_t/d\tau_t = V_c^2/V = -(c^2b + H_E^2 r_t^2)R_t/H_E r_t^2 \quad (6)$$

Since when $t(r) = \mathbf{const}$:

$$V_t = \left(\frac{\partial R}{\partial r} \right) \frac{dr_t}{d\tau_t} + \frac{\partial R_t}{\partial \tau_t} = \left[\frac{\sqrt{ab}}{r_t \sqrt{b + r_t^2 H_E^2/c^2}} \left| \frac{dr_t}{d\tau_t} \right| - H_E \right] R_t, \quad (7)$$

where taking in to account relativistic shrinkage of dimensions (that occurs only in the equilibrium process of evolutionary self-contracting of matter in the CFREU) when $\tau(R) = \mathbf{const}$:

$$\left| \frac{\partial R}{\partial r} \right| = \left| \frac{\partial \bar{r}}{\partial r} \right| \sqrt{1 - \frac{V^2}{V_l^2}} \frac{R}{r} = \frac{\sqrt{a}}{\sqrt{1 + r^2 H_E^2/c^2 b}} \frac{R}{r},$$

then, when $\partial r / \partial R > 0$, we'll have:

$$d\tau_t = -\frac{H_E r_t dr_t}{c[(c^2 b + H_E^2 r_t^2) b / a]^{1/2}} = -\check{v}_H v_l^{-2} d\hat{r}_t = -dt_\tau, \quad (8)$$

where: $\check{v}_H = -v_l V / V_t = H_E r / \sqrt{1 + r^2 H_E^2 / v_l^2}$ is the false Hubble velocity of an astronomical object, determined on a scale of metrically inhomogeneous time (exponential time, currently used in cosmology), with which it moves away from the observer (in its own frame of reference), being conventionally motionless in the Euclidean fundamental space of the CFREU (Newton-Weyl absolute space [21,25,26]). It is this false velocity that does not exceed the false coordinate velocity of light of the GR at each point in the intrinsic space of the body on which the observer is located, and on the motionless event pseudo-horizon of conventionally empty space it is equal to zero, as is the false coordinate velocity of light on it. This velocity doesn't exceed limit velocity of matter v_l in every point of intrinsic space and is equal to zero on the motionless event pseudo-horizon ($r = r_c$) of conventionally empty space, the same as false coordinate velocity of light $v_c = v_l$:

$$\check{v}_{Hc} = \frac{v_l r}{r_c} \sqrt{\frac{1 - r_{ge} / r_c}{1 - r_{ge} / r}} = H_E r \sqrt{1 - \frac{r^3 (r - r_{ge})}{r_c^3 (r - r_{ge})}} = 0.$$

But the use in the Universe of a static gravitational field and the corresponding to it metrically inhomogeneous (non-uniform) scale of matter's proper time (which really do not correspond to the undoubted eternity of the existence of the Universe and ensure that the radial velocities of motion of distant galaxies do not exceed the values of the false coordinate velocities of light of the GR) does not ensure not only the gravitational-relativistic invariance of thermodynamic parameters and potentials of matter, but also the true general covariance of all physical laws. And therefore, only in the case of the joint use in the Universe of a physically and metrically homogeneous (non-exponential) scale of the unified gravithermodynamic time and a dynamic gravitational field, which ensure the invariance in space and time of the vacuum velocity of light and the Hubble constant, is it possible to ensure not only the true general covariance of all physical laws, but also the gravitational-relativistic invariance of the thermodynamic parameters and potentials of matter.

3. The Event Pseudo-Horizon of the Universe and Global Dynamic FRPW

For conventionally empty space ($ab = 1$) we have:

$$d\tau_t = -\frac{H_E r_t (1 - r_{ge} / r)^{-1/2} dr_t}{c^2 (1 - r_{ge} / r_t) - H_E^2 r_t^2} = \frac{r_t^{5/2} (r_t - r_{ge})^{-1/2} dr_t}{H_E (r_t - r_c)(r_t - r_s)(r_t + r_c + r_s)}, \quad (9)$$

where: $r_s = \left\{ \sqrt{(r_c + 3r_{ge}) / (r_c - r_{ge})} - 1 \right\} r_c / 2$ is Schwarzschild sphere radius.

After integrating (9), we'll receive equation for difference $\Delta\tau_{ij} = \tau_{ij} - \tau_{ii}$ between cosmological ages of events, simultaneous in FR of evolutionarily self-contracting physical body, in optional points j and i ($r_j > r_i$) of intrinsic conventionally empty space of this body:

$$\Delta\tau_{ij} = \frac{2}{\check{H}_E} \left\{ \ln \left| \frac{\sqrt{r_j} + \sqrt{r_j - r_{ge}}}{\sqrt{r_i} + \sqrt{r_i - r_{ge}}} \right| - \frac{(r_c + r_s)^{5/2}}{(2r_c + r_s)(r_c + 2r_s)\sqrt{r_c + r_s + r_{ge}}} \times \ln \left| \frac{\sqrt{r_i + r_c + r_s} \left[\sqrt{r_j (r_c + r_s + r_{ge})} + \sqrt{(r_c + r_s)(r_j - r_{ge})} \right]}{\sqrt{r_j + r_c + r_s} \left[\sqrt{r_i (r_c + r_s + r_{ge})} + \sqrt{(r_c + r_s)(r_i - r_{ge})} \right]} \right| + \right. \\ \left. + \frac{r_s^{5/2}}{(r_c - r_s)(r_c + 2r_s)\sqrt{r_s - r_{ge}}} \times \ln \left| \frac{\sqrt{r_i - r_s} \left[\sqrt{r_j (r_s - r_{ge})} + \sqrt{r_s (r_j - r_{ge})} \right]}{\sqrt{r_j - r_s} \left[\sqrt{r_i (r_s - r_{ge})} + \sqrt{r_s (r_i - r_{ge})} \right]} \right| - \frac{\sqrt{r_c (r_c - r_{ge})}}{(2r_c - 3r_{ge})} \ln \left| \frac{\sqrt{r_c - r_i} \left[\sqrt{r_j (r_c - r_{ge})} + \sqrt{r_c (r_j - r_{ge})} \right]}{\sqrt{r_c - r_j} \left[\sqrt{r_i (r_c - r_{ge})} + \sqrt{r_c (r_i - r_{ge})} \right]} \right| \right\}, \quad (10)$$

where $\check{H}_E = H_E$ when $\partial r / \partial R > 0$ and $\check{H}_E = -H_E$ when $\partial r / \partial R < 0$.

According to (10), for any values of r_{ge} , and, thus, for any values of body mass, events in points of event (observer) pseudo-horizon of intrinsic space of this body took place in cosmological time in infinitely far past (because when $\partial r / \partial R > 0$ and $r_j = r_c$: $\Delta\tau_{ij} = -\infty$). And this means, that observer pseudo-horizon of any evolutionarily contracting body, as it was shown in, covers all infinite fundamental (absolute) space of Universe (because according to (2) and (10) when $t = \mathbf{const}$: $R_c = \infty$) [18,21]. Higher concentration of astronomical objects near observer pseudo-horizon, which is caused by this, and finiteness of intrinsic space of physical body, however, are not being observed in the process of astronomical observations. This is related to determination of distances to distant stars by their luminosity, starting from assumption about isotropy of their brightness (which is valid, of course, for Euclidean absolute space, but not for intrinsic space of

matter, which has curvature), and directly by their concentration in certain solid angle. But it means, that in fact not metrical radial distances \hat{r} to distant objects in finite non-Euclidean metrical intrinsic space of body, from surface of which observation is taking place, but continuously renormalized radial distances $\tilde{r}_k \equiv \tilde{R}_k$ to these objects in infinite Euclidean fundamental (absolute) space are being determined.

Simultaneity in matter FR of infinitely far past on event (observer) pseudo-horizon (when distances between interacting elementary quasiparticles of protomatter in fundamental (absolute) space were as long as desired) with every concrete event in any point of matter intrinsic space causes the finiteness of pseudo-metrical distance in intrinsic static space to its event (observer) pseudo-horizon (the possibility of this was shown earlier by Penrose [27]) [18,21].

The true metric distance to the pseudo-horizon of events should be calculated not at all in the static space of the observer, but in its dynamic space that is comoving with the matter of the expanding Universe. After all, not only are the radial dimensions of stars lengthening, but the radial distances between stars in galaxies and between galaxies themselves are increasing as well.

Taking into account not only the curvature of the static space (which is given by the parameter a of the Schwarzschild solution of the gravitational field equations), but also the kinematic elongation (in the dynamic gravitational field of the expanding Universe [22-24]) of the metric segments comoving with matter, we will have the following ratio of the increment of the radial metric segment $d\hat{r} \equiv d\hat{R}$ in a dynamic space of the global dynamic FRPW (GDFRPW) to the increment of the Schwarzschild radial coordinate, which is given by the parameter a_{cH} :

$$\sqrt{a_{cH}} = d\hat{r} / dr \equiv d\hat{R} / dr = \sqrt{a(b + v_H^2 c^{-2}) / b} = a \sqrt{b_{0H} / ab} \approx a \approx (1 - r^2 r_c^{-2})^{-1}, \quad (11)$$

where: $b_{0H} \equiv b_{cH} = b + v_H^2 c^{-2} \approx 1 = \mathbf{const}(r)$, $ab = 1$ (for a conventionally empty space); $r_c \approx c / H_E$ – the radius of the event pseudo-horizon.

Hence, we have: $\hat{r} \equiv \hat{R} = (r_c / 2)[\ln(1 + r / r_c) - \ln(1 - r / r_c)]$, $\hat{r}(r_c) \equiv \hat{R}(r_c) = \infty$.

And therefore, the global dynamic curvature $\sqrt{a_{cH}} = d\hat{r} / dr \approx a$ of the space of the Universe, in contrast to its static curvature $\sqrt{a} = d\hat{r} / dr$, ensures that the event pseudo-horizon of the static FRPW (SFRPW) covers the entire infinite Euclidean fundamental space of the CFREU. And this is due to the correspondence of the dynamic gravitational field to the metrically homogeneous time of matter, which is almost identical to the beginningless cosmological time. And thus, the GDFRPW outside our galaxy is actually equivalent to the CFREU.

But the dynamic gravitational field corresponds not only to the GDFRPW, but also to the SFRPW, which is inherent only to the stars of our galaxy and the planets of the Solar System. And therefore, only the dynamic gravitational field can correspond to the general covariance of physical laws.

Therefore, near the observer horizon of any body the delayed (by the clock of the body) process of origination of matter is continuously “observed”, which corresponds to Gold-Bondi-Hoyle theory only formally [2,28]. If observer horizon of matter intrinsic space is in fact a pseudo-horizon of past, then Schwarzschild sphere, according to (10) and (11), is a pseudo-horizon of future of matter. Events, which take place on this sphere, are simultaneous in physical body FR with every event on the surface and in any other points of this body. Therefore, they can take place in cosmological time only in infinitely far future (when $\tilde{m}_e \rightarrow \infty$ and $\Delta t_{cij} = \infty$). There is nothing inside the “fictive”

Schwarzschild sphere in that “moment” of cosmological time, and thus, in any moment of proper time of physical body, because, according to (2) and (10), when $t = \mathbf{const}$ and $r_i = r_s$: $\Delta \tau_{js} = \tau_s - \tau_{kj} = \infty$, and $R_s = 0$ (and thus $\hat{r}_s = 0$, despite value of r_s is nonzero).

This, of course, is related to principal conservation of finite eigenvalues of matter dimensions, when its dimensions are as large as desired or as small as desired (hypothetically – conventionally “zero” in infinitely far future) in fundamental space, and, thus, with the fact that Schwarzschild radius in principle can’t obtain (analogously to absolute temperature) not only infinitely large value but also zero value.

The presence of negative feedback between eigenvalue of dimension (stabilizable output parameter) and length unit, which is being determined in absolute space by the length standard of matter, becomes apparent here. This negative feedback prevents from catastrophic decrease not only intrinsic dimensions of self-cooling astronomical objects, but also rates of physical processes in matter (which is possible because of the decrease of the limit value of the velocity of matter) and, thus, guarantees the stable existence of matter. Moreover, it causes

the self-organization and stable existence of spiral-wave structural elements (matter elementary quasiparticles) in physical vacuum, which gauge-evolves (becomes older) and is the pseudo-dissipative medium in CFREU.

Analogous phenomena take place in thermodynamics (Le Chatelier – Brown principle), in electromagnetic phenomena (Lenz rule) and in the process of motion (isotropic kinematic reduction of dimensions in CFREU, relativistic shrinkage in length in the SFRPW, and kinematic increase in length in the GDFRPW [10,24,25]). The character of any physical law or phenomenon is being determined by the presence of explicit and implicit (hidden from observation in principle) negative feedbacks, which are formed between parameters and characteristics of matter in the process of its self-organization and are aimed at maintaining the stability of the established phase state of matter. Revelation of global topology of direct and feedback relations between parameters and characteristics of matter is the supreme aim of physics.

4. Conclusions

Thus, we should finally recognize the cardinal difference and mutual harmonious coherence of the phenomena and patterns that occur in the FR of the people's world (FRPW) and in the comoving with expanding Universe FR (CFREU):

1. In the FRPW, the unified gravithermodynamic (universal astronomical) time, which applies to all gravithermodynamically related substances, is in effect. The complete compensation of the gravitational deceleration of the flow of this time is carried out simultaneously by both the directed and chaotic thermal motion of all macro- and micro-objects of these substances, which are spiral-wave self-formations [11,15,29-31].

2. The true general covariance of all physical laws is ensured by the use (in the Universe) of a dynamic gravitational field and a corresponding metrically homogeneous cosmological time scale, which is identical to the gravithermodynamic time scale (instead of the exponential time scale of matter currently used in cosmology, which corresponds to a static gravitational field). The infinite dynamic space of the Universe together with the beginningless cosmological time form the global dynamic FRPW (GDFRPW), which is equivalent to the comoving with expanding Universe frame of reference of spatial coordinates and time.

3. There are two types of similar transformations of increments of spatial coordinates and time, which do not deny the existence of each other, but on the contrary harmoniously complement each other. After all, they mainly relate to different FRs of these increments in objects moving in one FR and at rest in another FR. Namely, these are well known to all the ordinary Lorentz transformations (OLT) related mainly to CFREU, and the considered here ordinary synchronization-compensation transformations (OSCT) related mainly to FRPW, in which the mutually proportional evolutionary reduction in the sizes of all objects of the Universe is fundamentally unobservable. In addition, the OLT and conformal Lorentz transformations relate mainly to the equilibrium (balanced) and quasi-equilibrium motions of matter, and the OSCT apply mainly to the motion of matter by inertia. During the directed and rotational inertial motions of cooling astronomical bodies in the FRPW, a coordinated combined application of these transformations of increments of spatial coordinates and time takes place.

4. Indeed, on the physically homogeneous scale of cosmological time all macro-objects of matter move uniformly in the process of their evolutionary self-contraction in CFREU (similar to the uniform motion of "inertial" FRs of the SR [26]) [22-24]. And due to the evolutionary decrease in the CFREU of the distances between the mutually motionless in the FRPW objects, there is an inherent to OLT blueshift of the centripetal radiation frequency (which is directed towards the center of evolutionary self-contraction of matter, which is also the center of its gravity).

5. Due to the unobservability in the FRPW of the evolutionary decrease in the CFREU of the sizes of all objects in the Universe, distant galaxies move away in the FRPW from the center of evolutionary self-contraction of matter, and the centripetal radiation from them has an inherent to OSCT redshift of its frequency [15,23,24,28].

6. It is precisely because of the inherent to OLT blueshift of the centripetal radiation frequency that OLT are not suitable for use in the FRPW. And therefore, the conclusions regarding the relativistic dilation of proper time of matter moving in a gravitational field by inertia should be considered false.

7. Only due to the conservation of the Newtonian of inert free rest energy and the Keplerian of ordinary rest energy of matter, and therefore, the absence of dilation of the proper time of this matter moving in a gravitational field by inertia, we have the correspondence of the gravitational acceleration of the motion of matter to Newton's gravitational law and the gravitational-kinematic invariance of the thermodynamic parameters and potentials of matter [6,22-24].

8. Only the invariance in time of the fundamental Hubble constant ensures the continuity of the spatial continua of rigid FRs [6]. Therefore, the conclusions about its variability based on both ignoring the absence of dilation of the proper time of galaxies and the improper use of the

luminosity distance (instead of metric distances) in Hubble's dependencies are incorrect. And therefore, the so-called dark energy is not needed in the Universe.

9. The intensity of the gravitational field depends fundamentally not only on the propagation speed of the electromagnetic interaction, but also on the distance of interaction of elementary quasi-particles, which during the motion of matter is significantly reduced due to the isotropic kinematic self-contraction of matter in the Euclidean background space of the CFREU [32].

10. The correspondence of OSCT to reality in the people's world is confirmed by the parameters of the motion of both stars in galaxies and planets in the Solar System, and therefore by the laws of Kepler and Newton [22-24].

11. The kinematic, as well as the gravitational deformation of micro-objects of matter is fundamentally unobservable in the FRPW and therefore, instead of it, it is necessary to use the comoving kinematic local curvatures of the space of the observer of the motion of matter.

12. The vacuum velocity of light (propagation of electromagnetic waves in space) in any FR and at any point of the gravitational field is a priori equal to the constant c and therefore is not subject to any transformations of velocities. After all, it is given in time, the rate of flow of which is determined by this very speed of propagation of electromagnetic waves. Only the frequency and length of electromagnetic waves are subject to transformation. And therefore, the gravitational field is a spatial distribution not of the speeds of propagation of electromagnetic waves at all, but of the frequencies of electromagnetic interaction between micro-objects of any identical motionless matter under standard conditions.

13. On singular surfaces, it is not the speed of propagation of electromagnetic waves that is zero, but the frequency of electromagnetic interaction in a hypothetical motionless and absolutely cooled matter. Therefore, the Hubble velocity of matter on the pseudo-horizon of the infinitely distant cosmological past can theoretically be equal to the constant of velocity of light.

14. Both the chaotic thermal motion of micro-objects of hot matter and the directed motion of matter itself compensate for the gravitational (gravity-quantum) deceleration of the flow of its proper time for all GTD-bound matter. Therefore, the change in the collective thermodynamic Gibbs microstates of all GTD-bound matter occurs with the same frequency, which determines the rate of flow of the unified gravithermodynamic (universal astronomical) time of this matter.

15. The gravitational field is only a manifestation of the spatially inhomogeneous thermodynamic state of matter. Before the breakup of the single gas continuum of the Universe, gravity (which is associated with the electromagnetic interaction of elementary quasiparticles) was completely absent in it.

16. The true value of the gravitational coefficient ("constant") is proportional to the square of the absolute temperature of the environment. Therefore, in the early (hot) Universe, the gravitational "constant" was significantly larger than Newton's gravitational constant.

17. The Universe exists eternally, and its further existence cannot be limited by anything. After all, the tendency towards zero dimensions of elementary quasiparticles in the CFREU is asymptotic.

The postulation of Universe stationarity in CFREU (as well as in Gold-Bondi-Hoyle theory [2,28]) causes principal impossibility of finiteness of its cosmological age in future, as well as in the past. Thus, the possibility of birth of Universe from "nothing" and its expansion into "nowhere" is excluded. Concept of Big Bang of Universe is based on using in cosmology instead of metrically homogeneous scale the exponential scale of "cosmological" time (ESCT), which requires mutually proportional continuous renormalization of all time intervals and is inverse to physically homogeneous scale of cosmological time (FHSCT) in CFREU. If by FHSCT in any moment of cosmological time singularity will be realized in future after the same time interval, then by ESCT in any moment of time of FRPW singularity is distanced from present into past for the same time interval, invariant only due to its renormalization.

Because of this, such conception substitutes infinitely long evolutionary development of the Universe by revolutionary event, which took place "not known where and not known inside of what". Rejection of it, however, doesn't deny the possibility of hot condition of matter at early evolutionary stages and other results in Universe evolution research, achieved by cosmology (only some remaking sense of these results is required). Moreover, this rejection leads only to metrical transformations of STC, which have no influence on sequence of cause and effect in evolutionary physical processes.

Despite this, use of metrically inhomogeneous exponential time scale in cosmology in most cases may be expedient, the same as the use of metrically inhomogeneous logarithmical time scale in physics sometimes. But we must remember, that cosmological singularity, born in this case, is fictive.

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Conflicts of Interest

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