A model of universe as harmonic oscillator with periodic and avoided singularities of the mass and energy density

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1 Construction of the universe U

There are two static points O_1 and O_2 (Fig. 1), where the Big Bang (BB) occurs periodically. Each point P of the Universe moves with velocity c on a circle with diameter $|O_1O_2| = R$. Let $l_1 = |O_1P| = R\cos(w\tau)$. The *inertial velocity* of this point toward the point O_1 is

$$(R\cos(w\tau))' = -Rw\sin(w\tau) = -c\sin(w\tau),$$

where $w = c/R$, and $w\tau = \angle O_2O_1P$ (Fig. 1). Indeed, by Lorentz contraction of the distance R by the factor $\sqrt{1 - v^2/c^2}$, we obtain the distance l_1. Symmetrically, let $l_2 = |O_2P| = R\sin(w\tau)$. The *inertial velocity* of this point toward the point O_2 is

$$(R\sin(w\tau))' = Rw\cos(w\tau) = c\cos(w\tau).$$

By Lorentz contraction of the distance R by the factor $\sqrt{1 - v^2/c^2}$, we obtain the distance l_2.

The BB periodically repeats at the points O_1 and O_2. When the point P passes through one of the BB points, the coefficient of contraction $\cos(w\tau)$ or $\sin(w\tau)$ is equal to 0 at that moment, but not permanently. The passing through a BB point does not mean the beginning of the Universe.

The Universe U can be described in the following way. Let S_1 be the sphere with centre at O_1, which passes through the point P and let S_2 be the sphere with centre at O_2, which passes through the point P. Then the intersection of these two 4D spheres is a 3D sphere with radius r, which is our Universe U. The non-constant radius r is the distance between each point P of the Universe to the line between O_1 and O_2 (Figure 1), i.e. $r = R\cos(w\tau)\sin(w\tau)$.

The time τ is related to the global time t in the universe which is the same at each point of the universe, and it does not depend whether the chosen point is moving or not. This global time depends on the angle $w\tau$.

We find the variation of the time in the universe. From the Lorentz trans-

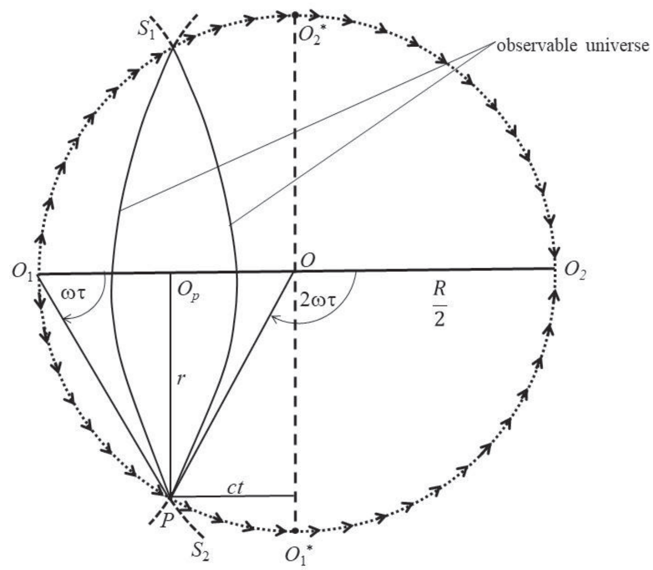

Figure 1: Our universe $S_1 \cap S_2$ and its periodical motion between O_1 and O_2.

formations with the formula for non-simultaneity we obtain

$$\delta t = t_2 - t_1 = \frac{t' + x_2' v/c^2}{\sqrt{1 - v^2/c^2}} - \frac{t' + x_1' v/c^2}{\sqrt{1 - v^2/c^2}} = \frac{v \Delta x'}{c^2 \sqrt{1 - v^2/c^2}}.$$

Using this formula one can prove that the time displacement with respect to the point O_1 is given by

$$\Delta t(O_1) = -\sin^2(w\tau) R/c.$$

Analogously, the time displacement with respect to the point O_2 is given by

$$\Delta t(O_2) = \cos^2(w\tau) R/c.$$

The total time displacement in the universe is their arithmetical mean, i.e.

$$\Delta t = [\Delta t(O_1) + \Delta t(O_2)]/2 = \cos(2w\tau) R/(2c),$$

which implies that the distance ct is the projection of the point P on the axis O_1O_2 and it changes periodically from $-R/(2c)$ up to $R/(2c)$ and back.

The relative speed of time is $dt/d\tau = -\sin(2w\tau)Rw/c = -\sin(2w\tau)$.

All quantities in the universe should depend on $\sin(2w\tau)$, or $\cos(2w\tau)$, or they are constants. So, if H_0 is a constant which is the minimal value of H, when $2w\tau = \pi/2$, we may assume that

$$H = H_0/\sin(2w\tau). \tag{1}$$

Since $rH = R\cos(w\tau)\sin(w\tau) \cdot H_0/\sin(2w\tau) = RH_0/2 = const.$, we assume also that $rH = c$, which means that $r = c/H$.

2 Construction of the temporal part U' of the universe

The 3D universe U can be called spatial universe. Although the time parameter τ changes, in this universe everything would be static. In order to exist motions, it is necessary to upgrade it like a bundle. Let a temporal space U' at each point P be attached as follows. In the plane determined by the points O_1, O_2 and P we choose two points O_1' and O_2' such that O_1O_2 and $O_1'O_2'$ intersect at a middle point O and $|O_1O_2| = |O_1'O_2'|$. These two points depend on the choice of P. Similarly as U is intersection of two 4D spheres S_1 and S_2, $U'(P)$ is also intersection of two 4D spheres S_1' and S_2' with centers at O_1' and O_2'. So the temporal universe $S_1' \cap S_2'$ is also 3D sphere. The total dimension of the universe is 8, because besides the 6-dimensional space $(S_1 \cap S_2) \times (S_1' \cap S_2')$, the coordinates t and r also have roles.

3 "Frozen epochs" where singularities are avoided

We introduce a hypothesis that there is a maximal admitted density, which will be called critical density ρ_c. Consequantly, there is a minimal admitted radius of the universe $r_{\min}$. This minimal radius of the universe is a consequence of the *maximal admitted density of matter* $\rho_{\mathrm{m}} = M_U/V$ *in the universe* (not in black hole). Close to the point O_1, when the point P should pass here, the radius of the sphere S_1 tends to 0. When the minimal radius of the universe $r_{\min}$ is achieved, the universe, or any point P of it, cannot be part of S_1, and also cannot be part of S_2, S'_1 and S'_2. Then the universe remains fixed, with constant values of r and constant value of the global time t. So, the global time t does not flow, and there are no motions, as everything is "frozen". So, this epoch can be called "frozen epoch". It seems like a static universe one time interval close to the BB occasion. This relatively short period ends when the two spheres S_1 and S_2 intersect again on distance $r_{\min}$. Then the universe begins to expand and the BB close to the point O_1 is avoided. Close to the point O_2 we have similar situation, and the BB point O_2 is also avoided.

The conclusions of this hypothesis are the following. All galaxies and clusters remain unchanged when the universe passes through both of these two time intervals. It is in accordance with the recent observations in the last few years by the 6.5-meter James Webb Space Telescope (JWST) that there are many well-formed very old spiral galaxies. It is much more then it was expected previously. The large quantity of dark matter is needed in order to avoid close distance between the galaxies and clusters close to the frozen epochs.

Similarly to the frozen epochs near the points O_1 and O_2, there are also frozen epochs near the points O'_1 and O'_2 for U'. The reason is the existence of a minimal value of the global temporal coordinate t, which corresponds to the *maximal admitted (critical) density of energy* $\rho_{\mathrm{e}} = E_U/(2\pi^2(ct)^3)$, where r and ct are related by $r^2 + c^2t^2 = (R/2)^2$. It was used here that the energy, for example electromagnetic, transmits with velocity c during a limited time t and the corresponding volume in the "temporal space" which is also 3D sphere is $2\pi^2(ct)^3$. These 4 frozen epochs near the points O_1, O_2, O'_1, and O'_2 are common for both U and U'. The parameter τ and also the global time t depend on the quotient (density of mass):(density of energy) in the universe. The change of this quotient which is different than the cosmic quotient, leads to time travel. As a conclusion we obtain that a point P moves periodically in interval, for example $[1^0, 89^0]$ instead on the whole circle.

4 Our present position in the universe

Now we are able to find the angle $w\tau$ at the present epoch. We use that the observations show that the radius of the Universe is 46.5 billions of light years. Since the speed of time is $\sin(2w\tau)$, the observable radius of the universe as a semicircle is $\pi c/H$, and so

$$\frac{\pi c}{H} = \sin(2w\tau)c \cdot 46.5 \cdot 10^9 \text{yr}, \tag{2}$$
$$\frac{\pi c}{H} = \sin(2w\tau) \cdot 3.37\frac{c}{H},$$

and hence $\sin(2w\tau) = 0.9322225$, and $2w\tau \approx \pi - 1.2$.

Let us denote by T the full period of time together with the four frozen epochs, with respect to the present speed of time. Starting from the proportionality

$$1.2 : (2\pi) = 13.8 \times 10^9 \text{y} : T,$$

we obtain $T = 72.256 \times 10^9$ years. A quarter of this period $T = 72.256 \times 10^9$y is equal to $T/4 = 18.064 \times 10^9$y. It means that after $18.064 - 13.8 = 4.264$ billions of years, the universe will be close to the temporal BB points O'_1 or O'_2. Note also that the circumstances for the life in the universe depend on the global time t. The worst position for life development in the universe is close to the spatial frozen epochs O_1 and O_2, because of the dense matter. The best position for life development in the universe is close to the frozen epochs O'_1 and O'_2, and these epochs can be called "Heaven", full of dense energy.

These comments from the previous sections suggest that there exist two parallel universes: one for global time t, which is denoted by U_1, and one for global time $-t$, which is denoted by U_2 (Fig. 2). They do not have the same space position. We can observe only one of them, where we belong, but we are not able to observe the other universe. These two universes have equal mass and they are in equilibrium. They are symmetric with respect to the central point O.

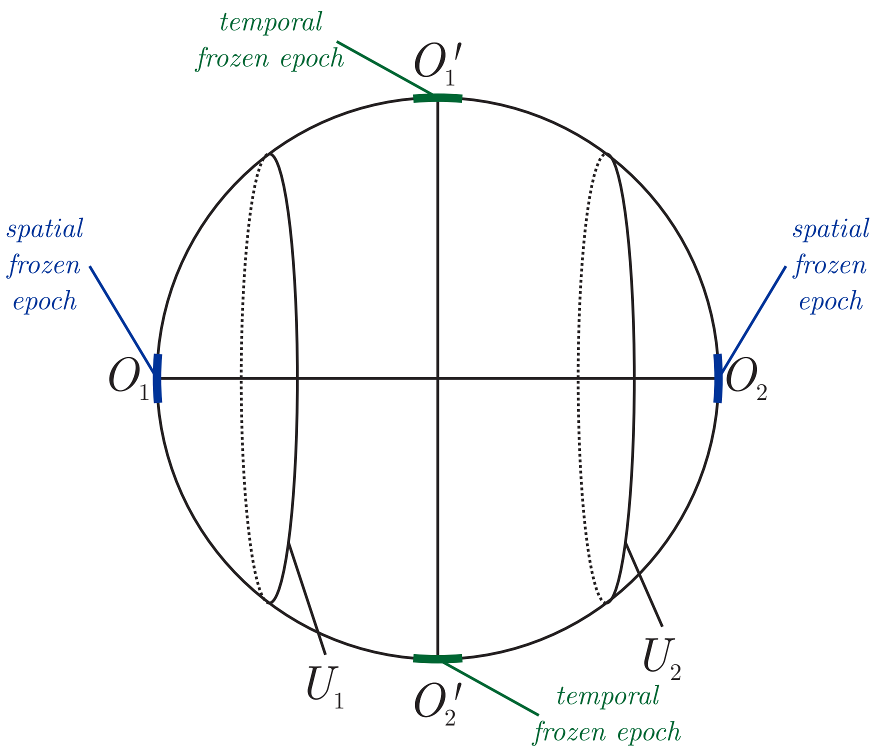

Figure 2: The two parallel universes U_1 and U_2.

Let us determine the mass of the observable universe which is half of the total mass M. We start from the equality from the gravity ([2]) $\frac{GM}{rc^2} - \frac{1}{\sqrt{1-v^2/c^2}} = const$. In our case the constant is 0, $v = c\sin(w\tau)$, $r = |O_1P| = R\cos(w\tau)$, M is the total mass of the universe, observable and non-observable because the diameter R is determined by the total mass inside, G is the constant G_0, which corresponds to $2w\tau = \pi/2$. Since $G_0 = G/\sin(2w\tau)$, the total mass is equal to $M = 3.516 \times 10^{53}$ kg. So, the observable mass is 1.758×10^{53} kg, while the estimated mass of the observable mass by NASA is about 1.5×10^{53} kg.

5 About the time travel

There exist two different types of time travel, where the global time t changes in different way than the global time in the universe:

i) the angle $2w\tau$ changes quickly in positive of negative direction, while the distance $R/2$ to the center O remains unchanged, and

ii) the angle $2w\tau$ remains unchanged, while the distance $R/2$ changes.

In case i) when a time traveler begins its "journey", it changes the quotient (density of energy):(density of mass) in different way than it naturally occurs.

The case ii) is based on the following argument. The time traveling particle (or body) should be able to change its local gravitational potential for ΔV as it has changed the position in the gravitational field, but, the change of its gravitational potential ought to be without a change of the position in the gravitational field. Then it will be time displaced for $\Delta t = (\Delta V)/(c^2 H)$. This is true, because after small time Δt the speed of time will be multiplied by ([4, 5]) $1 + \Delta t H = 1 + (\Delta V)/c^2$, which is true according to the standard knowledge about gravitation. If its speed of time is increased, then it will travel in the future, and if its speed of time is decreased, then it will be translated in the past. The time travel particle can stay on distance different from $R/2$ by using some energy, because it is attracted toward the surface with radius $R/2$ (Fig. 1).

6 Schwarzschild sphere

For the sake of simplicity we will consider the metric far from the massive bodies, because close to the massive bodies we have the theory of gravitation. Inside the universe, locally it may appear additional time parameter t, as a consequence of the local gravitational potential. This time parameter is delivered through the motion, locally, for example, by the sinusoidal motion of our Solar system with respect to the galactic plane. This motion of the Solar system influences increasing or decreasing of its own energy, which results in flow of time related to another physical phenomena. The variations in the speed of time for the local time (as in gravitational field) cannot be used for the so called time travel. The change of the Hubble constant is related to the global galactic time, while the average change in periods of the local cyclical phenomena (ex. the duration of year) is related to this local time. For another star in arbitrary galaxy, the local time would be different. The local time t is a function of the global time and the spatial coordinates, but the global time does not depend on the local time t. In this section we will neglect the global time, i.e. we assume that $w\tau = const.$ and we will consider only the change of the local time t. Consequently far from the massive bodies, there is no time flow and so, we should have $g_{44} = 0$. In general, $g_{44} = -u^2$, where $u = 1 - \frac{GM}{rc^2}$ and r is the radius of the Universe. Later we will use that it is essential that $d^2u/dr^2 = 0$. So, $du/dr = 0$ means that u does not depend on the angle $w\tau$, and it is satisfied since $u = 0$ when there is no time travel.

The mass of the Universe can be found from $u = 0$, and so, $c/H = r = GM_U/c^2$, i.e. $M_U = c^3/HG = 0.88 \times 10^{53}$kg. Note that this mass is half of the determined mass 1.758×10^{53} kg from the previous section, because half of that mass is only mass and the other half is in form of energy Mc^2. Since there is a singularity in the time ($g_{44} = 0$), our Universe as a 3D sphere is indeed Schwarzschild sphere. This singularity may be avoided in case of time travel of type ii), where $g_{44} \neq 0$.

7 Metric in the universe U and the temporal universe U'

Although the time t disappears on the Schwarzschild sphere, it appears outside the Schwarzschild sphere and also close to the stars. In the universe U we have 3 spherical coordinates θ, ϕ, ψ (considered as spatial), one radial coordinate r and singular temporal coordinate t. In order to find the curvature scalar, we start from the spherical symmetry in the general form

$$(ds)^2 = a(dr)^2 + r^2[(d\theta)^2 + \sin^2(\theta)(d\phi)^2 + \sin^2(\theta)\sin^2(\phi)(d\psi)^2] - b(cdt)^2, \quad (3)$$

where on the Schwarzschild sphere it is $b = 0$. The Levi-Civita connection leads to the following curvature scalar

$$\mathcal{R} = -\left(\frac{b''}{ab} - \frac{(b')^2}{2ab^2}\right) - \frac{b'}{b}\left(\frac{3}{ar} - \frac{a'}{2a^2}\right) - \frac{6}{ar^2} + \frac{6}{r^2} + \frac{3a'}{a^2r}, \quad (4)$$

where differentiation refers to r. The density should not depend on the temporal part of the metric, which means that it does not depend on b and its derivatives. Since the density is proportional to the scalar $\mathcal{R}$, so the curvature scalar $\mathcal{R}$ should not depend on b and its derivatives, and according to (4) it must be i) $\frac{b''}{ab} - \frac{(b')^2}{2ab^2} = 0$ and also ii) $\frac{3}{ar} - \frac{a'}{2a^2} = 0$. Specially, on the Schwarzschild sphere the dimensionality is 4 with coordinates r, θ, ϕ, ψ. The condition i) is satisfied, since $b = u^2$ and we obtain $\frac{b''}{ab} - \frac{(b')^2}{2ab^2} = 2\frac{u''}{au} = 0$, because u'' is identically 0 on the Schwarzschild sphere (since there it is $u = 0$), while u is close to 0 near the Schwarzschild sphere. The second condition ii) implies that $a = Cr^6/r_0^6$ where on the Schwarzschild sphere it is $r = r_0 = R\cos(w\tau)\sin(w\tau)$. This manifold parameterized by r, θ, ϕ, ψ, t becomes Einstein manifold for $C = 4$ and $b = 0$. Probably this is the reason that the material part of the Universe is just on the Schwarzschild sphere, where $b = 0$. By plugging $C = 4$ into (4), we obtain $\mathcal{R}_{\mathrm{s}} = 3\frac{r_0^6}{r^8} + \frac{6}{r^2}$. On the Schwarzschild sphere $r = R\cos(w\tau)\sin(w\tau)$ for the curvature scalar we obtain

$$\mathcal{R}_{\mathrm{s}} = \left(\frac{6}{R\sin(2w\tau)}\right)^2. \quad (5)$$

In case of the temporal universe, instead of length coordinate r we have temporal coordinate t, and conversely. So, in this case we have the following coordinates $v_x/c, v_y/c, v_z/c$, which are related to the velocities at a chosen point, and one temporal coordinate t which takes value between $-R/(2c)$ and $R/(2c)$, while the length coordinate r is singular. In spherical coordinates the values $v_x/c, v_y/c, v_z/c$ will be written as $v_\theta/c, v_\phi/c, v_\psi/c$. Analogously to (5) in this case we have

$$\mathcal{R}_{\rm t} = \left(\frac{6}{R\cos(2w\tau)}\right)^2. \qquad (6)$$

According to (5) and (6) we obtain $\frac{1}{\mathcal{R}_{\rm s}} + \frac{1}{\mathcal{R}_{\rm t}} = \left(\frac{R}{6}\right)^2$.

8 Cosmic redshift and Cosmic Microwave Background radiation

The relative speed of time in the past or in the future, compared with our present time, is just the Doppler effect, where instead of v/c we should take $\Delta t H$. By using the relativistic formula for the Doppler effect, the relative speed of time after local time Δt starting from the present time is

$$\sqrt{\frac{1+H\Delta t}{1-H\Delta t}}$$

The observer is at the present time. The previous formula is supported by the following examples.

Example 1. When the age of the universe was about one billion of years, then the speed of time was $\sqrt{\frac{1-12.8\cdot 10^9\text{y}\cdot H}{1+12.8\cdot 10^9\text{y}\cdot H}} \approx 1/5$, i.e. 5 times slower. This result the astronomers have experimentally verified by observing many old quasars ([6]).

Example 2. The accelerated speed of time in the Universe, besides the cosmological red-shift, causes also change of the orbital period of the binary pulsars ($\dot{P}_{\rm b} = \frac{1}{3}P_{\rm b}H$), which well fits with the experimental measurements [4].

Now we give approximation of the length of the "frozen epoch". Let us assume that the maximal value of z is 20.4 (F200DB-045 from JWST). It means that

$$21.4 = 1 + z = \sqrt{\frac{1+H\Delta t}{1-H\Delta t}},$$

where Δt refers from the end of the frozen epoch until now. The previous equation leads that $\Delta t = 0.99564/H$. Hence half of the frozen epoch is about $(1 - 0.99564) \times 13.8 \times 10^9$ yr $= 60 \times 10^6$ yr. The total length of the frozen epoch is about 120 millions of years. It is easily to obtain that the angle $2w\tau$ changes in the interval $[0.33^0, 89.67^0] \cup [90.33^0, 179.67^0]$. Since the speed of time is not a constant, these 120 millions of years refer to the present speed of time in the solar system. If the maximal value of z is larger, then the length of the frozen epoch will be shorter.

The CMB radiation is a consequence from the scalar (or Tesla) waves. These waves can be considered as magnetic field in the temporal direction and they are radiated by the photons together with the electromagnetic field [3]. The property that the scalar waves are transmitted immediately (not with velocity c) can give explanation of the CMB radiation, since the small averaged temperature in the universe (2.725K) refers just to the present time. Thus the CMB radiation is not related to the BB effect. The fluctuations in the CMB radiation suggest that they do not come from one (singular) point, but from the whole observable universe.

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